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Roberto Buonanno

The Stars of Galileo Galilei and the Universal Knowledge of Athanasius Kircher

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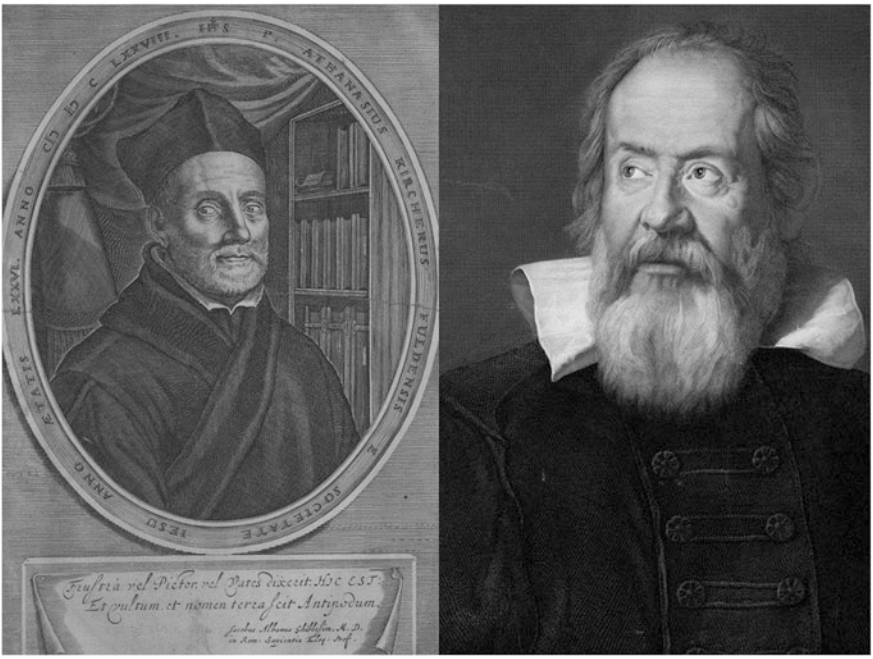

Athanasius Kircher and Galileo Galilei as mature men (Kircher's portrait in G. de Sepi, 1678, *Romani Collegii Societatis Iesu Musaeum Celeberrimum*, Janson-Waesberg, Galileo's one at http://www.illaboratoriodigalileogalilei.it/galileo/iconografia/ico_ver/cronol/cronol.html)

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The Stars of Galileo Galilei and the Universal Knowledge of Athanasius Kircher

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Although a certain number of historical texts quoted in this book are mostly available online, I often choose to quote the original passages in the footnotes. This helps interested readers to find the meaning of the quote at once, without breaking off reading

To my early student

Contents

Introduction

Light and shadow of the seventeenth century. This metaphor is often used as an allusion to the contradictions of a century which was responsible not only for the burnings at the stake and forced denials of astronomical observations, but also for a meaningful, enlightening art, as commissioned by princes of the Church and powerful men, who were fascinated by the beauties of the very world they ruled.

Revolutionary thought caused condemnations to the stakes, but also paved the path to the creation of a totally new idea of art. More than ever before, in the seventeenth century, the way of thinking has been at the same time clear-headed and contradictory: in a word, dramatic.

In this century, philosophers, scientists, artists, religious and powerful men realized they were at a crucial crossroads: on the one side was the reassuring subordination of new discoveries to the references in the Holy Scriptures; and on the other side, loomed a complete reversal of a comprehensive view of the world and of human life. The background was constituted of progress, astronomical discoveries, Martin Luther's theses, Reformation and Counter-Reformation, which had paved the way to Science, as well as to a renewal of philosophic thought, which the Church sought to control and rule, in vain.

Galileo, for instance, kept saying that sensible experiences alone could interpret natural phenomena. However, if you want to reduce the conflict between Galileo and the Church to opposing factions, one right and the other wrong, you would be surprised. These kinds of surprises enrich the historical scene, thus giving particular shades to the drama, inasmuch as Galileo appears as a self-confident winner, just when he is about to give in.

In the background, we can see interesting characters, such as laymen, Jesuits, missionaries, who bring experiences from another world. These are remarkable men, who tend to take into consideration all scientific discoveries, and would like to discover something themselves, in order to show the grandeur of God and of the world, as framed in a perfect, pre-established order.

They were all thrilled by a sense of wonder.

Perhaps Galileo might easily have saved himself. After all, he was a man of faith as well, but he was even more convinced that Science could not obey the authority of the Holy Writ.

The Jesuit Athanasius Kircher was also an actor on this historical stage. He was a real master of lights and shadows, as well as an indefatigable researcher, an

inventor, who loved reality and played with it, who believed in God and in Science. He was certainly not a follower of Galileo, but rather a complementary character.

Galileo and Kircher, though different from each other, if taken together, help us understand a century which paved the way to contemporary knowledge.

We know almost everything about Galileo, if we may say so about such a complex scientist and thinker. His limpid, fascinating style, his clear demonstrations, and his ability to admit he could be wrong—all these elements well introduce his character to us. A few doubts are left about why he recanted his findings, as well as about other moments of his intellectual life.

These are doubts about faith and about what kind of human, abstract, or mathematical language the Creator would use. These are the doubts of a scientist who keeps searching, thinking, teaching, and talking with other philosophers. Galileo was also a man adored by one of his daughters, and almost ignored by the other. Light and shadow.

As far as Kircher is concerned, we know many strange, curious, incredible, and fascinating details of his life. He is a priest who entered the Society of Jesus and a peculiar scientist, who is in love with everything he sees and with everything he thinks he sees. He is obsessed with collections, and enjoys his own experiments. He is an inventor who, at times, believes so much in his own judgment that he considers an experimental check useless. If you really are a genius, can you allow yourself to do this? You certainly can, if the ultimate goal is the astonishment you feel for the miraculous, unquestionable proof of God's intelligence. This was probably what Athanasius Kircher was thinking as he organized his own museum, as he let himself down in the bowels of the Earth, as he recreated, measures ready, Noah's ark.

His life was full of journeys and unremitting studies, criticism and praise, pain and hard work. And yet, he had the pleasure of showing that God had thought about everything! The world was a marvel! Where God cannot be seen, He can be imagined, by reading the Holy Scriptures. Better still, the wonders of His creation can be painted in the beautiful illustrations of Kircher's books.

The universe has its own music, as well as its own language, endowed with rules, through which we can understand and interpret an unknown language. For instance, we can decipher Egyptian hieroglyphs, and read absent signs too. Kircher's fanciful interpretation of this mysterious writing tells us a lot about this Jesuit's culture and dreams. In Kircher's view, the marvels of the world are not only an object of devotion, but also of fetishism and enthusiasm.

While, on the one hand, both scientists and inventors often showed a dangerous heedlessness and effrontery, on the other hand the Church appeared very careful, and ready to welcome new, disruptive theses only if they agreed with the Holy Scriptures.

Since theology is not a superstition, but rather a line of reasoning, complete with proofs, none of the scholars of the Collegio Romano, though stubbornly defending the principles of faith as taken from the Holy Writ, felt capable of denying the evidence of new discoveries and the cogent value of scientific

disquisitions. This mood was common to Cristoforo Clavio, who had followed the path of Galileo since his youth in Pisa, as well as to Roberto Bellarmino, a tormented inquisitor, but also a careful investigator into the results of Galileo's research.

The general attitude was certainly not obscurantism or the opposition to enquiry or reform, but rather a defense of established faith, as well as worry for the handling of novelties in front of a mass of people who—then and even now—were asking certainties from faith, while offering devotion and obedience. On the other hand, the Science which originated in that century—as well as Galileo's discoveries—were caused by doubt, by the chance of bringing all up for discussion in order to obtain a proof.

We are still far from a management of Science subject to the needs of humankind, and from a redeeming philosophy. However, at the crossroads of the seventeenth century, this path had been opened, and the Church was well aware of it.

Chapter 1
The World Theatre

> *"Copernicus, I tell you, Don Eligio, Copernicus has ruined mankind beyond repair. Since his day we have all come gradually to realize how unutterably insignificant we are in the whole scheme of things – less than nothing at all…"*
>
> Luigi Pirandello, *The Late Mattia Pascal*, 1904
>
> ("*Copernico, Copernico, don Eligio mio, ha rovinato l'umanità, irrimediabilmente. Ormai noi tutti ci siamo poco a poco adattati alla nuova concezione dell'infinita nostra piccolezza, a considerarci anzi men che niente nell'Universo…*", translation by Arthur Livingston, in http://gutenberg.net.au/ebooks03/0300381.txt, chapter II)

"That is so: the Lord made us live in a complex, but well-ordered world. The richness of the world's beauties corresponds to the order He wanted to instill in Nature, an order which our progenitors in Heaven knew well, but has been lost afterwards. Only in Rome will I be able to find the faded traces of this primordial knowledge and, with the help of God, I will try to rebuild it. The enchantment of knowing everything: it is never too hard to pursue such a wonderful goal…" Thus would probably meditate Father Athanasius Kircher as, in the Fall 1633, the ship he was embarked on was approaching Civitavecchia.

His journey from Marseille had really been unforgettable, but Athanasius Kircher was used to mishaps and miraculous rescues since his childhood. Once, as a young boy, he had been trampled by the hoofs of horses taking part in a competition, yet he had got off without scratches. On another occasion, he lost his way in the woods and had wandered about for days and days, just like Thumbling and then, by chance, had been found by local farmers. At 15 years of age, as he was skating on an iced lake, his feet started freezing. This happened in 1617, and Kircher risked an amputation, if the Virgin Mary had not interceded on his behalf in a dream.[1]

Kircher, a young Jesuit scientist who only wanted to spend his life studying and researching, happened to live in an age of conflict with Lutherans, so that divine assistance was indispensable for him. He had realized this in 1623, when he had had to move from the University of Koblenz to Heiligenstadt, and had come across a patrol of lansquenets, who hated all Catholics–Jesuits in particular. In fact, they could not believe they had actually caught a follower of Ignatius from Loyola and,

[1] A. Kircher, 1684, "*Vita Reverendi Patris Athanasii Kircheri Societatis Jesu*", Archivium Romanum Societatis Jesu, Cat. N. 18-A-55962. Translation in Italian by F. De Luca "*Vita del Reverendo Padre Athanasius Kircher*", La Lepre ed., 2010, p. 27.

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after a mock trial against the whole Jesuit Order, they had decided to hang him. Father Athanasius himself reports that he started praying, and he was invoking the Virgin Mary while they were putting a slipknot around his neck. Perhaps those soldiers were impressed by the faith shown by the young Jesuit, or else, because of a celestial intervention, the execution was suspended, and they freed him, after giving him back some of the money they had previously stolen.

Ten years later, the journey towards Rome still showed Kircher the special protection he could count on. Together with his Jesuit brothers, he had spent about 10 days on a ship from Marseille to Genua, since two storms had forced the galee sent by the Pope to stop and look for shelter. Once sailed from Genua, yet another storm had diverted them towards Corsica. Only after an unexpected northwest wind broke out, did they manage to reach Civitavecchia. They finally moored here, on the verge of a shipwreck.

As from the report of Father Athanasius in his autobiography, it seems that he was not really worried about these mishaps, probably because he was used to them and was comforted by faith, but also because his book was published many years later, when the details had faded in his memory, and he only remembered the heroic part of his life. The real danger, according to his autobiography, was the possible transfer to Wien, at the court of Emperor Ferdinand II, as his "Imperial Mathematician", a role which had been left vacant after the death of Johannes Kepler. This task, in fact, would have introduced him to court life, thus preventing him from cultivating the studies he was interested in. This perspective was even more depressing for him, since he was going to realize the dream of his life, namely getting to Rome, though only fleetingly. There he would be able to see the relics of ancient wisdom, in particular, the secrets of the many hieroglyphs which could be found in Rome.

Passing through Rome in his journey from Avignon to Wien certainly is a peculiar choice. However, in a period of strong religious contrasts, during the 30-year War, the direct route would have been dangerous for a Jesuit. Besides, since he had this chance, Father Kircher would have never missed the opportunity to pay a visit to the city which Galileo had defined "the world's theatre".

Pope Urban VIII had decided to abandon the self-punishing attitude of the grass roots Counter-Reformation and promoted a sense of pride for a city which was so full of history and beauty; Caravaggio had already left his imprint there, while—in those same years—Bernini, Borromini, and Pietro da Cortona had started to shape Rome anew. Therefore, it is no wonder that Kircher, once arrived, immediately started to dream of a few plans to be realized if he had been able to stay in Rome.

We must say that he had been preceded by letters of introduction, written by Nicolas-Claude Fabri de Peiresc, a French scholar who was in contact with other scholars all over Europe. Peiresc had sent these letters to Cardinal Francesco Barberini, nephew of the Pope, as well as to Cassiano del Pozzo,[2] who Kircher

[2] Nicolas-Claude Fabri de Peiresc to Cassiano del Pozzo, 10 September 1633, and to Cardinal Barberini (same date) quoted in D. Stolzenberg, 2013, *Egyptian Oedipus: Athanasius Kircher and the Secrets of Antiquity,* University of Chicago Press, p. 79.

wanted to meet, because he belonged to the "Lincei" circle. This was a group of young scholars, who had gathered around Prince Federico Cesi: among them, we count Galileo Galilei, who was particularly proud of belonging to this circle, so much so that he gave the prince an *occhialino* (small eyeglass) he had built himself, probably hoping that this instrument could help him understand the microscopic world, just as the *occhiale* (telescope) had helped him understand the heavens.

The young Jesuit was particularly fascinated by Cassiano's *Museo Cartaceo* (*Paper Museum*) in Via dei Chiavari, at a walking distance from Piazza Navona, where he had collected drawings by various Renaissance artists, reproducing the antiquities of Rome, pastoral landscapes, studies of animals and plants. He had also collected a great quantity of accurate pictures of mushrooms and exotic birds which, in a period in which photography had not been invented yet, aroused lively interest in the general public.

The Museum of Cassiano del Pozzo probably made Kircher think of realizing an even more ambitious project, a "World Museum", namely a collection of historical documents, inventions and human as well as natural creations—in short, evidence of the whole universe.

The letters of introduction, which an influential person like Peiresc had sent to both Cassiano and Francesco Barberini, were not "standard" letters; they were full of embarrassing praises, expressions of the wish of the French scholar that Kircher could stay in Rome and carry on his studies and research. Indeed, while introducing the young Jesuit, Peiresc writes "[while declaring myself] *your servant, and admirer of his genius and worth, which is much greater than the average, as* [your Excellency] *will realize when you first meet him, over and above his noble-mindedness, and his genius, which enabled him to gain an insight into the secrets of Nature and the ancient times, as well as to learn the main languages of the Christian world.*"[3]

Actually, all this enthusiasm cannot be fully comprehended, because Peiresc did not have a particular reason to be grateful to the young German priest, who had left France without keeping his promise to reveal the key to the Egyptian hieroglyphs, which he claimed he had discovered. However, they shared a passion for the ancient Egyptian culture, following the sixteenth century Neoplatonic tradition, so that they both aimed at forging ahead this enterprise. As a consequence, the French scholar often bordered on naivety, while the German Jesuit was so sincerely involved in these studies, that he lost sight of the necessary critical evaluation of his sources.

In fact, Kircher is convinced that the Egyptian culture derives straight from Adam, the first man who, even after being thrown out of Heaven, had maintained the wisdom the Lord had given him and, through his son Seth, had passed it on to

[3] N. C. Fabri de Peiresc, 1633, *Letter to Francesco Barberini,* 10 September 1633, quoted in D. Stolzenberg, 2013, *op. cit.* p. 79,"[dichiarando me stesso] *suo servitore intrinseco, et ammiratore del suo Genio et del suo valore, molto maggiore di quelli che si veggono d'ordinario* [e che V. Eccellenza] *riconoscerà sin dal primo aspetto della sua persona, et nulla dimeno quella magnanimità, acutezza d'ingegno, che gli hanno fatto penetrare tant'avanti, nella scoperta di molti secreti, così della natura, come dell'antiquità, et delle principali lingue della Christianità".*

the patriarchs, until Henoch, according to the tradition, who had passed it on, in turn, through various secrets.[4] Henoch generated Methuselah, who, in turn, had a son, Lamech, the father of Noah. The latter, who had survived the Deluge together with his family, had passed on the knowledge he had inherited from his ancestors to his children. One of them, Cham, once arrived in Egypt, had delivered this divine knowledge to Moses, as well as to the priests, who knew Nature's mysteries. The deep knowledge of things which, according to Matthew's Gospel, have been *"hidden since the world's foundation"*, must be transmitted to the initiates only and hieroglyphs are used to communicate secret truths to those who can interpret them. According to Kircher, the key to interpret this writing lies in the fact that it expresses concepts, not mere words.

His plan is difficult, but the young Jesuit is convinced that, since he knows twenty-three languages very well and the Lord has always assisted him, he can try and translate the writing of the ancient Egyptian scholars. The chance to stay in Rome a little longer is indispensable to this aim, since it is the only place where he can directly examine the hieroglyphs of obelisks, as well as the ones of the *Mensa Isiaca,* which were brought to Rome at the time of the Roman Empire.

The obelisks, according to Kircher, constitute the main finding which can help him undertake the study of hieroglyphs, since Egyptian priests had initially thought of passing on their mysteries by carving in the pyramids' sides. Later on, however, they had realized that, due to their obliqueness, they were not an ideal writing surface, so they chose obelisks instead.[5] This explanation—partly logical, partly pure fantasy—is a typical example of this recurring ambivalence in the life of Father Athanasius.

A fixed point of reference along the intellectual path of Kircher is his unshakeable faith in the Holy Writ as a sort of map of knowledge: even the content of hieroglyphs should be retraced there. The proof which Kircher finds is the letter written by Saint Paul to the Corinthians, where he refers to the mysterious divine knowledge, "*which has been left hidden, but pre-ordained by God before the centuries, for our own glory*".[6]

Moreover, Kircher is convinced he has important documents, such as news from ancient Greek historians, and even a mysterious essay, the so-called *Barachias Nephi,* which illustrates a method for interpreting Egyptian hieroglyphs. Unfortunately, Kircher's plan is ahead of its time, since the Rosetta's stone had not been found yet, and, without concrete references, the Jesuit scholar is forced to trust improbable sources, and finds a dead end, even though he does give his contribution to the future interpretation of the hieroglyphs by identifying its structural similarity with the Coptic.

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[4] Quoting D. Stolzenberg, 2013, *op. cit.* p. 136, "*The elements of this narrative are scattered and repeated in numerous places in Obeliscus Pamphilius, 2–32, 79–88, and Oedipus Aegyptiacus II.1, 42–80, II.2, 142–50.*"

[5] A. Kircher, 1650, *Obeliscus Pamphilius, hoc est, interpretatio Nova…,* Roma, Typis Ludovici Grignani, digitized by ECHO.mpiwg-berlin, p. 45.

[6] St. Paul, *Letter to the Corinthians,* 1, 2–7.

The failure of the enterprise of Father Athanasius is due not only to his unreliable sources, but also to his being charmed by mystery. This weakness brings him to trust news which are related more to dreams than to history. Kircher is interested in Hermetism, in particular in Hermes Trismegistus, a mythical author, already studied in the framework of magic and alchemy, whose name itself—Trismegistus—is subjected to interpretation. Indeed, literally, it means "three times big", but it can also be identified with three different characters, namely Henoch, Elijah and an Egyptian post-deluge king. Kircher is convinced that the *Corpus Hermeticum*, the text which is attributed to Hermes, is founded upon *prisca teologia,* namely on the wisdom which Moses handed down to the Egyptians. This wisdom gave life to the Holy Writ, the only possible means of expression of the mysterious nature of divine knowledge. Even though the *Corpus Hermeticum* and the credibility of Trismegistus have been a moot point since the start of the seventeenth century, the Jesuit scholar is sure he can refute these statements and keeps thinking that hieroglyphs are a sort of writing used in order to transmit divine knowledge. Naturally, this writing "*is different from everyday writing, namely letters, words and certain parts of our speech. Hieroglyphs constitute a far better, sublime writing, which is akin to abstract minds, as well as to the intrinsic nature of things, and therefore transmits the sense of hidden natural mysteries*".[7]

This statement, enriched by an exceptional, polyhedric learning, produces a technique for the interpretation of hieroglyphs, which Kircher proposes after years and years of study: "*first of all, we should accurately copy down individual hieroglyphs. Then, we should indicate suitable actions for each figure, that is to say, the transformation of pictures; finally, we should add the mystical meanings of each sign…*".[8] This approach justifies the final liberating outburst of the Jesuit scholar "*In the name of the immortal God, how many different paths we had to try beforehand! What a huge sea of secrets did we overcome! We had to fight against innumerable monsters and prodigies!*"[9]

If Kircher manages to study the hieroglyphs for so many years, a subject that could not be interpreted at the time, this is largely due to the letters of introduction written by Peiresc. These letters, indeed, reach their goal, since they convince Francesco Barberini to solve the matter of the court mathematician with the

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[7] A. Kircher, 1636, *Prodromus Coptus sive Aegyptiacus,* S. Congregazione de Propaganda Fide ed., Roma, digitized by ECHO.mpiwg-berlin, p. 260-261, CAPUT ULTIMUM. *"…Scripturam enim hanc quandam esse certum est, non eam quidem, quam ex literis, verbis, nominibus, certisque orationis partibus composita, nos plerunque utimur. Sed multò excellentiorem, sublimiorem, & abstractis mentibus viciniorem, qua integra saepe numerò ratiocinatio rerumque altissimarum conceptio, aut insigne aliquod in naturae aut divinitatis sinu delitescens mysterium…*".

[8] A. Kircher, 1650, *Obeliscus Pamphilius, op. cit.*, p. 391 *"…primo, singula ordine hierogrammata occurrentia suis nominibus exprimimus. Actiones figurarum, seu imaginum trasformationes indicamus; deinde singulorum mysticas significationes adjungimus…*".

[9] A. Kircher, 1650, *Obeliscus Pamphilius, op. cit.*, p. 92, *"sed pro Deum immortalem: quanta nobis his adita tentanda: quam immensus rerum reconditarum Oceanus nobis superandus! Cum quot monstris et portentis confligendum!…"*.


ATHANASII KIRCHERI Soc. JESU
ARS MAGNA SCIENDI
Sive
COMBINATORIA
Alphabeta Artis
AMSTELODAMI 1669.

◀ **Fig. 1.1** *Ars Magna Sciendi sive Combinatoria*, Frontispiece (from A. Kircher, 1669, *Ars Magna Sciendi…,* Amstelodami, Apud Joannem Janssonium a Waesberge, Viduam Eliz. Weyer). *Divina Sophìa* emanates the rays of knowledge, which dispel the mist of ignorance and shows the universal alphabet of knowledge, from which, according to the rules of the combinatorics of Raimond Lull, we can infer the key to understand the Cosmos. We can learn through the human senses, indicated with an eye and an ear. The ornaments under the central scroll indicate the rules which enable to reach knowledge: Reason, Exercise and Experiment. The Sciences indicated in the central swag, namely Theology, Metaphysics, Physics, Logic, Medicine, Mathematics, Ethics, Esthetic, Law, Politics, Interpretation of the Holy Scriptures, Controversy, Moral Theology, Rhetoric and Eloquence, emanating from Divine Wisdom, are unified by Kircher into one Universal Science, according to the combinatorics explained in the text. At the foot of the throne, we can see an inscription, which sums up the meaning of the book: "*Nothing is more beautiful than the knowledge of everything*"

Emperor by sending him Christoph Scheiner, the author of *Rosa Ursina*, Maths teacher at the Collegio Romano and fierce enemy of Galileo. In this way, he enables the young Athanasius Kircher to stay in Rome.

There is an outstanding detail in this matter. Of course, a scholar such as the young German Jesuit, who is interested in Astronomy and Cosmological systems, should know all of Galileo's works. However, Kircher never mentions the name of Galileo, who as fallen into disgrace—until his late books, more than 20 years after the sentence of the Holy Office. We can imagine that, just after the sentence, Kircher wisely chose to appear mainly as a scholar of Eastern languages, thus understating his interest for Astronomy. However, if the Jesuit scholar ignores so tenaciously Galieo for such a long time, we may think that his motivation is neither the prudence nor—in case—a simple dislike. We should also mention Galileo's indifference towards Kircher, who, since the end of 1630, has become a reference figure in the local scientific community, and was therefore often mentioned by his correspondents.

Probably, the two scholars did not mention each other because they, respectively, represented two worlds which simply could not communicate. Galileo had expressed the concepts which inspired him when, while talking to the Maths teacher of the Collegio Romano, Orazio Grassi, had clearly written that Nature is a big book "*which is always open before our own eyes (I am talking about the Universe). However, we cannot understand it unless we first learn its language, and its writing. Indeed, it is written in a mathematical language, and its letters are triangles, circles, and other geometrical figures. Without them, we cannot possibly learn a word; without them, we would be wandering aimlessly in a dark labyrinth*".[10] It is true that triangles and circles are only approximations of a complex reality. As a consequence, the world we get to know through experiments is a

[10] G. Galilei, 1623, *Il Saggiatore, Giacomo Mascardi, Roma*, p. 25, "*La filosofia è scritta in questo grandissimo libro che continuamente ci sta aperto innanzi a gli occhi (io dico l'universo), ma non si può intendere se prima non s'impara a intender la lingua, e conoscer i caratteri, ne' quali è scritto. Egli è scritto in lingua matematica, e i caratteri son triangoli, cerchi, ed altre figure geometriche, senza i quali mezi è impossibile a intenderne umanamente parola; senza questi è un aggirarsi vanamente per un oscuro laberinto*".

simplified world, where regular, recurring events take place, almost the opposite of the real world we live in. However, an analysis of this simplified world allows us to derive the general rules which constitute the basis of the real world. According to Galileo, Science proceeds by *abstracting* principles from experiments.

In Kircher's opinion, this approach is too limited, because he thinks that Science consists in drawing generalizations from the results of experiments. Kircher studied ancient languages in order to retrace the global knowledge which was lost when the Earth was submerged by the Deluge.

Anything but a simplified world! The Jesuit scholar is charmed by exceptions and by monsters which, according to him, play a specific role within the design of Nature. Kircher thinks that scientific research should start by taking stock of all existing things, and then try and identify what they have in common. In conclusion, the global knowledge pursued by Kircher consists in finding relationships between the various manifestations of the Universe.

As it often happens in Kircher's works, where pictures are more meaningful than words, this concept is clearly expressed in the illustrated page preceding the frontispiece of his book, which is devoted to the art of knowledge. At the foot of the statue of Wisdom, we find a few words in Greek engraved on the marble: "*Medèn kàllion è pànta eidènai*" which Kircher takes from Plato's Cratylo. It means "*Nothing is more beautiful than the knowledge of everything*" (Fig. 1.1).

Kircher's approach to the study of Nature is exactly the opposite of Galileo's approach. On the one hand, Kircher, young and brilliant scholar, appreciated by the Church hierarchy, considers Science from a conservative point of view, namely as a re-discovery of relationships among well-known concepts (when this technique does not produce convincing results, one can recur to "demonstrations", which aim more at confusing and astonishing the audience than at convincing them). On the other hand, all through his life, Galileo considers Science as an autonomous activity, based upon the experiment, which by nature cannot be submitted to the principle of authority. Even in his old age, defeated by circumstances, Galileo can only write to trustworthy friends. He does not deny what he had written in his letter addressed to Christine of Lorraine, wife of the Grand duke of Tuscany, a well-known bigot "*Therefore, it seems to me that, in the debates on nature, we should not start from the authority of passages from the Scripture, but rather from sensible experiences and necessary demonstrations*".[11]

[11] G. Galilei, 1615, *Lettera a Madama di Lorena Granduchessa di Toscana, "Stante, dunque, ciò, mi par che nelle dispute di problemi naturali non si dovrebbe cominciare dalle autorità di luoghi delle Scritture, ma dalle sensate esperienze e dalle dimostrazioni necessarie"*.

Chapter 2
Watches and Sunflowers Rotating Upon a Stationary Earth

He who mixes business
and pleasure, reaches perfection

Horace, Ars poetica, vv. 343-4

Omne tulit punctum, qui
miscuit utile dulci

The arrival of Athanasius Kircher in Rome does not pass unnoticed. For example, Raffaello Magiotti, a priest from Tuscany who had studied with Galileo, immediately informs his teacher "*… a Jesuit scientist has just arrived in Rome: apparently, he has lived for a long time in the East, he can speak 12 languages, has studied geometry, and has brought with him a few interesting objects. Among other things, he has a flower which turns according to the Sun's rotation, and works like a watch. He has pinned this flower upon a piece of cork, which floats on the water: there is an iron pointer on top showing the hours, and there is a mechanism which calculates the time in other parts of the world…*".[1]

This message is rather imprecise, since Magiotti does not know Kircher's name; moreover, Kircher has never been in the East. However, it is quite clear that he is impressed by the Jesuit's culture and is interested in this strange invention, namely a watch based on a root or seed which, like a sunflower, rotates by following the Sun.

This *heliotropic clock*—according to Kircher's definition—may seem to us an attempt to impress an ingenuous audience, but this is not what really happened.

At the start of the century, an English doctor, William Gilbert, published *De Magnete, magneticisque corporibus et de magno magnete tellure* (*On the Magnet and Magnetic Bodies, and on That Great Magnet the Earth*), an essay on the Earth's magnetic field, where he suggested that the Earth behaves like a large magnet, which is in its turn submitted to the magnetic field related to the Sun. As a consequence, the Earth magnet is dragged by the external magnetic field, which

[1] R. Magiotti, 1634, *Letter to Galileo Galilei,* Roma, 18 March, 1634, in *Le Opere di Galileo,* 1966, *vol. XVI,* G. Barbera ed., Firenze, "*…di nuovo, c' è in Roma un Gesuita, stato gran tempo in Oriente, quale, oltre al posseder 12 lingue, buona geometria* etc.*, ha seco di gran belle cose, e fra l'altre una radica, quale si volta secondo gira il sole, e serve per horiolo perfettissimo. Questa è incastrata da lui in un pezzo di sughero, quale la tenghi libera sopra l'acqua, e sopra il sughero una lancetta di ferro che mostri le hore, con un calcolo per sapere qual ora sia in altre parti del mondo…*".

R. Buonanno, *The Stars of Galileo Galilei and the Universal Knowledge of Athanasius Kircher*, Astrophysics and Space Science Library 399,
DOI: 10.1007/978-3-319-00300-9_2, © Springer International Publishing Switzerland 2014

would force it to rotate upon itself. Since Gilbert—as a doctor—is used to checking his insights, he realizes a model Earth—which he calls "*terrella*" (small Earth), by shaping a spherical magnet. In this way, Gilbert wants to demonstrate that the small Earth rotates just like the real Earth.

Kircher, a typical Jesuit scholar, cannot share the idea of a rotating Earth. Nevertheless, he is excited by the study of magnetism, because he thinks this can represent the key for an explanation of a series of natural events. Not by chance, the description of this botanic clock appears in the essay *Magnes, sive de Arte Magnetica,* about the effects of magnetism. Kircher is so strongly convinced of the ubiquity of magnetism that he maintains the opposite of what Gilbert says—namely that the Earth stands still because its magnetic poles are attracted by two imaginary celestial reversed poles, so that the Earth must stay still forever, at the centre of the Universe.

Father Athanasius is thus near to the trend of "magnetic philosophy", also shared by two influential brothers, Nicolò Cabeo and Nicolò Zucchi. However, always an enthusiast, Kircher considers magnetism not only as the basis of the Universe, but also as the main key in understanding the Cosmos around us.

At the end of "*Magnes*", Kircher appears so convinced of the pervasive nature of magnetism that he considers it as the main cause for the harmony we observe in the Universe. The chapter "*The Magnetism of Love*"[2] reveals that this is the same concept which Dante expounds in the "*Divina Commedia*", as he ascribes to the force of love the motion of the planets. According to Dante, the nearer they are to the Lord—the main source of Love in the Universe—the faster planets move. According to Kircher, the Lord keeps the balance of the Universe through the magnetic force, which issues from Himself and goes down to the Earth passing through the angels.[3]

Since the Earth lies inside the Sun's magnetic field—according to Kircher—one can suppose that the whole biological sphere is affected by it. For instance, plants grow vertically, whereas their roots plunge into the ground because of the magnetic polarity, just as they are inclined in the Sun's direction. If this is true, as the behaviour of various "heliotropic" plants show, a basic principle of symmetry lets us assume that the Moon should magnetically affect the Earth too.

Naturally, such an innovative hypothesis would require an empirical testing, namely the discovery of a plant which could show a "selenotropic" effect. Kircher thinks about the Far East which, because of the difference of culture and language, emphasized by the superficial accounts of Jesuit missionaries, is considered as a sort of archive, where we can discover surprising natural phenomena.[4] Therefore, Kircher writes to his brothers, asking for information about plants which may be affected by this night influence. Kircher even suggests that they look for plants similarly affected by the motion of other planets.

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[2] Kircher, 1641, *Magnes, sive de Arte Magnetica libri tres*, Romae, Ex Typographia Ludouici Grignani, digitized by ECHO, p. 777 "*Libri Tertii, Pars nona, De Magnetismo Amoris*".

[3] *Ibidem,* "*Epilogus, Totius Naturae Magnes*" pp. 796–797.

[4] Martha Baldwin, 2001, "*Kircher's Magnetic Investigations*" in "*The Great Art of Knowing: The Baroque Encyclopedia of Athanasius Kircher*", D. Stolzenberg ed., Stanford, CA. Stanford University Libraries, p. 27.

This is certainly a bold hypothesis. However, at that time, many scholars explained a number of events through magnetism, in the hope of overcoming the mysterious spheres of Aristotle. For instance, Johannes Kepler, imperial astronomer at the court of the Holy Roman Empire, having at his disposal the precious collection of Tycho Brahe's measurements, assesses the laws ruling the planets' orbits, but, since he cannot explain its reason, looses his path while searching for complex geometric explanations bordering on magic.

Kircher's sunflower clock is certainly a baroque show, organized to impress the audience, but it is not simply a childish entertainment. Indeed, according to Aristotle's philosophy, impressing your audience is a teaching technique which makes the audience realize their own ignorance and start wanting to learn. After all, Kircher uses a specific approach of scientific research, namely the study through analogy which, by giving up the search for the first cause of natural phenomena, which he considers as hidden in God's mind, focuses his attention on secondary events. Thus, the study of plants affected by the Sun and the planets, for example, might be a minor manifestation of the same cause which allows the planetary system to rotate while staying still through millennia.

In this context, Kircher plans a few clocks based on the imaginary magnetic properties of plants. These so-called oroscòpi, like the one with the sunflower (Fig. 2.1), fascinate many people, even scholars, who cannot resist the wish to observe how such a prodigious clock works.

Magiotti is not the only person impressed by Kircher's projects. In the same day in which he writes a letter to Galileo, a French scholar working for Francesco Barberini, Giacomo Bouchard, also writes to Galileo about Kircher "…*I cannot imagine a better ending to this letter than the news about the invention of a clock, in which the time is marked by a plant, which by nature moves according to the Sun's rotation, provided it is placed into a bowl filled with water. This clock has been invented by a German Jesuit, a Father Anasthasius, who recently arrived in Rome. However, he admitted that he got the idea from some Arab authors, since he can read and speak Eastern languages. I do not doubt that, with your sublime intelligence, you will be able one day to benefit from this invention, even though—sofar—you have not been allowed to show the advantages of your discoveries*…".[5] (apart from sunflowers and clocks, it is worthwhile to note the last line of this letter, where Bouchard, who worked for the Pope's nephew, makes a disheartened reference to the way in which Galileo had been treated in Rome).

[5] G. Bouchard, 1634, *Letter to Galileo Galilei,* March 18, 1634, 1966, in *Le Opere di Galileo, vol. XVI,* G. Barbera ed., Firenze, "…*Non m'imagino potere finire questa per nuova più grata a lei di quella dell'inventione d'uno horologio, dove l'hore vengono notate da una certa radica, la quale per proprietà naturale si va movendo continuamente col sole dell'istesso suo moto, posta che sia in libertà dentro all'acqua. Un tal Giesuita Tedesco, arrivato a Roma da poco tempo in qua, il quale si domanda P. Anastasio, n'è stato l'inventore. Egli confessa nondimeno haverlo cavato da certi autori Arabi, essendo detto Padre molto versato nelle lingue orientali. Non dubito che V. S. col suo sublime intelletto non rechi un giorno da questa inventione qualche utilità grande al mondo, benchè hora mai fatto indegno di così fatti suoi beneficii*…".

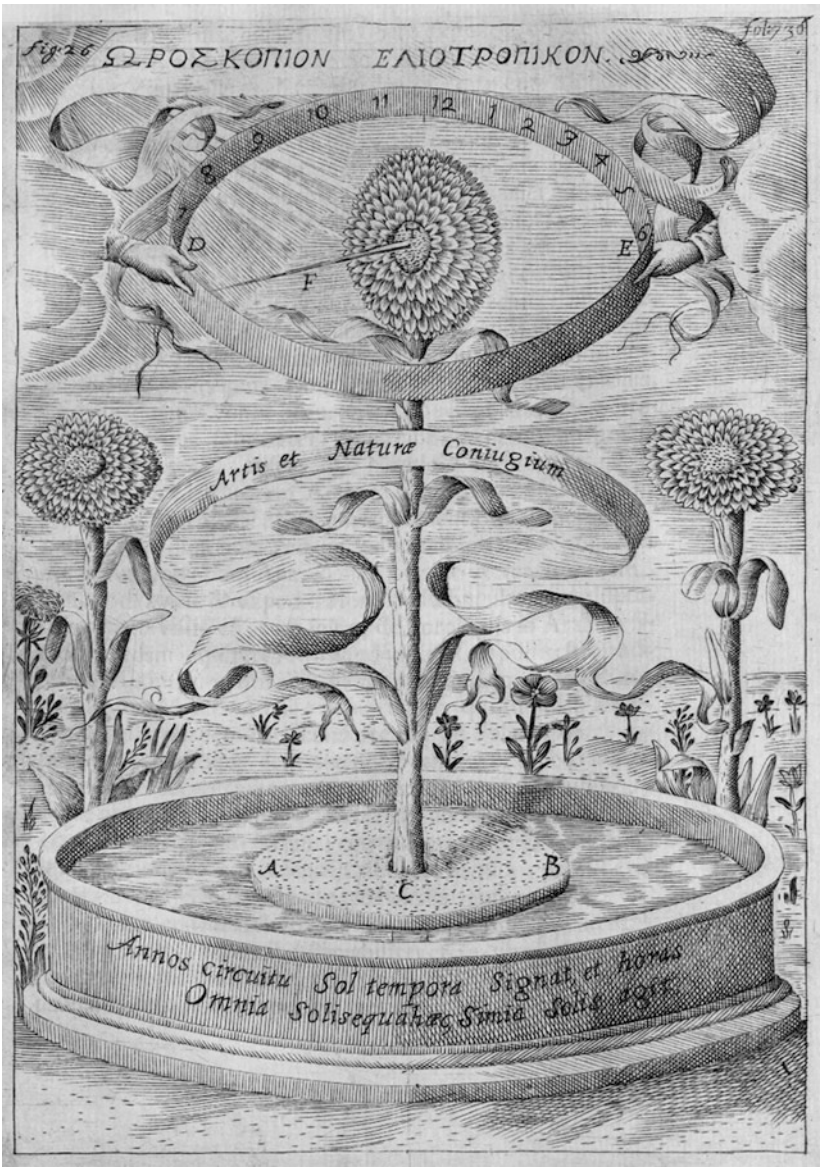

Fig. 2.1 *The heliotropic clock.* (Kircher, 1641, *Magnes, sive de Arte Magnetica libri tres*, Romae, Ex Typographia Ludouici Grignani, p. 736). The sunflower is supported by a cork platform floating inside a bowl. The hands supporting the circle with the time represent the Sun's magnetic influence. The idea is that the sunflower is a heliotropic plant, affected by the Sun. When the Sun moves during the day, the plant, submitted to the magnetic field, is attracted by it and rotates. By placing a small mirror at the centre of the flower, the clock face is lit up, thus realizing a natural clock. Since the clock should work at night too, the mirror should be replaced with a small beam, so that you can look at it with a candlelight. Kircher warns the reader that such a "oroscòpio" tends to work only for a limited amount of time; therefore, he recommends that the sunflower roots be wrapped with a wet cloth, so that they will be kept moist for some time

The study of the heliotropic clock dates back to the time when Kircher, fleeing from Germany—devastated by the Thirty Years' War—had found refuge in the Jesuit College of Avignon. Needless to say, even while leaving Würzburg where he lived, Kircher had been assisted by some divine intervention, since he had been warned in a dream of the horrible invasion of the College by the Swedish soldiers of King Gustav Adolf. He had escaped just in time, together with his student Kaspar Schott.[6] This happened in 1631: his arrival at the College of Avignon must have had a redeeming effect on him, as we can notice in the introduction of his essay on the study of light, where he defines Avignon as a city which is particularly favourable to astronomical studies.[7]

In Avignon, Kircher finally feels free to devote some time to his passions. Therefore, while fulfilling his task as a teacher of Eastern languages, Philosophy and Mathematics, he starts at once to realize a planetary clock on the wall of the Tour de la Motte, inside the College. A planetary clock was not simply a solar clock, like the ones he had already built. This clock uses a series of mirrors in order to send light from both the Sun and the Moon inside the tower, on whose walls, together with the hours marked by the Sun, he marks various uranium–graphic projections, as well as the constellations and the zodiac stars.[8]

In Provence, Kircher meets Nicolas-Claude Fabri de Peiresc. This meeting will affect the future career of the Jesuit scholar, because, thanks to the excellent introduction of this French astronomer, Kircher will be able to realize his dream: namely settling down in Rome, free to devote himself to the study of innumerable subjects, without specific teaching commitments. Peiresc is interested in the young Jesuit scholar mainly because he hopes that he will discover how to translate the Egyptian hieroglyphs. However, apart from this, he is certainly fascinated by the huge learning of Kircher, who can talk with a certain authority about Physics, Theology, Combinatorics and Astronomy. Peiresc trusts Kircher so much that he offers him more than once his help in order to have him transferred from Avignon to Aix, where he lives, so that he can get the chance to collaborate with him on a long-term basis.

Probably, Kircher prefers to stay in Avignon, where he thinks he can work at peace, without Peiresc always urging him to publish at least the first results of his work on hieroglyphs. In fact, the idea of the heliotropic clock looks very much like a distraction created by Kircher in order to resist the insistence of his patron.

The clock finalized by the Jesuit scholar consists in a piece of cork floating on the water inside a bowl, with a sunflower seed on top, so that—according to Kircher—it maintains the plant's ability to follow the Sun's movement even when the sky is cloudy. It works like a clock (in fact, Kircher must have prepared different clocks of

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[6] A. Kircher, 1684, "*Vita Reverendi Patris Athanasii Kircheri Societatis Jesu*", *op. cit.* p. 46.

[7] A. Kircher, 1635, *Primitiae gnomonicae catopriticae*, Avenione, Ex Typ. I. Piot, *Dedication* p. 2 "…*Civitatis Avenionensis, ad astronomicis incumbendū studiis situm admodum opportunum, Solis dispositionem peramaena, continuo ridentem*….

[8] J. Fletcher, 1970, *Isis*, Vol. 61, p. 54.

the same type, since certain people who had seen it talk about a mysterious "root", whereas others speak of the whole sunflower plant, or of its seeds).

Peiresc has never seen a working heliotropic clock himself, but he does not consider it indispensable because, according to the way of thinking of that age, several influential people had been particularly impressed by the wonderful properties of sunflower seeds. Therefore, he decides to organize a public experiment on the working of the sunflower clock.[9]

Father Athanasius, who would probably like to avoid this "show", introduces two devices, one with a sunflower seed embedded in cork and a second one with a small magnet. The experimental mechanism is the same in both clocks. They both require a bowl filled with water, and the 24 hours of both night and day are marked upon it, and a cardboard pointer on the floating cork. According to Kircher's thesis, since both systems are affected by the Sun's magnetic influence, their position must change according to the Sun's movement, thus acting as a natural clock.

However, the result of this demonstration is only half successful, since the magnet clock actually rotates when you move it from the position it had reached (as expected, since it is well-known that a magnetized needle tends to keep its direction…), whereas the sunflower, which should also be affected by the Sun's magnetism, does not show any convincing movement. Peiresc does not seem to be particularly disappointed by this result, probably because the effect on the magnet remains misterious. Indeed, while it is well-known that the magnetic needle always points to the Northern pole, the reason why it does so remains unknown: some talk about a legendary magnetic mountain placed near the Arctic Circle, others suggest that the North Star attracts the needle. According to Kircher's report, the experiment somehow increases his credibility and Kircher himself promises his patron a botanic clock, so that he may check how it works himself.

In any case, the magnetic clock represents a fashionable topic, all the more since—according to rumours—there is another spectacular magnetic clock in Liège. This piece of information, according to the age, assumes total credibility because it is related by Silvestro di Pietrasanta, the confessor of the papal Nuncius Pierluigi Caraffa who, Pietrasanta said, had been watching how this clock worked in his house for several days.

Moreover, a trustworthy proof is constituted by a letter, which the well-known baroque painter Piet Paul Rubens sends to Peiresc "… *we should not doubt the authenticity of the clock (the secret lies in a certain magnetic attraction); I spoke about it with an ingenuous man who saw it and made it work without problems*…".[10]

The author of this contraption is an English Jesuit scholar, Father Linus, "*…who realized a clock made of a [wax or copper] sphere, which stands still at the center of a larger sphere—filled with water—exactly like*"—in Pietrasanta's

[9] For a full account see T. L. Hankins and R. J. Silverman, 1995, *Instruments and the Imagination,* Princeton Univ. Press, Princeton, NY, pp. 14–36 and references therein.

[10] P. P. Rubens, 1634, *Letter to Fabri de Peiresc,* 18 December 1634, in Ruth Saunders Magurn, 1955, *The Letters of Peter Paul Rubens,* Harvard U. Press., p. 394.

words—"*the Earth stands still at the center of the surrounding atmosphere. The smaller sphere, pushed by an unknown force, such as love, moves along in the opposite direction with regard to the skies which move from east to west. Floating on the water surface, we find a small pointer—shaped like a fish, pointing with its face towards the smaller sphere, which bears the 24 hours of the day, and seems to be watching carefully the hours running by in front of it…*".[11]

Peiresc, who had been so far merely curious about hydraulic and magnetic clocks—a traditional attitude for scientists at the time—is suddenly hopeful when the effects of the Sun's magnetism upon the Earth seem confirmed. Indeed, Peiresc asks himself: "If we can show that the clock rotates thanks to the mysterious magnetic virtues of the Sun, could this be the proof that the Earth also rotates in the same way? Faced with such a clear result—Peiresc goes on—even the Inquisition would be forced to revise its inflexible attitude on this matter and, in any case, the position of poor Galileo might be improved, perhaps his exile in Arcetri might be suspended…".

Indeed, Peiresc, who is a convinced follower of Copernicus and has known Galileo since his days in Padua, cannot accept the plight of his friend after the trial of 1633 and would like to help him in some ways. He takes this chance by writing to the Pope's nephew, cardinal Francesco Barberini "*… I would like to plead with Your Eminence with all my strength, so that you can somehow intervene for the well-being of a frail seventy-year old scientist, whose memory will not be effaced in the future… Indeed I feel sorry for good old Mr. Galileo Galilei… who is confined to his house near a monastery, where his daughter—his only consolation—had died as a nun, and everything is forbidden—visits and letters from friends, as well as access to the city and to his own house…*" After striking a sentimental note, Peiresc goes back to rationalism, denies that Galileo's opinion could be identified in the *Dialogue*, and continues "*…I've noticed that excellent painters have been forgiven very serious sins, whose enormity was horrifying, in order not to stain their merit; thus his recent inventions, better by far than any preceding one in centuries, will not be worthy of indulgence, since Galileo has never actually stated that he believes in the theories which have not been approved?*".[12]

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[11] S. Pietrasanta, 1634, *De Symbolis Heroicis Libri IX,* Antuerpiae, pp. 145–147, "*In Collegio Anglorum nostrae Societatis, P. Franciscus Linus, Magister Matheseos, excogitavit felicissimè orbem, qui intra phialam in circumsusae aquae centro (sicut in circumsuso aere tellus) heret secreto sue molis libramento. Sed conversionem coeli tamen ab Ortum in Occasum, arcana vi, & veluti quodam amore, confectatur, spatioque; viginti quatur horarum omnino circumagitur. Pisciculus interea indicis loco est, & quasi nandi peritus, ac libratus pondere suo, praetereuntes horas veluti admirans designat rostro, easque oculis defixis intuetur…*".

[12] N. C. Fabri de Peiresc, 1634, *Letter to Francesco Barberini,* 5 December 1634, in 1966, *Le Opere di Galileo, vol. XVI,* G. Barbera ed., Firenze, "*… Una supplica mi resta ancora a fare all'Em.za V., della quale io la preggo quanto so et posso di schusare la speranza ch'ella si degnarà far qualche officio per la consolatione d'un buon vecchio settuagenario et poco sano di corpo, la cui memoria difficilmente sarà scancellata nell'avenire… Questo dico per la compassione che tengo del povero buon vecchio S.r Galileo Galilei… confinato in una sua villa vicino ad un monasterio, dove gli era morta una figlia monacha, sua unica consolatione, et che gli erano prohibite le visite et corrispondenze degli amici, non che l'accesso della città et della*

Peiresc is so enthusiastic about this possibility that he even expresses his hope to his friend Galileo "…*it seems that a proof in the hands of a Jesuit priest, rather than of anyone else, …will show that the enemies of Copernicus' doctrine are wrong, and what you had jokingly suggested was only a problem… I shall try to write to Father Lino* [and] *have him in Rome… all in order to have new argumentations, so as to talk about you to anyone who can help you better than myself…*".[13]

Galileo, however, must remind Peiresc that, in the *Dialogue concerning the two chief World's Systems,* he had made fun of the idea that a magnetic sphere might turn upon itself in 24 hours; indeed, "…*the hydraulic clock will be marvellous if it is true that the globe floating on the water really rotates because of a hidden magnetic power. A few years ago, I invented something similar, resorting to a stratagem. This was the device: the small globe, divided up in 12 meridians for 24 hours, was made of copper, empty inside, with a small magnet at the bottom…*", and, after a detailed description of the trick, he cannot help recurring to his Tuscan irony "…*if this device created by Father Lino makes its globe rotate according to the sky, then it really is a celestial, divine thing, and we shall obtain a perpetual motion…*".[14]

Unfortunately, Galileo is far-sighted as he does not share Peiresc's trust in the possibility of a "revision" of his trial. This is confirmed by the letter he wrote to his friend Elia Diodati, from Lucca "…*once I got home, I met the Vicar from the Inquisitor, who had come to order me… with letters from Cardinal Barberino* (Peiresc's friend!) *to stop asking to go back to Florence, otherwise they would get me back there, but in the prison of the Holy Office…*".[15]

(Footnote 12 continued)
propria casa"… "…*Io veggo che a pittori excellenti nell'arte loro si sonno condonati peccati gravissimi, et l'enormità de' quali era a sommo horrore, per non lasciare inutile il precedente merito; et tante inventioni, le più nobili che si fussero scoperte in tanti secoli, non potranno meritare l'indulgenza d'un scherzo problematico, dove egli non ha mai affirmativamente asserito esser suo proprio parere quello che non s'è voluto approvare?*".

[13] N. C. Fabri de Peiresc, 1635, *Letter to Galileo Galilei,* 1 April, in 1966, *Le Opere di Galileo, vol. XVI,* G. Barbera ed., Firenze, "…*par che sia una pruova et testificatione caduta dal Cielo in mano d'un Padre Giesuita, più tosto che d'un'altra professione, …per convincere il torto di quelli trovavano tanta repugnanza nella dottrina Copernicana et in ciò che V.S. n'haveva proposto per scherzo problematico… cercarò qualche prattica et corrispondenza con detto P.re Lino* [e] *procurrerò di farlo chiamare in Roma… il tutto per haver sempre nuovi argomenti di rammemorare V. S. Ill.re a que' che la possono aiuttare meglio di me…*".

[14] G. Galilei, 1635, *Letter to Fabri de Peiresc,* 12 May, 1635, in 1966, *Le Opere di Galileo, vol. XVI,* G. Barbera ed., Firenze, "… *l'horologio Hydraulico sarà veramente cosa di estrema maraviglia quando sia vero che il globo pendente nel mezo dell'Acqua vadia naturalmente volgendosi per occulta virtù magnetica. Io feci già molto anni sono una simile invenzione, ma con l'aiuto di un ingannevole artifizio, e la machina era tale. Il globetto, diviso con 12 meridiani per le 24 ore era di rame, voto dentro, e con un pezzetto di calamita postogli nel fondo*"… "*ma se questa del P. Lino senz'altro artificio fa sì che il suo Globo ubbidisca al moto del Cielo, sarà veramente cosa celeste e divina e havremo così il moto perpetuo…*".

[15] G. Galilei, 1634, *Letter to Elia Diodati,* 25 July, 1634, in 1966, *Le Opere di Galileo, vol. XVI,* G. Barbera ed., Firenze, "…*arrivato a casa, trovai il Vicario dell'Inquisitore che era venuto a intimarmi… con lettere del Signor Cardinal Barberino ch'io dovessi desistere dal far dimandare*

Kircher, who had been in Rome for almost one year, stays out of this debate, and his adviser Peiresc does not try to involve him, perhaps because he fears Kircher would be embarassed, since the echoes of Galileo's trial are still tangible in Rome. Father Athanasius, for his part, has apparently lost interest in his magnetic clock and focusses his attention upon the botanic clock. Notwithstanding the failure of Aix, a few years earlier, he creates more clocks, which he somehow places everywhere. He even placed one in the house crib of the late Cardinal Sacchetti, as Magiotti relates in a letter addressed to Galileo "*On Christmas day, together with the Sacchettis, I went to see the crib (which contained several clocks, which moved thanks to a root, and had been made by Father Athanasius, a Jesuit priest)…*".[16]

Even though he is not a prominent person in Rome at that time, Magiotti is so influential that he wrings from Kircher the promise of "*a piece of that root*"[17] even though his enthusiasm will be disappointed, since he confesses in a letter addressed to Galileo, "*…that good Father suddenly left … and I did not get the promised root…*".[18]

If the Jesuit scientist does no keep his promise, this probably means that it is difficult for him to make the botanic clock work. However, this is not the only clue. Why, for instance, given Kircher's taste for sensational scenes, does he not show—at least once—the clock based upon the whole sunflower plant, like the one in his *Magnes*?

Indeed, Kircher seems to realize that the audience would expect a sensational demonstration, namely a big sunflower plant, fixed on a floating platform, which moves according to the passing of time. He justifies himself somehow: first of all—he explains—it is difficult to use a whole flower even for an experienced person like himself because "*it is impossible to put it inside a glass case and avoid that a light breeze moves it from the position it would reach*". Moreover, he has noticed that "*when the Sun is weak and the plant is somewhat withered, it tends to slow down, as if it was going to stop. Finally, such a clock would not survive more than a month*".[19]

All things considered, these motivations are reasonable, but we might infer that there is some obstacle which prevents the exhibition of a real sunflower clock,

(Footnote 15 continued)
più grazia della licenza di poter tornarmene a Firenze, altrimenti che mi arebbono fatto tornare là, alle carceri vere del Santo Offizio…".

[16] R. Magiotti, 1637, *Letter to Galileo Galilei,* 21 March, 1637, in 1966, *Le Opere di Galileo, vol. XVII,* G. Barbera ed., Firenze, "*…Fui per le feste di Natale, in compagnia delli SS. Sacchetti, a vedere il presepio (in questo erano diversi orologii, che si movevano in virtù d'una radica, del P. Atanasio Giesuita)…*".

[17] R. Magiotti, 1637, *Letter to Galileo Galilei,* 25 April, 1637, *ibidem.*

[18] R. Magiotti, 1637, *Letter to Galileo Galilei,* 16 May, 1637, *ibidem* "*…quel buon Padre della radica s'è partito all'improvviso… et io son restato senza la radica promessami…*".

[19] A. Kircher, 1641, *Magnes, sive de Arte Magnetica libri tres,* Roma, ex Typographia Ludouici Grignani, digitized by ECHO.mpiwg-berlin, p. 737 "*…Res industrium & solertem artificem, ut successum habeat, requirit; ego opus cum optimo successu expertus sum… quod machina vitrei carceris esset impatiens, libero autem aere facilè ab exigua aeris commotione à situ suo dimoreveatur… etsi flaccescente Sole & ipsu veluti marcidum & defesu nonnihil remoretur, quietem appetens; accedit Horologium huiusmodi vix mensem durare posse, etiam maxima diligentia cultum…*".

especially if we read an account which Kircher writes—years later—of a meeting he had in Marseille in 1633, just before starting his adventurous trip to Rome. This is a meeting he had never mentioned before.

According to this account, Kircher had met a mysterious Arab merchant in Marseille harbour. After talking for a while of this and that, this merchant tells him that there was a well-known physician in his country "*who, thanks to some substance which is always oriented towards the Sun, manages to know what time is it, day and night*". Incidentally, the Arab had carried a piece of that substance with him and had accepted an exchange with Kircher.[20]

This story seems especially made up in order to add an Eastern charme to the mysterious botanic clock. Above all, the story suggests that Kircher's clocks work (when they do work!) only because he has hidden this piece of mysterious substance somewhere. This is the idea Peiresc gets about the mystery, even though he remains convinced that the movement of magnetic clocks is linked to the Earth's rotation, so much so that he mentions two magnetic clocks, created, respectively, by Linus and Kircher, in his last will.

In *Magnes, sive de Arte Magnetica libri tres,* which was published in 1641, a few years after starting the experiments on magnetic clocks, Kircher presents a summary of his thought on the nature of magnetism. In this essay, the Jesuit scientist, starting from etymology, examines all phenomena which, in his opinion, may be ascribed to Nature's magnetic influences, such as terrestrial magnetism, astronomy and magnetic geometry, and, of course, he accurately describes magnetic clocks and planetaria.

This essay is rather technical. However, as it often happens in Kircher's books, the message is mostly conveyed through pictures. The drawings, however, immediately show something strange; namely, together with the magnetic clock, Kirchers also shows the secret mechanism which makes it work. In other words, Father Athanasius shows the device which he had always kept hidden in his experiments. This is even stranger, if we consider that the Jesuit scientist, since his demonstrations in Aix, had always affirmed that what he showed were always genuine natural phenomena: what had pushed him, 7 or 8 years later, to reveal that those clocks required an external device in order to work?

Here, we can follow Hankins and Silverman[21] and imagine that perhaps Peiresc himself, in his letters to Francesco Barberini, had unintentionally induced him to

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[20] A. Kircher, *ibidem,* "*… nescio quo Numinis anno 1633 Massiliae, in Mercatorem Arabem incidi, quocum de varijs rebus Arabiam & mare Rubrum concernentibus aliquantis per collocutus, dum hora redeundi domum instaret, egoque ad horam explorandam Annulo meo horario uterer, is ex tam commodi atque & expediti Horarijusu singularem voluptatem capere visus est; cum igitur de horologijs in Arabia usitatis quaedam inquirere scitu haud indigna, respondit; Astronomos varijs instrumentis ad horam explorandam uti solere, inter caeteros Medicum esse celeberrimum, qui subsidio alicuius materiae perpetuò se convertentis ad Solem, horas invenieret noctu diuque…. Secum inter merces suas Aromaticas attulisse, atque pro Annulo illo se paratum esse aliquid ex ista materia commutare; dictum factum…*".

[21] T. L. Hankins and R. J. Silverman, 1995, *Instruments and the Imagination,* Princeton Un. Press, Princeton, NY, pp. 31–32.

consider the danger in these experiments on the rotation of heliotropic clocks. Indeed, he might have suggested that, following Gilbert's theory, one might conclude that the Earth also rotates upon itself and around the Sun, thus transforming poor Kircher in a supporter of Copernicus. The Jesuit scientist obviously did not want this. On the contrary, he is likely to say that the magnetic influence makes the Earth even more stable in its position at the centre of the Solar System! Certainly, it must have pained Kircher a lot to admit, so many years later, that he had used a stratagem in his public demonstrations. He probably felt like a conjurer, forced to reveal the trick behind his magic.

Kircher has not solved—as yet—the problem of the magnetic clock, which Father Linus had created. According to the reports of Silvestro da Pietrasanta, this clock works perfectly.

Kircher has never seen this clock himself. However, he gets the chance to talk about it with Silvestro da Pietrasanta who, meanwhile, had moved to the Collegio Romano. Thus, Kircher discovers that the structure of the clock is essentially identical to the one he himself had built. Although he cannot say the Linus's clock is a sham, Kircher publishes the scheme of one of *his* clocks (Fig. 2.2), apparently identical to Linus's clock, showing its hidden mechanism. However, he writes that "*I found in Symbolis heroicis of Sylvestris Petrasancta a similar clock put in a glass sphere by a certain Francisco Linnio, who is a English Jesuit priest; but since I do not know the details of its construction, I think it is not suitable for me to express an opinion*".[22]

As if he wanted to show that he can build clocks which are even more complex than Linus's one, Kircher publishes also the model of one of his magnetic clocks (Fig. 2.3), based on the same concepts of Father Linus and showing the same hidden mechanism to the audience.

Kircher's "retraction" of the magnetic clock does not mean that he changed his opinion on the role which magnetism plays in the world. He simply thinks that the magnetic clock is a failed experiment, and his interest in the botanic clock is even greater now.

On the other hand, the clocks in which Father Athanasius is interested are not simple machines like any other. Rather than instruments which measure time, these clocks are models of the Universe, while underlying its unknowable principles, "*Just as we see the hand of the clock and read the hours from its turning without having insight into the ingenious workings of its complex gears, so we can observe the blessings and punishments without knowing and understanding their secret causes*".[23]

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[22] A. Kircher, 1641, *Magnes, sive de Arte Magnetica libri tres,* Roma, ex Typographia Ludouici Grignani, digitized by ECHO, p. 739, "…*Invenio in Symbolis heroicis Sylvestri Petrasanctae simile sympathicum horologium a quodam Anglo Societatis nostrae Sacerdote Francisco Linnio in sphaera vitrea concinnatum, verum cum eius construendi rationem & methodum hucusque cognoscere mihi non licuerit, de eo meum quoque iudicium interponere*…".

[23] G. P. Harsdöffer, 1651, *Delitiae Mathematicae et physicae,* Norimberga, 1651, quoted in T. L. Hankins and R. J. Silverman, 1995, *Instruments and the Imagination,* Princeton Un. Press, Princeton, NY, p. 34.

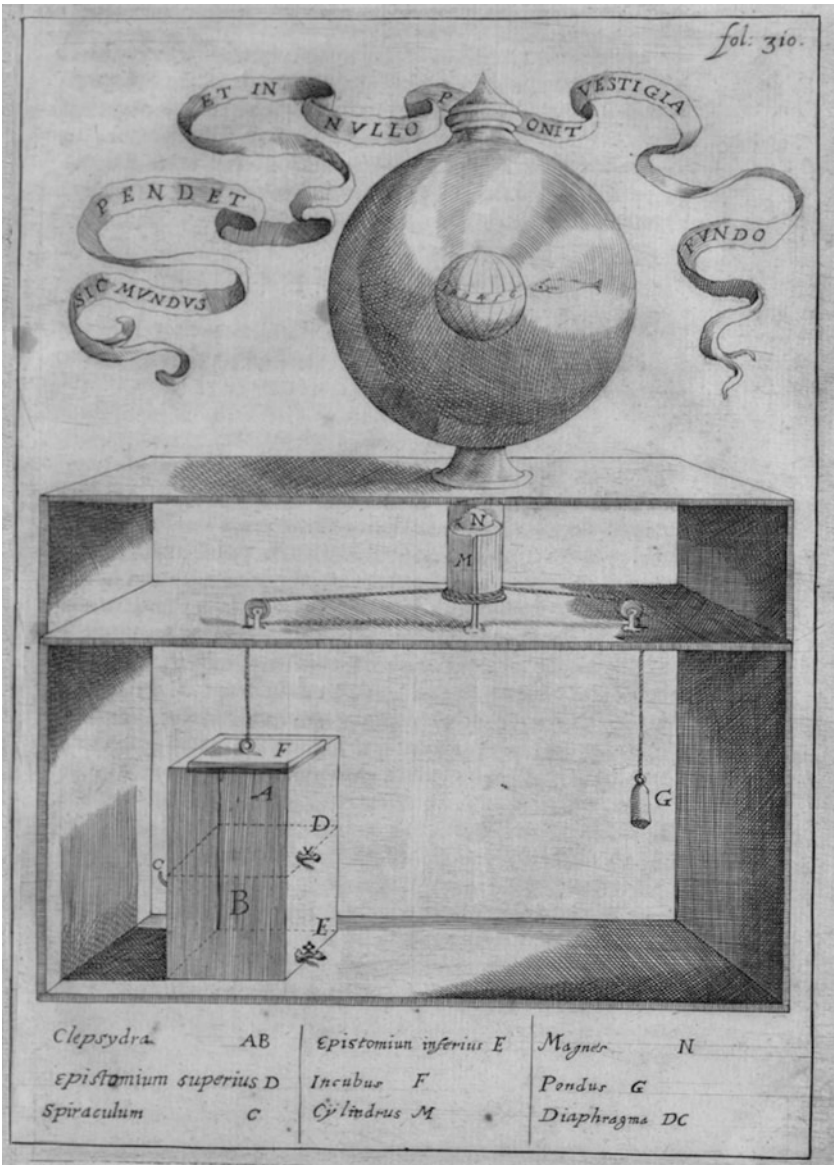

Fig. 2.2 *The* "*Clepsydra Aquatica*". (A. Kircher, 1641, *Magnes, sive de Arte Magnetica libri tres,* Roma, ex Typographia Ludouici Grignani, p. 310). This instrument is similar to the magnetic clock described in the book *De symbolis heroicis,* by Silvestro da Pietrasanta. The small *sphere* was made of wax, bronze or copper, depending on the witnesses. Since—according to its creator—the *sphere* rotates because of the Sun's magnetic influence, the small fish, which is fixed with respect to the external *sphere*, plays the role of the clock's hands in a modern clock, since its head indicates the hour, which is drawn upon the rotating *sphere*

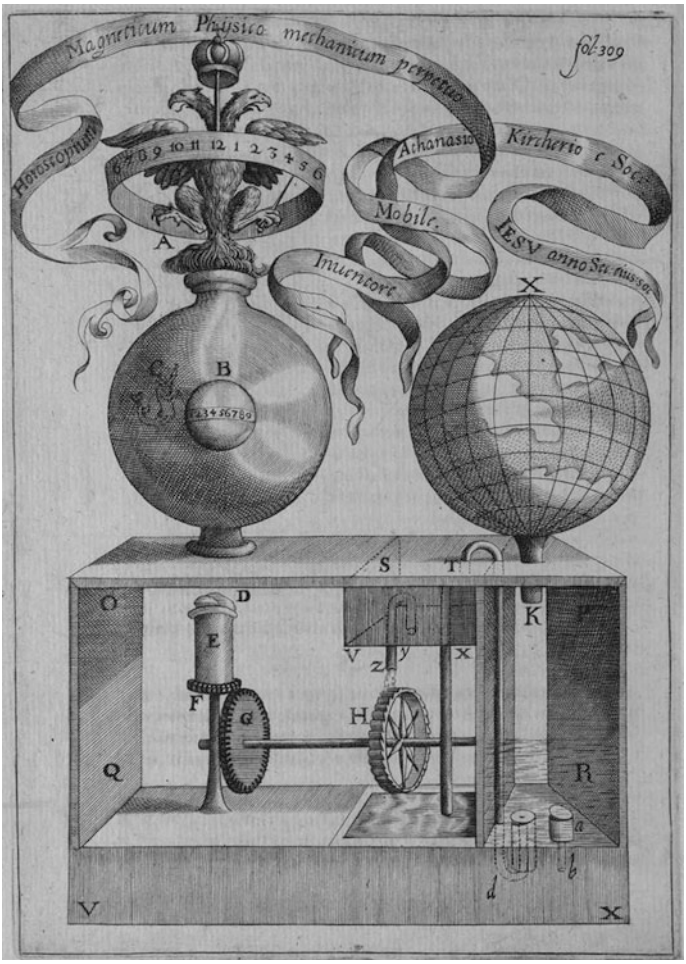

Fig. 2.3 *Kircher's perpetual magnetic clock.* (Kircher 1641, *Magnes, sive de Arte Magnetica libri tres,* Roma, ex Typographia Ludouici Grignani, p. 494). This instrument is similar to the one built by Father Linus in Fig. 2.2, but is endowed with a more complex mechanism, which is hardly explained by the author. We should notice that the drawing reveals the existence of a "*clepsydra*", i.e. the device which transmits the rotation to the small *sphere* on the *left*, thus admitting that the rotation does not take place because of the Sun's magnetic attraction. On the *upper right-hand side*, the scroll bearing the words "*Inventore Athanasio Kircherio*" underlines that this mechanism is different from the one made by Father Linus. The *sphere* on the *left* is made of glass, and there is an empty globe in the centre, "*which may be made of any material, except iron*", and is inserted from the mouth of the external *sphere*. The internal *sphere* is kept in its position by a magnet. The parallelepiped on the basis is made of metal and contains a diaphragm, which allows us to partially fill the section on the *right* with water. The *sphere* on the *right*, also made of metal and empty inside, puts into function a siphon, which pours water into the small tank, which constitutes the engine of the mechanism. The water drops regularly, making the cogwheel and—on its turn—the magnet E rotate. This rotating magnetic field transmits the rotation to the small *sphere* B. The mermaid indicates the hours, painted upon the small *sphere*

The vision of a Universe which may be explained through a clock has not been an original idea of Kircher. Kepler too, though a convinced follower of Copernicus and very far from the Jesuit's philosophy, shares the idea that the Universe might be represented by analogy, as machines built by human beings "*Once… I believed that the force moving the planets was a soul … My goal is to state that the machine of the Universe is similar to a clock… in which all movements depend on a simple material force, just like all clock's movements are due to a simple pendulum*".[24]

If Kircher's philosophy now and then touches Kepler's mystique, its distance from Galileo's is always quite clear-cut. Indeed, Galileo thinks that the scientist should investigate Nature on the basis of experiments from which he infers its functioning rules, whereas Kircher is convinced that the general framework of the world cannot essentially be discovered. The scientist's space of freedom which, according to Kircher, consists in proceeding by analogy: machines such as the botanic clock work according to principles similar to the ones we may notice in other natural events. As a consequence, the only way to confirm his vision of a magnetic Universe consists in gathering hundreds of similar events we can observe in Nature and describe them accurately. This is what Kircher does in *Magnes*, thus increasing his reputation as an encyclopaedic scholar for some people and a perplexity bordering on sarcasm for others, as in the letter which Galileo's pupil, Evangelista Torricelli, writes to his teacher "…*There are two spectacular news: the death of Cardinal Pio, and the eagerly awaited publication of a book by Father Athanasius Kircher. This is a Jesuit mathematician studying in Rome. This big volume is about magnetism, and is enriched with many other interesting topics, such as astrolabes, clocks, anemoscopes, with a number of strange words. Among other things, there are many epigrams, couplets, epitaphs, inscriptions, partly in Latin, partly in Greek, partly in Arabic, partly in Hebrew and other languages. Among a few beautiful things, there is a musical score which—he says—is an antidote to the tarantula's poison. That's enough: together with Mr. Nardi and Mr. Maggiotti, we laughed to our hearts' content.*"[25]

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[24] J. Kepler, 1868, *Opera Omnia, vol I,* Frankfurt/Erlangen 1868, p. 176, "*Olim enim causam moventem planetas absolute animam esse credebam, quippe imbutus dogmatibus J. C. Scaligeri de motricibus intelligentiis. At cum perpenderem, hanc causam motricem debilitari cum distantia, lumen Solis etiam attenuari cum distantia a Sole: hinc conclusi vim hanc esse corporeum aliquid, si non proprie saltem aequivoce; sicut lumen dicimus esse aliquid corporeum. id est. speciem a corpore delapsam. sed immateriatam.*"

[25] E. Torricelli, 1641, *Letter to Galileo Galilei (post scriptum),* 1 June 1641, in 1966, *Le Opere di Galileo, vol. XVIII,* G. Barbera ed., Firenze, "…*Due nuove famose ci sono: la morte del Card Pio, e la stampa, aspettatissima già sono anni, del P. Atanasio Kircher. Questo è il Gesuita matematico di Roma. L'opera stampata è un volume assai grosso sopra la calamita; volume arricchito con una gran supelletile di bei rami. Sentirà astrolabii, horologii, anemoscopii, con una mano poi di vocaboli stravagantissimi. Fra l'altre cose vi sono moltissime carraffe e carraffoni, epigrammi, distici, epitafii, inscrittioni, parte in latino, parte in greco, parte in arabico, parte in hebraico et altre lingue. Fra le cose belle vi è, in partitura, quella musica che dice esser antidoto del veleno della tarantola. Basta: il S.r Nardi e Maggiotti et io habbiamo riso un pezzo*".

Chapter 3
Jesuits, Scales and Telescopes

As for Astronomy, you should ask astronomers

Cristoph Clavius, 1591

Astronomos in rebus astronomicis esse consulendos

Magiotti and Bouchard write a letter to Galileo in 1634, when he is 70 years old, in order to inform him about the heliotropic clock made by Kircher. Galileo is an old man, and his beloved daughter, Sister Maria Celeste, has just died. In a letter addressed to his life-long friend, Elia Diodati, Galileo meditates upon the comments which Cristoph Grienberger, whom he had known at Collegio Romano, had made after his sentence "*If Galileo had maintained the affection of the Fathers of this Collegio, he would be famous, rather than disgraced, and he could have written freely on any topic, for instance about the Earth's movements, and so on*…". Galileo continues as he cannot explain to himself why "…*The cause of my disgrace was not this or that opinion* [i.e. *what I wrote about the Earth's rotation*], *but rather my falling out of the Jesuits' favour!*"[1] The whole matter was painful and incomprehensible to him.

Indeed, his relationships with the Jesuits in Rome had been excellent in the past, since, in the summer of 1587, he had been warmly received in Rome by the most important mathematician of the Collegio Romano, Father Cristoforo Clavio.

Back in Florence, Galileo had started with him a friendly exchange of letters which, though focussing on technical aspects of his studies, reveal a sincere openness of the authoritative professor towards the young scholar. The first letter was written by Galileo "*It seems to me high time I broke the silence I kept since I left Rome, in order to remind you my wish to be a your service, as well as to give you the chance to send me your latest news: indeed, I would like to hear your opinion about some difficulties I came across*…".[2] Clavio answered in no time

[1] G. Galilei, 1634, *Letter to Elia Diodati,* 25 July 1634, in 1966, *Le Opere di Galileo, vol. XVI,* G. Barbera ed., Firenze, "*Se il Galileo si avesse saputo mantenere l'affetto dei Padri di questo Collegio, viverebbe glorioso al mondo e non sarebbe stato nulla delle sue disgrazie, e arebbe potuto scrivere ad arbitrio suo d'ogni materia, dico anco di moti di terra,* etc.… *si che V. S. vede che non è questa né quella opinione quello che mi ha fatto e fa la guerra, ma l'essere in disgrazia dei giesuiti*".

[2] G. Galilei, 1588, *Letter to Cristoforo Clavio,* 8 January 1588, in 1966, *Le Opere di Galileo, vol. X,* G. Barbera ed., Firenze, "*Parmi hor mai tempo di rompere il silenzio sin qui usato con V S M R da che mi partii di Roma, si per rinfrescarli nella memoria il desiderio che ho di servirla, come ancora per darle occasione di satisfare al desiderio mio che è d'intender nuova di lei: et sentire di parer suo circa alcune mie difficoltà*…".

R. Buonanno, *The Stars of Galileo Galilei and the Universal Knowledge of Athanasius Kircher*, Astrophysics and Space Science Library 399,
DOI: 10.1007/978-3-319-00300-9_3, © Springer International Publishing Switzerland 2014

"*…I received your letter, and I am grateful for your memories of me, just as I remember you…*". Then, he examines Galileo's technical questions and answers his query about his essay on the Gregorian calendar—he was one of its creators. "*…As for the essay on the Calendar, I finished it, but I should revise it together with Cardinal Mondevi, who is very busy at the moment, and is holding up this matter… . In conclusion, I offer you my help, whenever I'll be able to*".[3]

The correspondence continued: Galileo apologizes for a delay of a few days in answering "I received your letter with pleasure a few days ago, but I could not answer earlier, because I travelled a bit and did not like to annoy you, since you must be very busy…".[4] Clavio uses a really friendly tone "*…Since I'm always rather busy, I cannot concentrate in answering your questions on the matter of the centre of gravity as I would like to… . I shall remember the promise, and will always be ready to help you…*".[5]

The difficulties mentioned by Galileo in these letters concern his essay on the barycentre of solids, on which he had been working for some time. Indeed, a couple of years earlier, he had written a short treatise, *La Bilancetta (The small Scales),* where the question of the specific gravity of solids was dealt with in a pleasant way, through a tale prefaced by these words "*…the reader of ancient writers knows that Archimedes had discovered that the artisan who had made Jeron's golden crown had stolen some gold, but sofar no one has understood how he discovered this…*".[6] According to this legend, reported in the book "*De architectura*", by Vitruvius, Jeron, the tyrant of Siracusa, was assailed by the doubt that the goldsmith he had entrusted with the creation of his golden crown probably had not used all the gold he had been given, but rather he had melted it together with a baser metal, and had kept aside some gold for himself. The question which Galileo poses himself in the essay is the following: how did Archimedes, to whom Jeron had turned, manage to discover the trick? He cannot accept the childish legend, according to which Archimedes

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[3] C. Clavio, 1588*, Letter to Galileo Galilei,* 16 January 1588, in 1966, *Le Opere di Galileo, vol. X,* G. Barbera ed., Firenze, "*Ho ricevuto la lettera di V.S., a me gratissima per intendere come si ricordi tanto particolarmente di me, si come lo fo anco io di lei.. …Quanto al trattato del Calendario, l'ho finito, ma l'ho da rivedere co'1 Cardinale di Mondevi, il quale è occupatissimo, et trattiene questo negotio… . Con questo fo fine, offrendomi in ogni sua occorrenza potrò*".

[4] G. Galilei, 1588, *Letter to Cristoforo Clavio,* 25 February 1588, in 1966, *Le Opere di Galileo, vol. X,* G. Barbera ed., Firenze, "*Ricevetti più giorni sono una di V S R. à me gratissima alla quale non prima che hora ho dato risposta si per essermi convenuto fare alcuni viaggi sì ancora per non l'infastidire sapendo quanto sia di continuo occupata…*".

[5] C. Clavio, 1588, *Letter to Galileo Galilei,* 5 March 1588, in 1966, *Le Opere di Galileo, vol. X,* G. Barbera ed., Firenze, "*…mi dispiace di non potere per le continue mie occupationi attendere con piu studio alla materia del centro gravitatis per satisfare a V. S. nel suo quesito, come io desidero… . Della promessa mi ricordarò, et sarò sempre pronto a servirlo…*".

[6] G. Galilei, 1586, e.g. in *Opere di Galileo Galilei,* UTET, 1980, p. 1 "*…è assai noto a chi di leggere gli antichi scrittori cura si prende, avere Archimede trovato il furto dell'orefice nella corona d'oro di Ierone, così parmi esser stato sin ora ignoto il modo che sì grand'uomo usar dovesse in tale ritrovamento*".

suddenly had this idea while he was having a bath, and then rushed out in the street, naked, crying "*Eureka, eureka*".

Actually, Galileo imagines that Archimedes had invented a small hydrostatic balance, which had allowed him, after various trials, to calculate the specific gravity of Jeron's crown, which he had later compared with the weight of pure gold.

As a matter of fact, the unfaithful artisan was indeed found out, but we should underline the fact that the young Galileo had not only invented a *divertissement* by imagining an experiment worth of the great Archimedes. He had also measured himself the specific gravity of 39 elements, which are accurately reported in two tables. With *La bilancetta*, in conclusion, Galileo had offered, at 24 years of age, his own letter of introduction as an experimental physicist.

Galileo has by now entered the Academic world, but earns little and gains dislike in Pisa. The situation gets worse when his father Vincenzio dies on 2 July 1591. Galileo becomes suddenly responsible for the whole family and cannot help moving to the University of Padua, where he is given a better pay and he must only teach a couple of hours a week. This gives him time for his studies of mechanics and the realization of instruments, such as the *geometric and military compasses,* which make him experience the first squabble of his life.[7] As it will happen again and again in the course of his life, he starts with good reasons, but ends up having a number of sworn enemies, and the whole thing might have been probably avoided, if he had restrained his rough character.

Compasses are essentially a slide rule for complex calculations, and Galileo hopes he can get some money from it, because, apart from scientists and scholars, it can be used to calculate the weight of cannon balls and the height to realize an effective launch (that is why he defines it "military" compasses). Moreover, this instrument may be useful for traders, who must calculate composed interests, or else want to know the cost of goods which were bought with a different currency. Galileo, however, since he had got wind of the fact that, once on the market, a mechanical instrument of this kind would have been copied immediately, secures himself by writing an essay on its usage, so as to dispose of a document which witnesses the priority of his discovery. However, in order not to make a present to his adversaries, he avoids entering into the details of its realization, and in particular, on the technique used to trace on the arms of the compasses the scale to make the calculations.[8] Notwithstanding this precaution, a Baldassarre Capra in Milan badly copies Galileo's essay, publishes it in Padua under the title *Usus et fabrica circini cuiusdam proportionis*, and even maintains that Galileo's essay, published in 1606, has been copied from his own essay, published in 1607… .

[7] G. Galilei, 1606, *Le operationi del compasso geometrico e militare*, Pietro Marinelli ed., Padova.

[8] G. Galilei, 1606, *Le operazioni del compasso geometrico et militare,* Pietro Marinelli, Padova, in *Classici della Scienza, UTET, 1980.*

Galileo's move follows immediately. He takes Capra to court, even if the latter is an unprepared fool who would never have been able to create a compass, and probably acted thus because incited by somebody else. Indeed, the trial ends quickly, with the recognition of Galileo's full right "*…since Capra could not answer, nor account for what he had added in the above-mentioned book, these gentlemen were convinced that Capra had actually copied Galileo's book into his own book…*".

The court also ordered to destroy all the copies of Capra's pamphlet.[9]

Perhaps, once his rights had been acknowledged, Galileo should have been satisfied. However, he publishes a further pamphlet with an explicit title: *Defense of Galileo Galilei against slanders and frauds on the part of Baldassare Capra from Milan,* which certainly discourages Capra from using such unfair means again, but at the same time further irritates the person hiding behind poor Capra, namely his teacher Simon Mayr (or Simon Mario), a shameless and spiteful person, who shall even attempt to take possession of Galileo's discovery of the Medici satellites of Jupiter, probably just because of the rage accumulated in this circumstance.

Apart from these troubles, the years which Galileo spent in Padova, as he will write himself, are "*the best years of my life*", because he enjoys freedom of thought and teaching. As far as Astronomy is concerned, his classes, where he examines the *Almagest* by Ptolemy, the *Mechanics* by Aristotle, and the *Tractatus de Sphaera* by Giovanni di Sacrobosco—namely all the classic astronomical books at the time—are always crowded with students. On the other hand, as far as his private life is concerned, Galileo still enjoys good wine, and together with his pupil Francesco Sagredo, has a good time making jokes on the hypocrisy of some priests.

Once, the two friends, passing themselves off as a rich widow, had started exchanging letters with a Jesuit monastery in Ferrara, in order to ask for suggestions about the best will she could write in order to protect her own soul after death, and had obtained clear hints… .

Between the end of the sixteenth century and the start of the seventeenth century, the big drive against Copernicus had not started yet. Apart from some disturbing episodes, such as the condemnation of Giordano Bruno, there is some tolerance in the whole of Europe. In 1597, the well-known German astronomer Johannes Kepler writes in his essay "*Prodromus dissertationum cosmographicarum continens Mysterium Cosmographicum*" the most explicit defence of the Copernican system published so far, although in a Lutheran country.

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[9] G. Galilei, 1607, *Difesa di Galileo Galilei contro alle calunnie ed imposture di Baldassarre Capra Milanese,* Tomaso Baglioni, Venezia, (digitized by Museo Galileo—Istituto e Museo di Storia della Scienza, Firenze) p. 22v "*… non avendo il Capra saputo rispondere, né renedere buon conto sopra le cose per lui aggiunte nel predetto libro, restorno detti Eccellentissimi Signori molto ben certi, che in effetti il predetto Capra havesse in gran parte trasportato il libro del predetto Galilei nel suo…*".

When Galileo receives a copy of the *Mysterium,* he writes a thank you letter to Kepler, where he declares himself a convinced follower of Copernicus, even though he is probably not entirely persuaded by the mystic hypotheses and the Neoplatonic vein characterizing this essay and therefore does not care going on with this correspondence.[10]

A few years later, however, sky events address once again Galileo's attention towards the study of Astronomy. A rare "new star" appeared in the sky; practically, what we nowadays define a "supernova". Moreover, this new star, which suddenly appeared in 1604, starts fading a few weeks later, until it almost disappears.

The causes of this phenomenon are nowadays well known; even though the event of 1604 represented the last time this was observed in our Galaxy. The event was caused by a complex mechanism which is very important in the Universe, as we think of it now, because it is the only possible means of creation of heavy elements, such as lead, tungsten, uranium, gold and silver, which we find on the Earth, and should have formed after the birth of the Universe.[11]

The study of this event is nowadays quite relevant for a number of reasons concerning astrophysics, nuclear physics, theoretical physics and cosmology. However, even in the seventeenth century, it did not constitute a simple curiosity; rather, it was considered such an important event, that it almost turned the framework of cosmology drawn by Aristotle and Ptolemy upside down, so much so that Kepler decides to devote to this event a whole essay, with the title "*De stella nova*".

The question, though full of revolutionary consequences, is actually quite simple.

Aristotles' world, which has been left almost unchanged until the seventeenth century, is the world of crystal spheres. The cosmos is a very large solid sphere, which contains other spheres, where the planets we observe in the sky—Mercury, Venus, the Moon, the Sun, Mars, Jupiter and Saturn—are framed. The farthest stars are set inside a further sphere, the sphere of fixed stars. All these spheres,

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[10] G. Galilei, 1597, *Letter to I. Keplero, 4 August 1597,* in 1966, *Le Opere di Galileo, vol. X,* G. Barbera ed., Firenze, "*Multas conscripsi et rationes et argumentorum in contrarium eversiones, quas tamen in lucem hucusque proferre non sum ausus, fortuna ipsius Copernici, praeceptoris nostri…*".

[11] The mass of stars which are going to die, namely White Dwarfs, cannot exceed a certain limit, because otherwise the star structure could not support its weight. Since most existing stars are not constituted by single stars, but rather by systems, made up of at least a couple of stars, a white dwarf may be orbiting together with a giant star. Provided there is a short distance between the two stars, the outer layers of the giant star, because of gravitational attraction, detach themselves from it and move to the white dwarf, which thus acquires a bigger mass. The white dwarf thus exceeds the limit beyond which the star structure becomes unstable, and violently collapses, while triggering off a process of quick nuclear fusion, with the creation of heavy elements, which are swiftly expelled from the star. The white dwarf which, because of its small dimensions and low luminosity, was not visible from the Earth, suddenly becomes extremely bright but will disappear after a few weeks, when the remains of the nuclear explosion have scattered.

which are made of a transparent matter, similar to crystal, rotate around the Earth and complete a whole round each day. The length of the day is actually determined by a rotation of celestial spheres.

Naturally, the cosmologic system, which was handed down to Christian Europe, filtered by dozens of philosophers for almost 2000 years, is much more complex than this. For instance, once the rotation of spheres has explained the alternation of day and night, we might wonder why the Sun seems to be changing its position during the year, since it is low on the horizon during the winter, whereas it rises during the summer. The old scholar Eudoxus of Cnidus, almost 400 years before Christ, had given a satisfactory interpretation of this movement, by imagining that there is a second sphere, moving more slowly and in the opposite direction, which drags the Sun along a complete rotation within 1 year. The same might happen for the Moon and the other planets. The substantial difference between the two systems does not lie in the number of spheres required, but rather in the fact that—according to Aristotle—the spheres are real physical spheres, whereas Eudoxus thinks that they are mere mathematical devices which allow us to understand the stars' movements and calculate their trajectories.

This scheme of concentric spheres, which at first sight appears rationally satisfying, cannot, however, explain a phenomenon which all astronomers observe regularly, namely that some planets change direction while moving! Ptolemy, using well in advance a mathematical technique which we nowadays define Fourier analysis, and will be recognized more than fifteen centuries later, imagines that, over and above the sphere—so-called "*deferent*"—which explains the daily movement, there is a smaller sphere for each planet—so-called "*epicyclic*"—set inside the bigger sphere. The planet is forced to rotate together with the *epicyclic*, which, in turn, is transported by the *deferent*, so that the resulting movement is sometimes the sum of the movements of the two spheres (so that the planet appears to be moving in one direction), and other times is their difference (in this case, the planet appears to be moving in the opposite direction). According to Ptolemy too, these smaller additional spheres are nothing but mathematical devices which allow us to calculate the movement of planets.

Another complex phenomenon within a system of concentric spheres is the fact that planets appear to be getting near to the Earth and far from it. Some mediaeval natural philosophers had already explained this behaviour by introducing the concept of *total sphere,* namely the sphere centred upon the Earth, and the *partial sphere*, a sphere with a centre which is different from that of the other one. The movement along the total sphere of each planet may be factorized into the sum of the movements along three partial spheres, so as to maintain the central idea, according to which the whole cosmos moves harmoniously around the Earth, which constitutes its core. The price to pay is represented by the fact that the cosmos of crystal skies, in the end, is composed of a number of spheres between 27 and 55, according to the various authors.

Of course, the system is complex, but also beautiful: it feels as if we all lived inside a big clock, where all wheels move in a different way and yet, all together, they constitute a perfect mechanism. This fantastic clock realizes a philosophic

system which agrees with the knowledge of the ancient world and is therefore psychologically satisfying for all scholars, who, for centuries, never put it up for discussion.

The circular motions of planets and fixed stars constitute a divine motion, because the sphere has no starting point. As Plato explains in his dialogue "Thymeus", "*…it is the most perfect of all figures and the most similar to itself, because God judged all things similar infinitely more beautiful than things dissimilar*". The perfect circular motions are the opposite of what happens on the Earth, where natural movements take place only along vertical lines.

It may therefore be inferred that the Universe is divided into two different regions: the first region is beyond the Moon orbit, whose distance has been known since ancient times, and is characterized by the perfection and immutability of celestial bodies. The second region, defined as sublunar, can be distinguished by the continuous changing process, which includes birth and death, as well as by the natural movements, directed either up or down.

Even the material structure of the two regions is different. Planets and stars are constituted by an incorruptible substance called *ether* or *quintessence:* it is crystalline, transparent and imponderable. The earthly region, instead, is composed of four elements: earth, water, air and fire, which are also set into concentric spheres around the geometric point, which is the centre of the system of all celestial spheres. The order according to which the spheres of the elements are placed can be discovered through simple experiments: if we take a bowl, fill it with water and let some earth fall into it, we may easily see that the earth immediately touches the bottom. Therefore, we infer that the "earth" is heavier than the "water". If we blow some air with a straw into the water, we'll observe bubbles going up; therefore, the "air" is lighter than the "water". Finally, by common experience, we know that fire moves up into the air, and is, therefore, the lightest of all elements.

From these considerations, we may infer that the Earth sphere must be the lowest, as we may observe. The spheres of water, air and fire will be placed all around it. The four spheres constitute the *natural places* of the four main elements. In this way, we can explain the origin of natural movements, since *terrestrial bodies*, heavy by nature, tend to fall down, whereas *fire*, which is light, moves up. The intermediate bodies, namely air and water, have analogous motions, up or down, according to where they are. The movement of the elements tending to reach the natural place of each one accounts also of particularly striking phenomena in the sublunar world. Indeed, elements are characterized, over and above their *heaviness*, namely the cause of their upwards or downwards movements, also by other features, such as *dryness* and *dampness*, *hot* and *cold*. Since in their movements, elements meet one another, they can also mix, according to their features.

Earthquakes and eruptions, for instance, are provoked—according to Aristotle—by a mixture of fire, hot element *par excellence*, with the earth, a cold element, which provokes the explosions we may observe on the Earth surface.

This cosmological system is introduced into the Christian world around 1175, when Gherardo of Cremona translates the Almagest by Ptolemy from the Arabic. This work had remained largely unknown because ancient Greek was no longer studied in Europe. It took Christian philosophers several years to understand its contents, because during the Middle Ages, they no longer studied Geometry and could not make calculations, and Ptolemy's book contained complex problems of spherical Geometry. Probably, there were individuals who could still read the Almagest in the original Greek, but at the time, a text had to be written in a well-known language in order to be copied and handed down; otherwise, an amanuensis might have made many mistakes, since he did not understand what he was writing. A second copyist might have done even worse while trying to interpret the first version, so that, in the end, the original text would be unrecognizable. This lack of general culture generates a scarcity of texts on which scholars might study. This is one of the reasons why, during the Middle Ages, the average knowledge regressed even in the upper social classes.

When Western scholars finally understood the structure of Ptolemy's cosmos, they realized that the division of the world into two regions centred upon the Earth is very similar to the one described in the Holy Writ. We live in the first changeable and imperfect region, whereas the second region is very similar to the divine Reign of the Bible and seems suitable for the Holy Writ, provided we admit that our world has been *created*—namely, it has not always been there, as Aristotle believed. This is a relevant distinction, because, if the world has been created, it must obviously have a goal, unlike the world imagined by Aristotle, which, being eternal both in the past and in the future, appears both hopeless and aimless to a Christian.

Moreover, Aristotle's cosmology presents various aspects which are not foreign to a Christian cosmos. For instance, the unicity of the Earth, which in the seventeenth century, became a topic of theological debate. Aristotle's world, indeed, excludes the physical possibility that there might be another Earth, inasmuch as the movement of the four elements is limited to the spheres all around the Earth. If there was another place out there, made of water, earth, air, and fire, according to Aristotle's Physics, those elements would be forced to move in the same direction of the spheres which constitute their natural places and surround our Earth. In conclusion, if there really was another place made of the same materials of our own Earth, it would be destined to disappear immediately.

The concept of the unicity of the Earth, which in the Ancient Greek world was accepted without discussion, in the Christian world immediately discloses the question of God's omnipotence. Theologists start wondering whether God might create another Earth just like ours. However, common people keep thinking that the Earth is unique and also that God is omnipotent.

The Christian cosmos also inherits from Ptolemy's cosmos the delicate concept of the cause for the rotation of the spheres. The movement starts from the *Primum mobile*, a sphere outside the sphere of fixed stars, which moves according to God's will, and, because of its proximity to God, moves quickly and transmits its movement to the spheres of planets, whose movement is slower the farther they are from the engine of movement.

The *Primum mobile* is an opaque sphere, beyond which there might be the Empyrean, where God receives blessed souls, and which is therefore motionless and immutable. This raises a problem for the Christian cosmos: how is it possible—one might ask—that holy souls may reach Heaven by crossing the spheres of both planets and fixed stars? This is the same question which people, in a more scientifically appropriate manner, ask about the nature of comets—namely, "if comets come from a far-away point in the Universe, how can they reach us after crossing the crystal spheres?"

The answer to this question was given in 1577 by a radically different cosmologic vision. Tycho Brahe is one of the most important observational astronomers before the introduction of the telescope. His measurements will allow scientists to make important astronomical discoveries, such as the orbit and speed of planets, which will be determined by Kepler. Brahe, based on his observations, introduces a cosmological system which may accurately describe what an observer may see in the sky from the Earth and suggests that the Sun and the Moon rotate around the Earth, whereas Mercury, Venus, Mars, Jupiter and Saturn rotate around the Sun, together with fixed stars. The so-called Tychonic system does not only include the movements of celestial bodies according to available observations; it also overcomes the existence of crystal spheres which, by crossing one another, must be considered *fluid*, therefore penetrable. After all, this is only another way of saying that crystal spheres may be useful in order to represent the movements in the cosmos but, in fact, do not really exist.

Tycho's cosmological system offers several advantages. First of all, since it represents the viewpoint of an observer on the Earth, it allows to calculate the orbits of planets directly and intuitively; secondly, once freed from the rigid crystal spheres, it does not have to explain how comets manage to cross them if they come from a long distance. A further advantage of the Tychonic system will turn up when Galileo discovers four satellites rotating around Jupiter: in Ptolemy's system, where all celestial bodies rotate around the Earth, the movement of these satellites cannot be explained. On the other hand, within Tycho's new system, it does not constitute a logical difficulty, since these new celestial bodies simply share with all planets the power not to rotate around the Earth. The last advantage of the Tychonic system is also its limit. We know that one of the objections to the Copernican system is that we cannot observe the stars' parallaxis from the Earth: if the Earth moved around the Sun, indeed, on the Earth we should observe its reflected movement and should see the stars make a circle in the sky during the year. Since we cannot observe that the stars go along this so-called parallaxis circle, we conclude that the Earth does not rotate around the Sun, just like the Tychonic system envisages, in opposition to the Copernican system. The conclusion is wrong for a reason which Tycho could not know, namely the stars' parallaxis does exist, but cannot be observed with the naked eye because it is extremely small, inasmuch as the stars are at a huge distance, far greater than they could have imagined 400 years ago.

The Jesuits like the new system because, instead of the troublesome and uncomfortable system of deferents and epicycles, it provides a logical framework

for the celestial movements which are observed and confirms that comets, as Father Grassi said, come from far-away regions of the Universe. Finally, this system removes an obstacle on the path of blessed souls towards Heaven.

Useless to say, progressive Catholics like the Tychonic system, because it allows them somehow to put aside the Copernican system, a moot point in the debates within both Catholic and Protestant circles.

Copernicus' work had been motivated by the need for a simple system: in Ptolemy's system, in fact, not only the number of spheres was extremely high, but, in addition, the Earth had lost its centrality, because it was located in the "equant" point. This is a point placed inside the deferent spheres, but not at their centre, from which an observer from the Earth observes the planets move at a different angular speed during the year, an effect actually due to the elliptical orbits of the planets. Copernicus' need for simplicity had been largely disappointed by the later development of the system, which still required not only to maintain the crystal spheres, but also the fund of minor spheres, introduced by Ptolemy's system. Therefore, the problems of the comets' motion and the ascent of holy souls to Heaven remained still unresolved (Fig. 3.1).

The Jesuits, as we know, represent the avant-garde of Catholic science, and their acceptance of Tycho's cosmological systems worsens the conflict with the most conservative part of Catholic orthodoxy, represented by the Dominican friars who, supposedly allied with the Church hierarchies, still cling to classical cosmology. The *stella nova* of 1604 seems to offer the chance to settle the question between Ptolemy's and Tycho's vision of the Cosmos.

According to the Aristotelian cosmology revisited by Ptolemy, the *stella nova* which suddenly appeared in the sky cannot be placed in the immutable part of the Universe, which lies beyond the Moon, so that most Orthodox Catholics are forced to say that what looks like a new star is not really a new celestial body, but rather the result of some phenomenon, or even an optical effect which comes from the Earth' atmosphere. In order to solve the question, the distance should be measured. If the *nova* was nearer than the Moon, we could say that it is a local phenomenon. On the other hand, if it were confirmed that the object was lying at a very large distance, almost comparable to the fixed stars, we could obtain the definitive proof that the old cosmology is outdated, and the world should be imagined—from now on—in a different way. Several astronomers start working for measuring the *local parallaxis* of the *stella nova*, a measurement which may be made accurately, even though Galileo has not introduced the telescope as yet and consists in observing from two different places on Earth the position of the object and of some fixed stars in the sky, and measuring their relative shifting. Clearly, if the *stella nova* is at the same distance of fixed stars, its position will be the same from wherever we observe it, whereas, if it is near the Earth, we shall observe a different shifting. The results, repeated by several astronomers, are unequivocal, because the star, observed from two cities—which were considered sufficiently far-away, such as Padua and Verona—appears in the same position as compared to the farthest stars. Therefore, the new star must be in the region of the immutable Universe, at a far greater distance than the Moon, Jupiter and even Saturn.

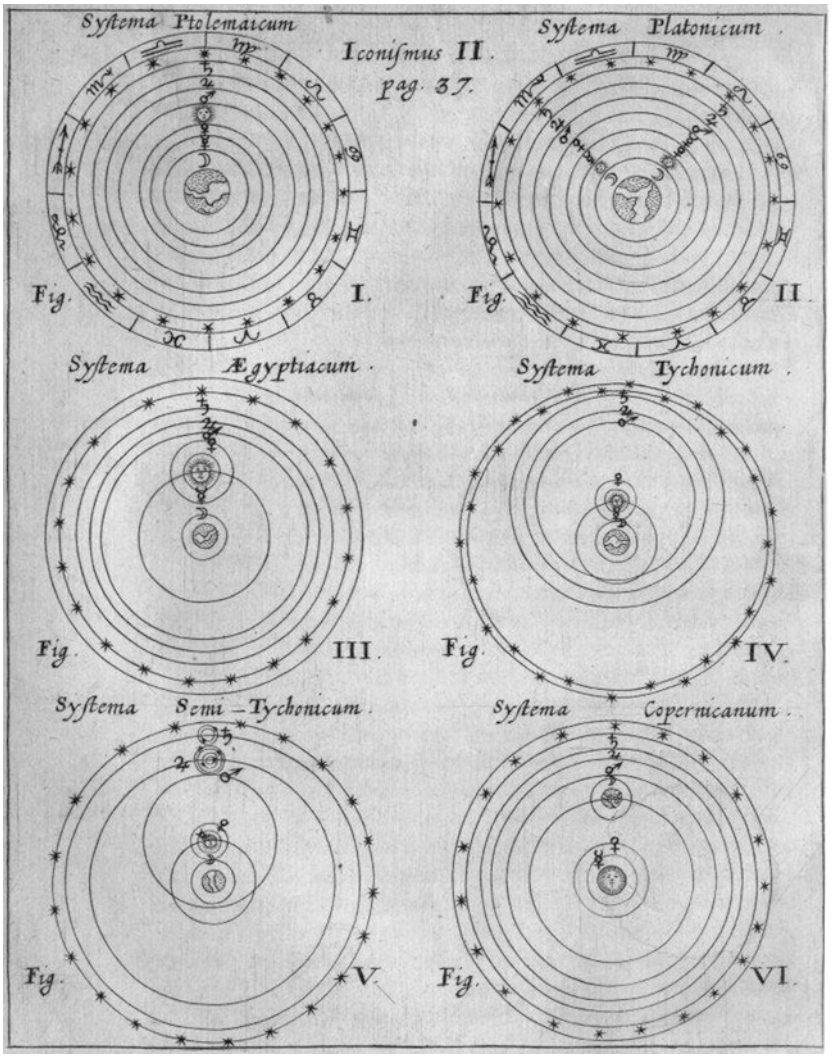

Fig. 3.1 *The seventeenth century cosmological systems.* (A. Kircher, 1671, *Iter exstaticum coeleste quo mundi opificium id est Coelestis expansi*…. Herbipolis, Johannis Andreae Endteri and Wolfgangi Jiunioris Haeredum, p. 37, digitized by Google). The systems created by Ptolemy, Tycho Brahe and Copernicus are indicated, respectively, with the Roman numbers I, IV and VI. Other cosmologies in the figure are essentially variations of the three main systems. Note that the cosmological system which Kircher defines as semi-Tychonic is essentially an update of Tycho's system, which reports the four Medici's satellites of Jupiter which, in Tycho's age, had not been discovered yet. The two bodies around the last planet, Saturn, cannot indicate its satellites, since while Huygens discovered the first one in 1655, one year before the publication of *Itinerarium Extaticum* (i.e. the first edition of the present book), the second was discovered by Cassini in 1675. As a consequence, the two points we may observe around Saturn must indicate Saturn's ring

Aristotle's followers react to this blow with inconsistent theories, such as that of Lodovico delle Colombe, a scholar from Florence, who says that, even if the new star is not an effect of the atmosphere, it must be a star which already existed.[12] Its sudden appearance could be the result of a local swelling of a celestial sphere[13] (if he wanted to save the perfection of the sky, he had used a medicine which produced an effect practically worse than the illness it should have cured).

Galileo, needless to say, does not miss this chance to use his sarcasm. In a pamphlet written in a Venetian dialect, in which he writes, with the signature of a figurehead, he makes the protagonist exclaim "*What a nuisance! This star was wrong in spoiling their philosophy!*"[14]

Naturally, in such important questions, the behaviour of a stubborn follower of Aristotle such as Delle Colombe is different from the behaviour of a careful scholar such as Cristoforo Clavio who, from the Collegio Romano, observes the new star and, forced to conclude that it must be very far from the Earth, even beyond Jupiter,[15] writes to Galileo "…*Here they talked a lot about the stella nova, which we have discovered in the 17th degree of height, with a boreal latitude of about 1 1/2 degrees. If you have made some observation, please let me know*…"[16] The Jesuit's request can be fully understood because, even though the letters exchanged between the two were fewer and fewer because of the growing engagements of both scholars, the relationships between them remained excellent, as we can see from the letter in which Clavio apologizes and provides a curious explanation of the fact that Galileo has not received the essay on the calendar: "*I am almost ashamed of my negligence, in letting you know that, at least 11 years ago, I had my Astrolabe published in 1593, sent you one copy, addressed to S.or Balì of Siena; in 1600 I went to the baths of S. Casciano and Siena, I found out that the book had not been sent to you, because he had left from Pisa while I was kept in the dark about this; a gentleman from Siena had taken the book, and since he asked me, I gave it to him.. Interim I am sending you the Geometria Prattica, just*

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[12] L. Delle Colombe, 1606, "*Discorso di Lodovico delle Colombe nel quale si dimostra, che la nuova Stella apparita l'Ottobre passato 1604*…". *Giunti, Firenze,* p. 32 *(digitized by Google)* "*Dico adunque la stella vedutasi l'Ottobre 1604 ne' 18 gradi del Sagittario, si come quella, che nella Cassiopea si vide l'anno 1572, e le altre di questa guisa nel Cielo apparite ne sono, qual fù quella che osservò Hiparco ne' tempi suoi, niuna altra cosa essere che una vera stella di quelle, che furono da principio nel Cielo*…".

[13] L. Delle Colombe, *ibidem,* p. 21 "*Vogliono altri, che quelle nuove stelle siano una parte condensata di Cielo, affermando cotale spessamento in quel semplice corpo altro non cagionare che perfezione maggiore*…".

[14] G. Galilei, 1605, *Dialogo de Cecco di Ronchitti da Bruzene,* Pietro Paulo Tozzi, Padova, p. 18, "*Cancaro, l'hà bio torto sta stella, a deroinare così la filuoria de costoro!*"

[15] C. Clavio, 1604, *Letter to G.A. Magini,* quoted in I. Altobelli, 1604, *Letter to Galileo Galilei,* 30 December 1604.

[16] C. Clavio, 1604, *Letter to Galileo Galilei,* 18 December 1604, in 1966, *Le Opere di Galileo, vol. X,* G. Barbera ed., Firenze, "…*Qui è stato un gran bisbiglio della stella nova, la quale habbiamo trovata nel 17 grado di altezza, con latitudine borea di gradi 1 1/2 in circa. Se V. S. ha fatto qualche osservatione, mi farà piacere d'avisarmi*…".

printed, though it is unworthy of you; however, I do this so as to keep our friendship alive".[17]

In the summer of 1609, because of one of those fortuitous circumstances which can change your life, Galileo discovers the existence of a telescope, and since he considers it rough and expensive, as suggested by his friend Paolo Sarpi, he decides to build one in the small workshop inside his house. At the end of the summer, he can already show a prototype to the authorities of the Republic, who are astonished by the power of that small instrument, which magnifies the objects almost by ten. The *occhiale* or *cannone*, as the telescope was defined from now on, changes the professional (and the personal) life of Galileo, both because it earns him an increase in his University salary, and because it enlarges the number of people speaking evil of him behind his back. Certainly that instrument will offer to the whole of humankind a completely new vision of the world where they live.

Starting from the Autumn of 1609, Galileo points his telescope towards the sky and is amazed for the objects which he observes and describes, a few months later, in his book *Sidereus Nuncius*. It is a very small book, almost a register of observations, which he reports in the first person "*It is a most beautiful and delighted sight to see the Moon as near as twice the Earth's semi-diameters… anyone may be convinced that the Moon surface is not smooth, but rather rough and uneven, and, just like the face of the Earth, full of large protuberances, deep hollows and gorges*".[18]

Galileo observes the Pleiades and Orion's belt and draws himself some beautiful maps of those regions, and then goes on to the "*…essence or matter of the MILKY Way, which can be seen so clearly with the telescope that all discussions, which have worried philosophers for so many centuries, are dispelled by the certainties of sensible experience…*" because "*…the GALAXY is nothing but a cluster of innumerable stars dispersed in plenty…*"[19] (capital letters in the original

[17] C. Clavio, *ibidem*: "*Mi vergogno quasi della mia negligentia, in fare a saper V. S. come molti anni sono, almeno 11, che finito di stampare il mio Astrolabio, l'anno 1593, mandai subito uno a lei, et indrizzai al S.or Balì di Siena; et andando io l'anno 1600 a i bagni di S. Casciano et a Siena, trovai che 'l libro non era mandato a V. S., perchè s'era partito da Pisa senza sapere io niente di questo; et un gentilhuomo Sanese s' l'haveva usurpato per sé, et pregandomi gli lo donai.. Interim gli mando la Geometria Prattica, stampato adesso, benchè non è degna di lei; ma lo fo per continuare l'amicitia tra noi*".

[18] G. Galilei, 1610, *Sidereus Nuncius,* Thomam Baglioni, Venetiis, p. 5, *Pulcherrimum atque visu iucundissimum est, lunare corpus, per sex denas fere terrestres semidiametros a nobis remotum, tam ex propinquo intueri, ac si per duas tantum easdem dimensiones distaret…. deinde sensata certitudine quispiam intelligat, Lunam superficie leni et perpolita nequaquam esse indutam, sed aspera et inæquali; ac, veluti ipsiusmet Telluris facies, ingentibus tumoribus, profundis lacunis atque anfractibus undiquaque confertam existere.*

[19] G. Galilei, 1610, *ibidem,* p. 16, "*a nobis fuit observatum, est ipsiusmet LACTEI Circuli essentia, seu materies, quam Perspicilli beneficio adeo ad sensum licet intueri, ut et altercationes omnes, quæ per tot sæcula philosophos excruciarunt, ab oculata certitudine dirimantur, nosque a verbosis disputationibus liberemur. Est enim GALAXIA nihil aliud, quam innumerarum Stellarum coacervatim consitarum congeries…*".

text). However, of course, the author keeps the most important discovery for the conclusion.

Galileo starts off solemnly, in order to underline the historical event which he is going to announce "…*On the seventh of January of the year one thousand six hundred and ten, at one o'clock at night, while I was observing with my telescope, I came across Jupiter; …I saw three small but very bright stars around it…*"[20] and describes in detail the position of the small stars, which change day after day. A description which seems long-winded because it occupies three quarters of the whole book, but is actually the report of an experiment, almost a rhetorical device to show the inevitable conclusion he is going to draw "I therefore concluded without doubts that there were stars drifting around Jupiter, just as Venus and Mercury drift around the Sun…".[21]

Thus—Galileo goes on—the old objection to Copernicus' system falls down: indeed it required that the Moon, considered a planet like any other, should rotate around the Earth, not around the Sun, because "*now, in fact, we do not have just one planet turning around another one, while they both go along the large orbit around the Sun, but the experience shows us four stars moving around Jupiter, just like the Moon moves around the Earth, whereas all together with Jupiter, with a period of twelve years, they rotate around the Sun*".[22]

The revolutionary power of *Sidereus Nuncius* does not only lie in its contents, but essentially in the concept, which finds its expression for the first time in history, that scientists, by using their rationality, can investigate that part of the Universe which cannot be submitted to experiments.[23]

The reactions of all those who still do not believe in such news appear sometimes full of rage and senseless, while sometimes they are worth of attention, because they either suggest that the transparency of the air might have created a mirage or suppose that the images Galileo observed with his telescope are not real,

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[20] G. Galilei, 1610, *ibidem,* p. 17, "*Die itaque septima Ianuarij instantis anni millesimi sexcentesimi decimi, hora sequentus noctis prima, cum caelestia sidera per Perspicillum spectarem, Iuppiter sese obviam fecit…. Tres illi adstare Stellulas, exiguas quidem, veruntamen clarissimas, cognovi….*

[21] G. Galilei, 1610, *ibidem,* p. 18 *Statutum ideo omnique procul dubio a me decretum fuit, tres in caelis adesse Stellas vagamntes circa Iovem, instar Veneris atque Mercurii circa Solem….*

[22] G. Galilei, 1610, *ibidem* p. 28 "*nunc enim, nedum Planetam unum circa alium convertibilem habemus, dum ambo magnum circa Solem perlustrant orbem, verum quatuor circa Iovem, instar Lunæ circa Tellurem, sensus nobis vagantes offert Stellas, dum omnes simul cum Iove, 12 annorum spatio, magnum circa Solem permeant orbem*".

[23] In fact, over and above the peculiar status of the Moon, there are, at the time, several further objections to the system of Copernicus, and we may wonder why Galileo still supports him with so much conviction. Perhaps this system offers a scientist like Galileo the intrinsic merit of not allowing *ad hoc* adjustments. In other words, the system prevents anyone from changing the dimensions or the positions of both epicycles or deferent because, as Copernicus says in *De Revolutionibus orbium coelestium*, "*the order and magnificence of all stars and spheres, and of the sky itself is so well-connected that you cannot move anything anywhere without generating confusion of parts and of the whole*".

but rather produced by the optics of his instrument. Perhaps, the most significant reaction was that of Cesare Cremonini, a collegue and a personal friend of Galileo. He was a convinced disciple of Aristotle and refused to approach the telescope, saying that "*observing with those lenses makes me feel dizzy: that's it, I do not want to know anything else…*".[24]

However, this had no importance: Galileo's fame is by now at a European level. In the month of June 1610, the Grand duke offers him the chance to go back to Tuscany at a favourable economic condition, and without teaching duties, which Galileo always considered a waste of time.

Naturally, some people recognize the soundness of his observations at once. For instance, Johannes Kepler, "Imperial Mathematician", who immediately writes a short essay, the "*Dissertatio cum nuncio sidereo*", which he sends to Galileo, who, however, does not show openness towards the German astronomer. Probably, Galileo is not actually cold, but simply professionally reserved, since his telescope keeps showing him marvellous celestial objects, which he cannot reasonably anticipate to a colleague, even though a well-known one like Kepler.

In the month of July, indeed, in a letter to the Secretary of State, Belisario Vinta, Galileo shows that he has inferred that the shape of Saturn is special because, even though he cannot manage to observe the ring around the planet, he says that Saturn seems to be composed of three aligned stars, and writes "*On the 25th I started to see eastern Jupiter in the morning, together with its crowd of Medici planets, and I discovered another eccentric marvel… Saturns' star is not one, but rather a group of 3, which almost touch one another, but never move or change; they are placed along a line according to the length of the zodiac, since the middle one is about 3 times bigger than the other two: and this is the shape in which they lie*  ".[25]

Galileo lives therefore a moment of grace, but does not neglect his relationships with the old teacher at the Collegio Romano: he writes a letter to Clavio with his usual respect "*It's high time I broke my silence with you, more material than intentional, since I thought about you…*". Since he had heard that the Collegio has been given a telescope by a Venetian artisan, Antonio Santini, Galileo encourages him to pursue his attempts at observing Jupiter's satellites "*I have heard that, together with one of your Brothers, you have tried to locate with a telescope the Medici satellites around Jupiter and did not manage to find them. This does not*

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[24] P. Gualdo, 1611, *Letter to Galileo Galilei,* 29 July 1611, in 1966, *Le Opere di Galileo, vol. XI,* G. Barbera ed., Firenze, "*Credo che altri che lui non l'habbia veduto; e poi quel mirare per quegli occhiali m'imbalordiscon(506) la testa: basta, non ne voglio saper altro*".

[25] G. Galilei, 1610, *Letter to Belisario Vinta,* 30 July 1610, in 1966, *Le Opere di Galileo, vol. X,* G. Barbera ed., Firenze, *"Ho cominciato il dì 25 stante a rivedere Giove orientale mattutino, con la sua schiera de' Pianeti Medicei, et più ho scoperto un'altra stravagantissima meraviglia… Questo è, che la stella di Saturno non è una sola, ma un composto di 3, le quali quasi si toccano, nè mai tra di loro si muovono o mutano; et sono poste in fila secondo la lunghezza del zodiaco, essendo quella di mezzo circa 3 volte maggiore delle altre 2 laterali: et stanno situate in questa forma"*.

surprise me, since the instrument might not be suitable, or else you did not keep it still; this is indispensable, because if you keep it in your hands, though leaning on a wall or somewhere else, even the blood running in your arteries, or just your very breathing, makes it impossible to observe them, especially if you have never seen them before, and you are not very experienced in using this instrument…".[26]

Clavio'a letter is equally friendly. He apologizes for not answering immediately, because "*…I wanted first to try and see the new Medici planets: indeed we have seen them here in Rome more than once, and very clearly…they are evidently not fixed stars, but rather erratic stars, since they move among themselves and with respect to Jupiter. Indeed you are worthy of praise, since you have been the first one who observed them…*".[27] Galileo answers this letter with gratitude, because Clavio's witness will help him in the academic debate, as well as in his irony, when he says that the Jesuit's letter "*convinced some of the unbelievers; there are still some obstinate ones, who think that your letter is a false, or was written to please me, and wait that I can find a way to make one of the four Medici planets come down from the sky to prove their own existence and clear up their doubts; there's no other way to gain their consent.*"[28]

A few months after the publication of *Sidereus Nuncius,* the astronomers of the Collegio Romano, though prudently, recognize that the cosmology taught in the Jesuit schools requires a careful revision, as Clavio's disciple Cristoph Grienberger admits in a letter to Galileo from the Collegio Romano "*…what you say cannot be accepted light-heartedly, and it is certainly difficult to abandon opinions which have been consolidated through so many centuries thanks to many scholars. Unless I had observed with my own eyes those prodigies which you had observed first, I do not know if I could believe it…*".[29]

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[26] G. Galilei, 1610, *Letter to Cristoforo Clavio,* 17 September 1610, in 1966, *Le Opere di Galileo, vol. X,* G. Barbera ed., Firenze, " *tempo ch'io rompa un lungo silenzio, che la penna, più che 'l pensiero, ha usato con V.S.M.R… ho inteso come ella, insieme con uno dei loro Fratelli, havendo ricercato intorno a Giove, con un occhiale, de i Pianeti Medicei, non gli era succeduto il potergli incontrare. Di ciò non mi fo io gran meraviglia, potendo essere che lo strumento o non fusse esquisito sì come bisogna, o vero che non l'havessero ben fermato; il che è necessariissimo, perchè tenendolo in mano, benchè appoggiato a un muro o altro luogo stabile, il solo moto dell'arterie, et anco del respirare, fa che non si possono osservare, et massime da chi non gli ha altre volte veduti et fatto, come si dice, un poco di pratica nello strumento…*".

[27] C. Clavio, 1610, *Letter to Galileo Galilei,* 17 December 1610, *ibidem* "*… volevo prima tentare di vedere i novi Pianeti Medicei: et così l'habbiamo qua in Roma più volte veduti distintissimamente…chiarissimamente si cava che non sono stelle fisse, ma erratiche, poi che mutano sito tra sè et tra Giove. Veramente V. S. merita gran lode, essendo il primo che habbi osservato questo…*".

[28] G. Galilei, 1619, *Letter to Cristoforo Clavio,* 30 December 1610, *ibidem* "*…ha guadagnato alcuno degl'increduli; ma però i più ostinati persistono, et reputano la lettera di V.R. o finta o scrittami a compiacenza, et insomma aspettano che io trovi modo di far venire almeno uno dei quattro Pianeti Medicei di cielo in terra a dar conto dell'esser loro et a chiarir questi dubbii; altramente, non bisogna che io speri il loro assenso…*".

[29] C. Grienberger, 1611, *Letter to Galileo Galilei,* 20 January 1611, in 1966, *Le Opere di Galileo, vol. XI,* G. Barbera ed., Firenze, "*…quanto tu asserisci non può essere accettato a cuor*

The mathematicians of the Collegio Romano do not hesitate to explain to Cardinal Bellarmino, a very influential member of the Catholic community and a Consultant of the Holy Office, that "*…we cannot deny that there are small stars along the Milky Way…we have observed that Saturn is not round, as Jupiter and Mars appear to be, but rather oval-shaped and oblong like this*  *… it is true that Venus gets smaller and bigger, like the Moon: since we have seen it almost full, in the evening, we have observed that, little by little, the brighter side was getting smaller…we cannot deny the unevenness of the Moon…*" and finally, "*…we can see four stars around Jupiter, which move together or in part, very quickly either eastwards or westwards, in a line: they cannot be fixed stars, since they move much faster than them, and constantly change their distance among themselves, and from Jupiter as well…*".[30]

We should note that the attention to the discoveries, shown by the astronomers of the Collegio Romano, is foreign to the members of the Aristotle Academy, who would rather consider the whole world wrong rather than doubting their old convictions. This group is represented once again by Lodovico Delle Colombe who, since he can no longer deny that the Moon seems to be very similar to the Earth, with its valleys and mountains, resorts to a stratagem, saying that those shadows observed on the Moon surface might be inner irregularities seen against the light. Delle Colombe evidently thinks that it is still possible to save Aristotle's cosmology if it is accepted that the planets are constituted by smooth, transparent crystal. However, as far as irregularities are concerned, the "*…difference between myself and Mr. Galileo, is that he thinks they are on the surface, just like the Earth, which is surrounded by air; whereas I think that they are inside the body rather than on its surface, because they are dense, whereas the rest of the body is full of lighter parts, so that the whole body would have a completely smooth surface…*"[31]

(Footnote 29 continued)
leggero ed è certamente difficile abbandonare opinioni che si sono consolidate in tanti secoli grazie al lavoro di tanti sapienti. E se non avessi osservato con i miei occhi quei prodigi che tu hai osservato per primo, non so se potrei crederci… .".

[30] Letter of the Mathematicians of the Collegio Romano to Roberto Bellarmino, 24 April 1611, *in ibidem* "*… non si può negare che non ci siano ancora nella Via Lattea molte stelle minute…habbiamo osservato che Saturno non è tondo, come si vede Giove e Marte, ma di figura ovata et oblonga in questo modo…è verissimo che Venere si scema, et cresce come la luna: et havendola noi vista quasi piena, quando era vespertina, habbiamo osservato che a puoco a puoco andava mancando la parte illuminata… non si può negare la grande inequalità della luna…*" "*…si veggono intorno a Giove quattro stelle, che velocissimamente si movono hora tutte verso levante, hora tutte verso ponente, et quando parte verso levante, et quando parte verso ponente, in linea quasi retta: le quali non ponno essere stelle fisse poichè hanno moto velocissimo et diversissimo dalle stelle fisse, et sempre mutano le distanze fra di loro et Giove…*".

[31] L. Delle Colombe, 1611, *Letter to C. Clavio,* 27 May 1611, in *ibidem* "*… differenza tra me ed il Sig. Galileo, ch'egli tiene ch'elle siano nella superficie, a guisa della terra ch'è circondata dall'aria; ed io tengo ch'elle siano per entro quel corpo, e non nella superficie, perchè sono parti più dense, e il restante del corpo sia ripieno di parti più rare, sicchè sia tutto un corpo, con una sola superficie liscia e in niuna parte diseguale o dentata…*".

◀ **Fig. 3.2** *Ludovico Cardi, Il Cigoli, 1610–1612. Assumption of the Virgin, Rome, S. Maria Maggiore.* Lodovico Cardi is fond of Astronomy and is an old friend of Galileo, with whom he discusses observation techniques "*…I do not think I wrote to you about my telescope. It is a good one, since from Santa Maria Maggiore I manage to see the details of Saint Peter's… . I can see the Moon very well, and around it, though towards its bright part, I do notice some irregularities: I can clearly see Jupiter's stars…*".[34] The fresco is in the Paoline Chapel of the Basilica of S. Maria Maggiore. It is the last work of this Tuscan painter in Rome. He will die in 1613. The figure of the Virgin, richly dressed, rests her feet on the Moon, according to the traditional iconography. Cigoli's new interpretation consists in the representation of the Moon, which shows a surface full of craters and mountains, just like the one described by Galileo in the *Sidereus Nuncius.* The fact that the Moon is partially lightened emphasizes the craters

Galileo's answer leaves its mark and is entrusted to a letter addressed to Gallanzone Gallanzoni, secretary of Cardinal Francesco de Joyeuse. The long letter, which takes to pieces all the inconsistencies of Delle Colombe, ends up with the words "*…these mistakes are so gross, that they make us wonder how there might still be such foolish minds, capable of such downright nonsense…*".[32] Galileo is certainly right: however, he appears particularly heedless of the risk of creating enemies who are looking forward to making him pay for it.

The interest for the new discoveries is not limited to the small circle of specialists, as the following works show. The first one is a fresco by Ludovico Cardi, called *Il Cigoli* (Fig. 3.2), who, when he is commissioned the decoration of the Paoline chapel in the Church of S. Maria Maggiore, does not find it strange (he is obviously given permission) to paint the Virgin ascending to the sky with her feet on the Moon. This would not be surprising, apart from the fact that the Moon is painted in a particularly realistic way, with the craters which Galileo observed, and is therefore very different from the perfect sphere of Aristotle's old scheme. The painter's choice looks like a challenge to the core of orthodoxy, as is confirmed by the letter which Federico Cesi sends to Galileo: "*Mr. Cigoli has given his best in the dome of the chapel inside S. S.tà a S. Maria Maggiore. As the good and true friend he is, under the image of the Virgin, he has painted the Moon as you discovered it, with its dents and islands. We are often together, talking about people's envy for your fame*".[33]

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[32] G. Galilei, 1611, *Letter to Gallanzone Gallanzoni,* 16 July 1611, in *ibidem* "*…sono errori tanto grossolani, che generano meraviglia immensa come possino ritrovarsi al mondo cervelli così stolidi, che di sì solenni scempiaggini siano capaci…*".

[33] F. Cesi, 1612, *Letter to G. Galilei,* 23 December 1612, in *ibidem* "*Il S. Cigoli s'è portato divinamente nella cupola della capella di S. S.tà a S. Maria Maggiore, e come buon amico e leale, ha, sotto l'imagine della Beata Vergine, pinto la luna nel modo che da V.S. è stata scoperta, con la divisione merlata e le sue isolette. Spesso siamo insieme, consultando contro l'invidia della gloria di V. S*".

[34] L. Cardi, 1612, *Letter to G. Galilei,* 23 March 1612, in *ibidem* "*…Non credo avere scritto a V. S. come io ò uno ochiale, et è assai buono, tanto che veggo da Santa Maria Maggiore l'orivolo di S.o Pietro… La luna la veggo benissimo, e nel dintorno, pur di verso la parte luminosa, qualche inegualità: le stelle di Giove me le mostra benissimo…*".

Fig. 3.3 *Adam Elsheimer, 1609,* "*The flight to Egypt*" *(Munich, Alte Pinakothek).* Although this painting on copper is only 31 × 41 cm wide, there is a remarkable richness of details. The Moon is certainly different from a smooth crystal sphere, and, though extremely bright, it does not hide the Milky Way. Surprisingly for that age, the Milky Way is represented not like a bright strip, but rather as a crowd of tiny stars. The sky, though rich of details, does not allow us to identify the constellations. Therefore, the painter might have added the stars at a later stage. This is still a moot point, because Elsheimer dies in 1610, shortly after the date written on the back of the painting itself

In this context, we find a significant small painting in which Adam Elsheimer, a German painter who moved to Roma at the start of the century, represents the flight to Egypt of the Holy Family (Fig. 3.3). This painting, which is now in the Alte Pinakothek in Munich, has been studied not only for its artistic quality, and for its evocative character, but also for its astronomical details.[35] In this painting, in which there are no angels, as it was usual at the time, the image of the Holy Family is small and completely decentralized, while most of the painting is occupied by the night sky, with the Milky Way crossing it diagonally from left to right. The Milky Way itself is not represented by a bright strip, as it appears to the naked eye, but rather by a crowd of small stars, which are only visible if you observe it with a telescope, as Galileo did. In the night sky, you can see the Ursa Major and the Moon, which is magically mirrored in a small lake and shows in detail its irregular surface. The only non-astronomical sources of light are represented by a fire, which a few shepherds have lit inside a cave, and Joseph's light,

[35] M. Kemp, 2006, *Nature,* 442, 276.

which lights up the face of the Madonna and of the sleeping baby. On the back of the painting, we find the signature *Adam Elsheimer fecit Romae, 1609*, the year in which Galileo makes his astronomical observations.

The relative calm following the publication of the *Sidereus Nuncius* may be surprising. This does not mean that the Catholic Orthodox group undervalued the possible consequences of Galileo's observations since, about 70 years earlier, in 1546, the publication of Copernicus' thesis had provoked an immediate reaction of the Holy See, when the Dominican friar Giovanni Maria Tolosani had written "*De coelo supremo immobili et terra infima stabili, ceterisque coelis et elementis intermediis mobilibus*"—where he attacked the new cosmogonic system.

There had already been signs of attacks on the part of the Dominican friar Niccolò Lorini, who, in 1612, had declared that Copernicus' cosmology was opposed to the Holy Writ, but this was only an attempt to excite people, without much of a following. Perhaps someone was waiting for the right moment to break out, or else, Galileo's observations were accepted as a fact, which did not provoke worries in the Catholic hierarchy so far.

During his year-long exile in Arcetri, Galileo was comforted by many letters written by his old friends. Among them, the Archbishop of Siena, Ascanio Piccolomini, in the summer of 1639 reminds him of a common passion "*…I'm really sorry that you cannot taste my wine because of your poor health; however, if you like, I can keep some wine, so that you can taste it when you feel better …*".[36] Probably, the Archbishop wanted not only to renew his friendship, but also to make Galileo smile while evoking the days in Pisa, 50 years earlier, when the young Math teacher showed his intolerance of contemporary affectation and backwardness, which were shown in Pisa by the obligation for teachers to wear the academic gown all day. This was doubtless an hindrance for a young man who often went out at night with his friends in the taverns, which he certainly knew well, as it can be noticed in his poem of 1590 "*Capitolo contro il portar la toga*" ("*Against the donning of the gown*").

"*… Ch'importa aver le vesti rotte o intere*	*What matter if it's rags or it's fine-woven,*
Che gli uomini sien Turchi o Bergamaschi,	*Weft you're seen wearing, what if you're a Turk or born in Bergamo,*
Che se gli dia del Tu o del Messere?	*A squire or simple citizen?*
La non istà ne' rasi o ne' dommaschi;	*The difference lies not with lace or fancywork;*
Anzi vo' dirti una mia fantasia,	*Rather, will you listen to this fantasy of mine:*
Che gli uomini son fatti com'i fiaschi.	*That men are demijohns, each with its quirk,*
Quando tu vai la state all'osteria,	*When in a summer's day you'll crave for wine*

(continued)

[36] A. Piccolomini, 1639, *Lettera a Galileo Galilei,* 19 Luglio 1639, in 1966, *Le Opere di Galileo, vol. XVIII,* G. Barbera ed., Firenze, "*…Mi dispiace infin all'anima che la sua poca salute non le lascia godere il saggio del mio vino; ma se almeno le gustasse, prenderei animo di serbargnene qualche poco per quando ella si fusse rihavuta…*".

(continued)

Alle Bertuccie, al Porco, a Sant'Andrea,	*Like you sip in fine taverns in the town,*
Al Chiassolino o alla Malvagia,	*And you'll visit them all, from sign to sign,*
Guarda que' fiaschi, innanzi che tu bea	*Look at those demijohns, ere you taste and down*
Quel che v'è dentro; io dico quel vin rosso,	*All they can hold – I mean such smooth claret*
Che fa vergogna al greco e alla verdea:	*To put to shame Greek wines of great renown:*
Tu gli vedrai che non han tanto in dosso,	*Those jugs, you'll see, are not making an effort*
Che 'l ferravecchio ne dessi un quattrino;	*To hide their liquid bliss, not their waistline,*
Mostran la carne nuda in sino all'osso:	*Under some straw or any other waistcoat,*
E poi son pien di sì eccellente vino,	*And yet they're full of such portentous wine,*
Che miracol non è se le brigate	*That no miracle is asked for many a drinker*
Gli dan del glorioso e del divino.	*To call it glorious nectar and divine.*
Gli altri, ch'han quelle veste delicate,	*The other demijohns, which sport some chi-chi cover,*
Se tu gli tasti, o son pieni di vento,	*If you tap them, are either full of wind,*
di belletti o d'acque profumate,	*Or of balmy lotions and balsamic water,*
O son fiascacci da pisciarvi drento"	*Or else they're pisspots, to their use destined"*[a]

[a] English translation by Giovanni Fabrizio Bignami, *Against the Donning of the Gown: Enigma* (London: Moon Books Ltd., 2000): reproduced by kind permission of the Author

Galileo's exile in Arcetri was peculiar. Doubtless, it was a true, strict forced residence, but it was still possible for him to keep an intensive correspondence with dozens of people, with whom, from 1633 until his death in 1642, he exchanged doubts, confessions and technical opinions. For instance, he was asked for lenses to realize a telescope, as in a letter to his old friend Elia Diodati in Paris, where he asked him to give them to the abbot Pierre Gassendi, a well-known astronomer and mathematician. "…*Together with this letter, you will receive the lenses for a telescope, which Gassendi asked me for himself and others, who wish to observe the sky; you can give them to him, telling him that the distance between the glasses must be more or less equal to the string tied around them, according to the eyesight of those who use them*…".[37]

However, Galileo is tired. In this same letter, referring to the fact that even Fabri de Peiresc had asked him for a pair of lenses, he apologizes since he cannot satisfy him, at least not at the moment, because he feels "*full of nuisances which*

[37] G. Galilei, 1634, *Letter to Elia Diodati,* 25 July 1634, in 1966, *Le Opere di Galileo, vol. XVI,* G. Barbera ed., Firenze, "…*Con questa riceverà anco V. S. i cristalli per un telescopio, domandatimi dal medesimo S.re Gassendo per suo uso e di altri, desiderosi di fare alcune osservazioni celesti; li quali potrà V. S. inviargli significandoli che il cannone, cioè la distanza tra vetro e vetro, deve essere quanto è lo spago che intorno ad essi è avvolto, poco più o meno secondo la qualità della vista di chi se ne deve servire*…".

sometimes prevent me from doing what I would like to do" and he asks both Gassendi and Peiresc to use the only couple of lenses which he had managed to prepare.

This is the end of the letter which, to those readers who are used to his refined way of writing, is more significant than a whole book "*I am really tired, and I have probably bored you to death: please forgive me. I kiss your hands*".[38]

[38] G. Galilei, 1634, *Letter to Elia Diodati,* 25 July 1634, in *ibidem,* "…*Con questa riceverà anco V. S. i cristalli per un telescopio, domandatimi dal medesimo S.re Gassendo per suo uso e di altri, desiderosi di fare alcune osservazioni celesti; li quali potrà V. S. inviargli significandoli che il cannone, cioè la distanza tra vetro e vetro, deve essere quanto è lo spago che intorno ad essi è avvolto, poco più o meno secondo la qualità della vista di chi se ne deve servire*…" …"*pieno di molestie che mi violentano a mancar talvolta a quelli officii che io più desidero di essequire*"… "*Sono stracco e averò soverchiamente tediata V. S.: mi perdoni e mi comandi. Gli bacio le mani*".

Chapter 4
The War of Telescopes in Rome

The modern era has ended. The Middle Age of specialists has started.

Ennio Flaiano, 1960

(From "Il taccuino del Marziano")
L'evo moderno è finito. Comincia il medioevo degli specialisti.

The aspect of the streets around the Collegio Romano has not changed that much since Kircher's time.

Nowadays in Rome, you can still find traces of the old associations and craft guilds in the names of streets, alleys, and squares, which recall the handicrafts once practiced there. Balestrari (crossbow), Barbieri (barbers), Baullari (trunks), Canestrari (baskets), Cappellieri (hatter), Chiavari (keys), Chiodaroli (nails), Ombrellari (umbrellas), Sediari (chairs), Funari (ropes), Falegnami (carpenters) and Pianellari (slippers): these are some of the handicrafts recalled by the toponomy of Rome. This also indicates the craftsmen's habit to get together in a single place.

On the other hand, it is useless to go and look for "Telescope Maker Square", or "Lense Maker Street"—they do not exist. And yet these activities were very important in Kircher's age. Indeed, there were two factories in Rome, which produced telescopes and optical instruments: Eustachio Divini and the Campani brothers, near to each other. Probably, many people were working there in different sections: there were craftsmen, glassmakers, carpenters, tanners and so on. Perhaps nobody gave the name of telescope-maker to a street, because a harsh competition originated between these two factories.

That is a shame, since practically nobody nowadays remembers that those two factories in Rome produced telescopes, which were sent all over Europe and were used for any astronomical discoveries in the seventeenth century. These two telescope-makers, Eustachio Divini and Giuseppe Campani, gave rise to opposed groups of supporters, just as it happens in the football leagues. Most intellectuals in Rome took part in this competition.[1]

Divini arrived first in Rome around 1640. He came from Sanseverino Marche, where he was born in 1610; he had done classical studies with poor results

[1] M. L. Righini Bonelli and A. Van Helden, 1981, *Divini and Campani: A Forgotten Chapter in the History of the Accademia del Cimento*, Supplemento agli Annali dell'Istituto e Museo di Storia della Scienza, fasc.1, Monografia n. 5 Firenze, (digitized by Museo Galileo—Istituto e Museo di Storia della Scienza, Firenze).

R. Buonanno, *The Stars of Galileo Galilei and the Universal Knowledge of Athanasius Kircher*, Astrophysics and Space Science Library 399,
DOI: 10.1007/978-3-319-00300-9_4, © Springer International Publishing Switzerland 2014

(an important detail, as we will see). As for technical topics, that is a completely different story.

Having heard that Benedetto Castelli, a student of Galileo, was teaching at the University "La Sapienza" in Rome, Divini immediately joins his course and evidently profits from it, since he makes friends with another brilliant student who has known Galileo—Evangelista Torricelli, with whom he starts to collaborate on optical theories and on lens-making methods.

In the same period, another young student, Gaspare Berti, follows the courses at "La Sapienza", in the hope of starting a university career. Berti has also followed Castelli's lectures and has been struck by Galileo's statement about a column of water, which cannot exceed, in a natural manner, the fixed height of 18 ells.[2] Berti is a friend of Torricelli, and they have both realized that the problem is strictly connected to the existence of void. Therefore, he studies experiments to establish whether the void can really exist.

In the seventeenth century, the concept of void is a serious problem, because Aristotle, on the basis of physical and philosophical inductions, had denied the existence of void, even as a mere logical possibility. Aristotle's view of the world is a coherent construction, in which, if one small brick is missing, the whole building falls down. For example, if we exclude the—hypothetical—existence of void, as a consequence, not even God might have created it, and His omnipotence would thus be limited! In a world where science is still defined as philosophy, it is better to conclude that Nature has "*horror vacui*" (horror of empty spaces), whatever this means.

In this context, Gaspare Berti continues his experiments in different occasions, both at home and in the convent of the "Padri Minimi" in Trinità dei Monti.[3]

Berti's machine is more than 13 m high (higher than 18 ells, a measure indicated by Galileo as the highest limit which may be reached by a column of water), and of course, it must be anchored to the cloister wall. It is a very long pipe, with a tap that, in its lower end, is immersed in a barrel filled with water.

In his experiments, Berti asks the assistance of his friends Raffaello Magiotti, secretary of the Accademia dei Lincei, Evangelista Torricelli, Niccolò Zucchi, a Jesuit of the Collegio Romano—and telescope maker—and, naturally, of Athanasius Kircher, who writes down all the details.

Berti, from a window, fills the pipe. Once it is full, he seals it. Then he asks one of his friends to open the tap at the other end of the pipe. There's tension. The pipe starts emptying, but, as soon as the column of water gets to 18 ells, which correspond to about 10.5 m, it stops. Perhaps, nowadays, this does not really impress us. In the same way, we are used to seeing a column of mercury 76 cm high

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[2] G. Galilei, 1638, *Discorsi e dimostrazioni matematiche intorno a due nuove scienze, Giornata I,* Elzeviri, Leida."*…mi soggiunse, né con trombe, né con altra machina che sollevi l'acqua per attrazzione, esser possibile farla montare un capello più di diciotto braccia: e siano le trombe larghe o strette, questa è la misura dell'altezza limitatissima*".

[3] G. Schott, 1687 (first edition 1664), "*Technica curiosa, sive mirabilia artis*", Jobus Hertz ed., Typographus Herbipol. pp. 200–204.

hanging on the wall of an improbable place, such as a restaurant or a doctor's waiting room. However, in the seventeenth century, a column of water that was three floors high and did not empty out—notwithstanding the opening at its basis—is a thought-provoking sight.

Once checked that the statement made by Galileo 5 or 6 years earlier was right, the first question is "what's there in the area on top of the pipe? Is there an empty space, or rather a strange substance such as water spirits, or even the air, passing through the pores of the pipe?" Even though these suggestions are somewhat weird, if one does not want to admit that the void exists, there are no ways out.

Kircher has a good idea to check whether there is an empty space inside the pipe.

He wants to put a bell hanging from a thread inside the higher portion of the pipe. Then a magnet should be placed outside, at the same height of the bell, so that its metallic clapper, attracted by the magnet, stands still. At this point, the above-mentioned experiment should be made once again. The bell in the higher portion of the pipe will be kept dry. If one removes the magnet now—Kircher goes on—the clapper will naturally strike the side of the bell. At this point, one should simply listen: if we hear the bell ringing, this means that inside the pipe, there is some material; on the other hand, if we hear nothing, we may conclude that there is an empty space. So much for Aristotle![4] Creative and ingenious as usual, Kircher also shows some nerve, since he does not care about the consequences, in case the experiment revealed that Aristotle was wrong.

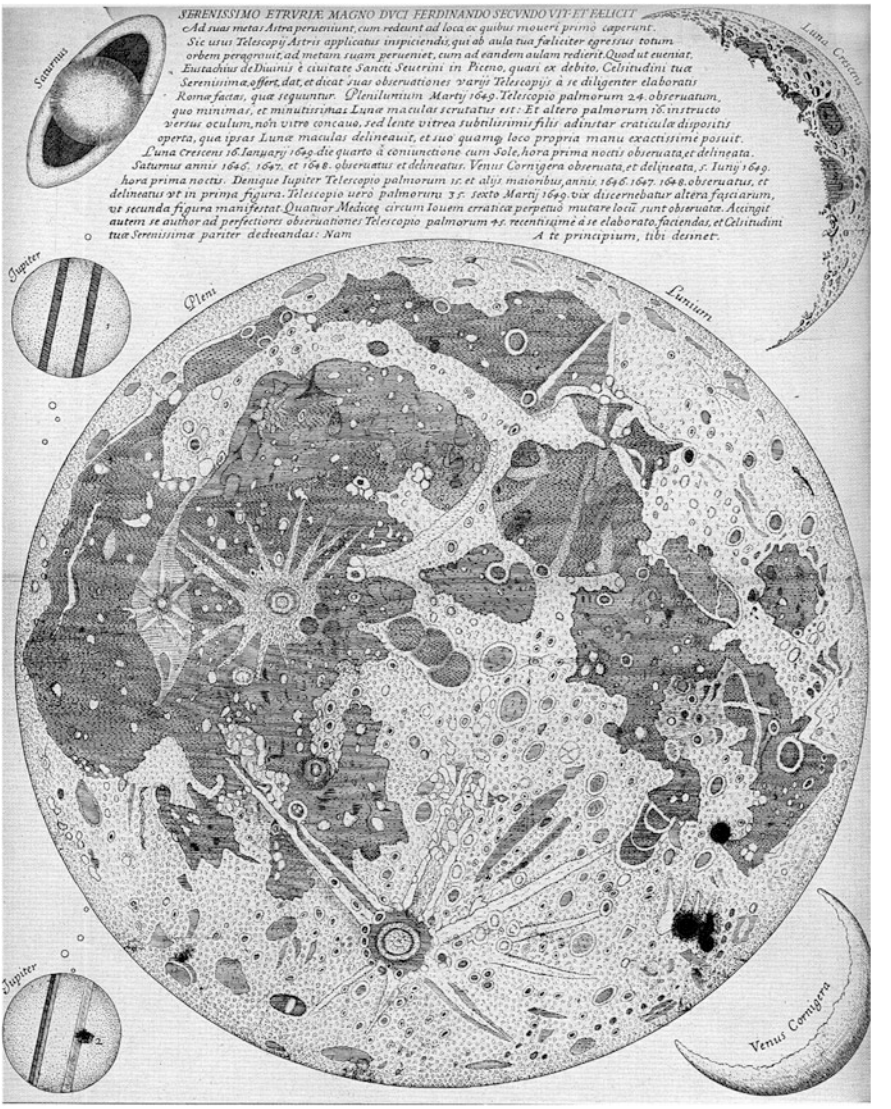
The experiment was repeated, with an even higher tension. Berti fills up the pipe, seals it and fixes the magnet. Someone opens the tap from the lower end and the bell stays dry. Berti carefully takes away the magnet, tied to one side of the pipe, and the clapper falls on one side of the bell. In the silence, everyone hears the sound coming from inside the pipe! In the pipe, therefore, there is no empty space.[5]

That is a shame. Such an elegant experiment has brought them to a wrong conclusion, because nobody thinks that the sound they heard has not been transmitted by the air, since there really is no air in the pipe, but rather from the thread from which the bell hangs.

Berti's experiments take place between 1640 and 1644. In that same period, Eustachio Divini sets up his optics and watchmaker shop. He becomes specialised in realizing microscopes and telescopes, which are immediately appreciated by

[4] G. Schott, *ibidem* p. 201 "*Intra phialam -suggerente P. Kirchero- campanulam unà cum ferreo malleolo ea dexteritate inseruit, lateribus internis phialae innixam, ut malleolus ferreus magnete exterius applicato attractus, elevatusque, & mox a magnete retracto liber dimissus, proprio pondere campanulae illideretur, ac sonum ederet.*" ["*According to Kircher's suggestion, a small bell with a metal clapper inside was skillfully put inside the pipe, so that the clapper might be attracted by a magnet outside the pipe. Once the magnet is removed, the clapper touched the side of the bel with all its weight, and emitted a sound.*"]

[5] G. Schott, *ibidem* p. 201 "*… malleolus allectus, & remoto dismussus est; a quo percussa campanula, limpidissimum edidit sonum, ab omnibus Experimenti spectatoribus auditum.*" ["*… the clapper was taken and then released; the small bell, striken by it, produced a clear ring, which was heard by all the people who witnessed the Experiment*"].


SERENISSIMO ETRVRIÆ MAGNO DVCI FERDINANDO SECVNDO VIT-ET FÆLICIT
Ad suas metas Astra perueniunt, cum redeunt ad loca ex quibus moueri primò caperunt.
Sic uirtus Telescopij Astris applicatus inspiciendis, qui ab aula tua feliciter egressus totum
orbem peragrouit, ad metam suam perueniet, cum ad eandem aulam redierit. Quod ut eueniat.
Eustachius de Diuinis è ciuitate Sancti Seuerini in Piceno, quasi ex debito, Celitudini tuæ
Serenissimæ offert, dat, et dicat suas obseruationes variis Telescopijs à se diligenter elaboratas
Romæ factas, quæ sequuntur. Plenilunium Martij 1649. Telescopio palmorum 24. obseruatum,
quo minimas, et minutissimas Lunæ maculas scrutatus est: Et altero palmorum 16. instructo
ueriùs oculum, nòn uitro concauo, sed lente uitrea subtilissimis filis adinstar craticulæ dispositis
operta, quæ ipsas Lunæ maculas delineauit, et suo quamq; loco propria manu exactissimè posuit.
Luna Crescens 16. Ianuarij 1649. die quarto à coniunctione cum Sole, hora prima noctis obseruata, et delineata.
Saturnus annis 1646. 1647. et 1648. obseruatus et delineatus. Venus Cornigera obseruata, et delineata, 5. Iunij 1649.
hora prima noctis. Denique Iupiter Telescopio palmorum 15. et alijs maioribus, annis 1646. 1647. 1648. obseruatus, et
delineatus sic in prima figura. Telescopio uerò palmorum 35. sexto Martij 1649. uix discernebatur altera fasciarum,
ut secunda figura manifestat. Quatuor Medicæ circum Iouem erraticæ perpetuò mutare locũ sunt obseruatæ. Accingit
autem se author ad perfectiores obseruationes Telescopio palmorum 45. recentissimè à se elaborato, faciendas, et Celitudini
tuæ Serenissimæ pariter dedicandas: Nam A te principium, tibi desinet.
Saturnus
Luna Crescens
Iupiter
Plenilunium
Iupiter
Venus Cornigera

◀ **Fig. 4.1** *Eustachio Divini* "*Map of the Moon*" (*Reprint*). (Osimo, Town Library). In the poster, we can see a few pictures of the astronomical objects Divini has observed with his telescopes: on *top*, there is a dedication to the grand duke of Tuscany, Ferdinand II, surrounded by the picture of the waxing Moon and of Saturn. In the *middle*, we see the full Moon: in the corners *Venere cornigera* (*Crescent Venus*), Saturn and Jupiter with its four *Medici's* satellites. Quoting his observation of the Moon, Divini describes the micrometer, (E. Divini, 1663, *Lettera all'Ill. Sig. Conte Carl'Antonio Manzini, Roma, Giacomo Dragondelli,* p. 59 "*feci un Occhiale di mediocre lunghezza, e nella lente oculare applicai… due capelli, che formavano una Croce, & veramente fanno effetto bellissimo, mentre si vedono distintamente, e pare che taglino gl'oggetti. Per l'appunto nell'istesso modo, che feci, quando disegnai la mia Luna, che publicai del 1649…*" "*I created a rather long telescope, and applied two crossing hairs on the eyepiece. They give the impression of cutting objects, since they can be seen very clearly. In the same way, I outlined the Moon and published it in 1649*") which, according to some historians, he has invented himself [G. Govi, 1887, Bullettino di Bibliografia e di Storia delle Scienze Matematiche e Fisiche, *Della Invenzione del Micrometro per gli Strumenti Astronomici,* vol. XX pp. 607–614, B. Boncompagni ed. (digitized by Goettingen State and University Library)]

some specialists, so that Divini is allowed to visit the Collegio Romano on a regular basis.[6] This is a silent revolution: more than 10 years earlier, Galileo had been put to trial, essentially for saying what his telescope had allowed him to observe. Now in Rome, there is a group of skilled technicians, who build telescopes, as well as experimental scientists who exchange their experiences with the Jesuits. Kircher is constantly among them.

In 1649, Divini, once reached a professional maturity, thinks it is time to acquire a larger audience than the inhabitants of Rome and decides to print a poster, in order to advertise the quality of his telescopes (Fig. 4.1).

By the middle of the seventeenth century, the telescopes built around Piazza Navona are unrivalled, essentially because Divini can make large, long-focal lenses: this is a necessary feature in order to increase the magnifying power of the telescope and mitigate the annoying optical aberrations, typical of these instruments. The remarkable focal length of the telescopes suggests that we should not consider Divini a simple craftsman working in his shop, with some help. It is far more realistic to imagine him as managing a small industry, where it is possible to realize telescopes with a length higher than 10 m, requiring a good engineering, both in planning and in the realization of winches and cogwheels, necessary for the movement.

Divini's activity is so thriving that he hardly satisfies the orders coming from all over Europe. However, Eustachio Divini comes up against an obstacle which, if we examine it closely, is provoked by his lack of talent for the classics, which brought him to avoid studying Latin well. Let us go into detail.

In 1659, a Dutch astronomer, Christiaan Huygens, publishes *Systema Saturnium* in which, on the basis of observations made with a telescope he built himself, he suggests that the peculiar shape of Saturn should be interpreted as a ring surrounding the planet. Huygens then reviews all the various interpretations of the shape of Saturn, starting from Galileo's age, and concludes that they are all based

[6] L. Lippi, 2001, *Eustachio Divini a San Severino Marche*, Quaderni del Consiglio Regionale Marche, "*Scienziati e Tecnologi Marchigiani nel Tempo*", p. 80.

upon observations made with poor-quality telescopes. Huygens then examines the drawing of Saturn, which Divini had published on his poster 10 years earlier. Divini—Huygens says, calling him "*excellent telescope maker [prestantissimus perspicillorum artifex]*"—made correct drawings, but some shadows have been arbitrarily added, probably during the printing stage.[7]

This statement is not particularly polemical, especially if we consider that Huygens does not seem to take into esteem the scientific activity performed in Rome. The activity of the only Roman Jesuit about whom Huygens keeps regularly informed is Athanasius Kircher. However, Divini realized that Huygens implicitly declares that he has built a better telescope than those produced by Divini. This is a professional attack on the part of a well-known scientist, and Divini cannot keep silent.

Though Divini is not an illiterate, he feels he does not know enough Latin to start a discussion at a European level and is conscious of being a technician, rather than a scientist. Divini therefore recurs to the French Jesuit scholar Honorè Fabri, who lives in Rome and, just like Kircher, is a correspondent of the Accademia del Cimento.[8]

Fabri is very keen on Physics and Mathematics and is, of course, a devout person. He had been transferred to Rome from Lyon, where he had placed himself in an unfavourable light, because he had published a pamphlet in which he had suggested that Copernicus' theory could be accepted. According to Fabri, the Bible contains some passages that should be read literally, whereas others should be interpreted in a figurative sense. Only the Church can distinguish the ones from the others. The interpretation of the Bible can also change with time, if new discoveries require it. However, until this happens, a good Christian should follow the rules established by the Pope. This is therefore a not particularly strict attitude, which agrees with the frame of mind of most Jesuits at the time.

When Divini recurs to Fabri to help him answer Huygens in Latin and demonstrate that his drawings of Saturn are accurate, and the telescopes in Rome are the best in the whole of Europe, Fabri accepts and writes an essay, *Brevis Annotatio in Systema Saturnium,* where, far from tackling any technical detail about the quality of Divini's telescopes, he wants to demonstrate that the recent astronomical discoveries do not require a new interpretation of the Bible passages on which the Earth's immobility is based. For example—according to Fabri—various problems are still open, such as the nature of comets and sunspots, which might find a natural explanation if we consider that they are two aspects of the same phenomenon, in as much as both comets and sunspots might be manifestations of the same ethereal matter, which lies beyond the Moon.

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[7] C. Huygens, 1659, *Systema Saturnium*, *Oeuvres Completes*, XV, p. 279: "*Isque cum praestantissimus perspicillorum artifex habeatur, credibile est omnium emendatissime nativam Saturni faciem nobis descripsisse, nisi quod umbras illas quae in schemate apparent, de suo, ut opinor, adjecit*" ["*Besides, there is no doubt that such a good telescope maker described to us the correct face of Saturn, apart from a few shadows, which he has been probably added later, I think*"].

[8] A. van Helden, 1994, "*Telescopes and Authority from Galileo to Cassini*", Osiris, 2nd Series, Vol. 9, Instruments, p. 22.

In this context, Fabri suggests that those strange handles, which can be observed around Saturn, are due to the presence of a series of pale and dark planets, which move in formation.

In other words, Saturn is perfectly spherical, according to Tycho's theory, which is by now accepted by most Jesuits, but is endowed with two symmetrical moons. As a consequence, it looks as if the planet had ears, more or less like this  . The apparent space between Saturn and the two Moons is actually due to the existence of two further moons, once again symmetrical with the planet. Since these moons are dark, rather than bright like the others, they create the impression that there is a space between Saturn and its major moons. As for the non-circular outer edge of the two "ears" of Saturn—Fabri goes on—there is a simple explanation: there are two small and bright further moons, which are symmetrical and adjacent to the two major ones. The result of the overlapping of all these moons looks more or less like this  .[9] That is how, though remaining with canonical cosmology, the shape of Saturn is explained. A far cry from the ring around the planet!

Who knows whether Divini, as a craftsman used to tackling real challenges, actually realizes that, by adding light and dark circles, it is possible to explain any shape, and whether he is really convinced of Fabri's theory. He certainly feels overwhelmed by the authority of the Jesuit scientist and accepts to publish the essay in his name.

Becoming an instrument for Fabri's goals is the biggest mistake of Divini's career, because, in all the arguments with Huygens which, from that first episode, will go on for at least a couple of years, he will always retain an ambiguous attitude, since he was forced to defend the technical perfection of his telescopes while, at the same time, he did not deny the untenable theories of Fabri which, however, should have been based on the observations made with Divini's telescopes!

Divini is conscious of the plight he is in and tries to transform the debate into a pure argument, by suggesting that Huygens might have got hold of one of his instruments.[10] In his rush, Divini even proposes to Huyghens to bet 100 scudi, in order to evaluate the quality of their respective telescopes in any Italian city.[11]

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[9] E. Divini, 1661, "*Pro sua annotatione in Systema Saturnium Christiani Hugenii aduersus eiusdem assertionem*" Romae: typis Dragondellianis, pp. 56–58, fig. p. 118 (Digitized by BEIC, Biblioteca Europea di Informazione e Cultura).

[10] E. Divini, 1661, *ibidem*, p. 8 "*…cum nulla mihi vitrorum à te fabricatorum copia facta fuerit; mea per totam Europam ab aliquot annis disseminata & sparsa in tuas manus venire facile potuerunt…*" ["*… since no copy of your lenses has ever been made for me, whereas you can easily find my lenses, which have been spread all over Europe in the last few years …*"]

[11] E. Divini, 1661, *ibidem*, p. 9 "*… elige diametrum sphaerae, nam mihi perinde est, & locum, in quo a peritis fabricata vitra probentur; Multas habes civitates in Italia, Romam, Meapolim, Venetias, Bononiam, Mediolanum, ti datur optio…victus demum centum dupliones, ut vocant, sponsionem vincenti numeret…*" ["*you will choose the diameter of the sphere, since it is the same for me, and the place, where the lenses will be tested by esperts. There are many cities in Italy—Rome, Naples, Venice, Bologna, Milan—take your pick. … the winner will receive 100 scudi, and will count the money in guarantee*"] quoted by M. L. Righini Bonelli e A. Van Helden, 1981, *op. cit.* pp. 13–14.

This proposal has no sequel, and, although the renown of Divini is weakened by this argument, since Divini cannot cancel the denial of a ring around Saturn, the opinion spreads at the time that he is one of the best producer of optical instruments in the whole of Europe.

In these same years, Giuseppe Campani, a youth born in 1635 in Castel San Felice, a small village near Spoleto, moves to Rome. His vicissitudes in Rome look very much like Divini's own, a similarity that will inevitably bring to a an encounter—and later to a fight—between them.

Campani, arrived in Rome together with his brothers, one of whom is the Pope's clockmaker learns, just like Divini, the art of building clocks. Like Divini, he studies Optics at the Collegio Romano, even though as a simple auditor. Like Divini again, he opens a laboratory in order to build clocks, an activity that will allow him to obtain his first professional success.

Alexander VII, the Chigi Pope, suffers from insomnia, and—like all insomniacs—attributes the reason to some disturbance. He complains with his secretary, Cardinal Barberini, of the clock in his bedroom, first of all because it makes an annoying *tick-tack* that wakes him up, and then, once he has woken up, because of the darkness, he cannot even read the time. Thus, the brothers Campani, Matteo and Giuseppe are requested to solve the problem: namely, they should create a silent clock, which may allow anyone to read the time at night. The clockmakers, using the projection of candlelight by exploiting the fall of a small quantity of mercury to make the spheres move, manage to create a clock with both features: it is silent and visible in the dark. Alexander VII is particularly satisfied with it, and, as Gregorius XIII had done with Lilio for the calendar, gives the Campanis the exclusive manufacturing right for silent clocks.[12] In 1656, this is the first step that will allow Giuseppe Campani to acquire the necessary protection in order to work in Rome. Campani now feels ready to pass on to a more demanding job: namely, creating lenses and telescopes.

We do not know exactly when Giuseppe Campani starts this new activity, since he keeps it secret for a long time. The reason is that the optical technique is becoming an advanced topic, so that it is not enough to see something blurred in the sky. Rather, they require a wide-field telescope, possibly without the distortions suffered by images when the light passes through the lenses' glass. These problems can be overcome only if you use a series of lenses, placed one after the other, and since many solutions are found empirically, there is the risk that someone might copy them. Therefore, we can understand his precautions. However, Divini remains the best-known telescope-maker of the time, and Campani realizes that a "*comparison*" (*paragone*) with Divini's instruments is inevitable.

In these *comparisons,* which will follow in the course of later years, the Campanis (Matteo and Giuseppe) always maintain an unprejudiced attitude, which

[12] M. L. Righini Bonelli e A. Van Helden, 1981, *op. cit.* p. 14 and references therein. For a technical description see G. Gregato and L. Pippa, 2006, "*Un raro Notturno di Giuseppe Campani*", La Voce di Hora, Ass. Italiana Cultori di Orologeria Antica.

regularly puts Divini in a condition of objective disadvantage, only because Divini has sold several telescopes in Italy, so that anybody can study his techniques of realization, while Divini himself can never examine the telescopes of his adversaries, either because they are not on the market, or because, when they are obliged to show a telescope in public, they immediately say that it is not a telescope made by Campani, but rather a loan from the Netherlands.[13]

Divini, convinced that the telescope had been made in Rome, frets under restraint, because he thinks he has the right to make a public comparison between the performances of this telescope—whether it be Dutch or Italian—and those of his own telescope.[14] The Campanis, however, maintain their position and try to avoid the comparison, though continuing to boast the superiority of their instrument.

Divini tries to startle the two brothers by challenging them with a bet: let us make a comparison according to precise rules—he suggests—and, if my telescopes turn out to be of a poor quality, I shall pay 200 scudi. Whereas, if the "Dutch" telescope turns out to be inferior, I will be satisfied with 100 scudi. Moreover, I will give the money for good actions, such as helping a single woman find a husband (this was probably considered a misfortune!), or "*deliver a bell to a poor church*".[15] We should say that Matteo Campani was a priest and that "campana" in Italian means "bell": therefore, one can easily see the pun in this phrase.

The Campanis cannot back out of this challenge. Therefore, they accept to submit the "Dutch" telescope to a *comparison* with Divini's telescopes. At first, no clear supremacy is established, because Divini manages to create better objectives (namely, the telescope's first lenses), whereas the Campanis have better eyepieces, i.e. systems for magnifying the image. In 1663, these competitions get to a turning point, as the Campanis observe Saturn and clearly see that the planet has a ring around it. Thus, the argument with Huyghens resurfaces, which Divini had considered as forgotten. Giuseppe Campani, naturally, increases Divini's

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[13] E. Divini, 1663, *Lettera all'Ill. Sig. Conte Carl'Antonio Manzini*, Roma, Giacomo Dragondelli, pp. 42–44.

[14] E. Divini, 1663, *ibidem*, p. 41. "*Resta che le dia notitia di varie prove, che si possano fare con questi Occhialoni. Ne a questo proposito voglio trascurar di avisarle, come qui in Roma sono di già molto mesi, che va girone con qualche pompa un'Occhiale dicono di palmi dieci, con 4 vetri, e danno nome, per quanto mi viene detto, che sia venuto di Olanda, si crede però sia fatto in Roma; questi tali sono andati raggirando dove hanno potuto sapere, che siano occhiali miei; e si sono fatte delle prove*" ["*I should tell you of some proofs which can be done with these lenses. Also, I should not neglect informing you that here in Rome there has been a ten-span telescope for a few months. They say it has four lenses and comes from the Netherlands, but it should actually have been made in Rome. These people have been asking around, and found out that the lenses are mine: and they have got the proofs*"].

[15] E. Divini, 1663, *ibidem*, p. 61. "*Si venghi dunque alla prova con scomessa grossa, o picciola; e perché sono quasi certo di guadagnarla, mi obligo d'impiegarla in qualche opera pia, come saria, maritar alcune Zitelle, o pure comprare una Campana a qualche Chiesa povera*" ["*Let us therefore make this test, with either a small or a large bet; since I'm pretty sure I'll win, I promise that I'll use the money for charity. I could help a spinster to find a husband, or buy a bell for some poor church*"].

embarrassment, by describing in detail the shadow of Saturn's ring above the planet, thus confirming Huyghens's statements.[16]

Giuseppe Campani thinks this is the right moment to reveal that he has no Dutch telescope, and that he has built the new telescopes himself (while his brother Matteo essentially plays the role of P. R. officer) and can therefore accept the challenge Divini has issued. As usual, the Campanis act with a certain cunning and organize the *comparison* in such a way that, when Divini arrives, his telescope, which had been bought by the Pope's nephew, Cardinal Flavio Chigi, has been somehow arranged upon a few chairs, whereas their own telescope is mounted properly.[17]

The test, which took place on 30 April 1664, consists in reading sentences written in different characters upon some billboards placed at a certain distance: it is rather like having one's eyes examined. The result, in such conditions, is as expected: that evening Divini is defeated. He tries to remedy by offering the powerful Cardinal to replace—free of charge—the telescope that has been shown as not equal to the competitor's.

By now, Campani has been launched: his name is well-known in the whole of Europe, and the dispute between the two telescope-makers is harsher and harsher.

It is difficult to establish the supremacy of either competitor, because the two telescopes should be mounted in the same place and the tests should take place in the same moment, at the presence of both authors. They also realize that the sentences on the billboards should not be taken from well-known poems, as they had done at first, because it is certainly easier to read a sentence you know, rather

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[16] G. Campani, 1664, *Ragguaglio di due nuove osservazioni*, Roma, Fabio de Falco. pp. 17–23, (Digitized by BEIC, Biblioteca Europea di Informazione e Cultura). "… *raccolsi con sommo mio contento un fenomeno diverso da tutti gli altri, che si sono finora pubblicati, ancorchè confermi a pieno il sistema del sig. Christiano Hugenij. Impercioche mi dimostrarono distintamente i miei Cannocchiali, esser Saturno cinto d'un cerchio quanto all'apparenza di forma Ellittica, disteso in tal positura d'intorno al globo…*" ["… *I was happy to observe a phenomenon, which was different from any other observed event, although it fully confirms Mr. Huygens's theory. My telescopes show distinctly that Saturn is surrounded by an elliptical ring, lying around the spherical planet …*"].

[17] E. Divini, 1666, *Lettera a Carlo Antonio Manzini*; Giacomo Dragondelli, p. 38–39, "*Seguì poi un altro paragone verso il principio di Maggio 1664 procurato dal Sig, Campani pochi giorni dopo, che haveva dichiarati li suoi occhiali essere suoi lavori, e non più in Olanda, il quale seguì in un Giardino, ed io fui mandato a chiamare a hore 21 senza sapere a che fare, e trovai aggiustato il suo occhiale di palmi 50 con 4 lenti nel suo cavalletto, o Machina, & il mio di palmi 52 il primo da me fabbricato con la nuova invenzione di lenti duplicate et arrovesciate fermato sopra sedie d'appoggio*" ["*There was another test at he start of May 1664, decided by Mr. Campani, who had revealed that the telescope was his own creattion and did not come from the Netherlands. The test took place in a garden, and I was called at 21:00 without knowing what to do. I found the telescope adjusted by 50 palms, with four lenses on its stand, whereas my own telescope, the first one I had made with the new double lenses upside down, was arranged upon two chairs, by 52 palms*"].

than a sentence formed by random words. Even the Pope seems to be interested, and in one of these tests, he asks for explanations on the way telescopes work.[18]

In fact, Pope Alexander VII considers the telescopes as a curiosity, more than a tool that may be useful in order to discover the Universe. For this kind of studies, his reference is Athanasius Kircher. They had met in Malta, where Kircher had been sent in the summer of 1637, as father confessor of the landgrave of Hesse, and the Pope-to-be was apostolic delegate and have stayed in contact ever since. It is worth mentioning that during the ongoing war of telescopes in Rome, Pope Alexander and Father Athanasius, instead of focusing on technical aspects of the competition, prefer to concentrate on discussions about the *Tractatus de Sphaera* of Giovanni di Sacrobosco, an essay that had been published about 400 years earlier.[19]

Prince Leopold of Tuscany calls even the Accademia del Cimento into question. Because of the dispute between Divini and Campani, some eminent members of the Academy often have difficulties. Michelangelo Ricci, considered as a *virtuous man*, namely a scholar, writes dejectedly on 18 August 1664, that the atmosphere of these *comparisons* and the touchiness of the two protagonists make it impossible to form an opinion.[20]

Paolo Falconieri, referent of the Accademia del Cimento in Rome, worn-out, writes a very clear letter to the Secretary of the *Accademia,* Lorenzo Malagotti, in the month of November of the same year, to report a *comparison* that has just taken place in the Palazzo di Propaganda Fide. First of all, the two telescope-makers

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[18] O. Falconieri, 1664, *Lettera a L. Magalotti*, in M. L. Righini Bonelli e A. Van Helden, *op. cit.* p. 87 "*…torno da Propaganda fide dove siamo stati … a fare esperienza dell'occhiale lungo del Campani…non ostante che ieri per essere stata la mattina all'udienza dell'Ambasciatore di Francia, fusse il Papa attorniato dall'occupazioni ordinarie … e benchè vi fossero nell'Anti-camera per avere udienza persone… volle anche la Santità sua ch'io gli mostrassi l'uso di esso strumento…*" ["*I am just back from the Propaganda Fide,… where we did a test on Campani's telescope … notwithstanding the fact that the Pope was busy because of the morning audience of the French ambassador … and there were people waiting in the anteroom …His Holiness wanted me to show Him the use of the instrument…*"].

[19] A. M. Partini, 2007, *Alchimia, Architettura, Spiritualità in Alessandro VII*, Edizioni Mediterranee, Roma, p. 44.

[20] M. A. Ricci, 1664, *Lettera al Principe Leopoldo di Toscana*, in Giovanni Targioni Tozzetti, 1780, "*Atti e Memorie inedite dell'Accademia del Cimento*", Tomo secondo, parte seconda, ed. Giuseppe Tofani, pp. 747–748 "*Quanto poi al paragone de' due grandi occhialoni, non sò che fin'ora si sia fatta comparazione tale, che se ne possa formare un certo giudizio, avendo quello del Divini avuto il pregiudizio o dell'Aria men chiara, ò della poca distanza, sù la quale eccezione continua il Divini, a mantenere il suo non cedere all'altro. Et a dirla a V.A.S., questi due Artefici e Virtuosi sono in una sì forte emulazione, che altri non può aprir la bocca a favore dell'uno, senza che l'altro se ne offenda: quindi è poi che ognuno si astiene dal dire il parer suo*" ["*As for the test of the two telescopes, I do not know whether they have sofar tested them so as to form an opinion, since Divini's own telescope was prejudiced by a less clear atmosphere, or by the small distance, so that he does not admit Campani's superiority. If I may say so, these two skilful craftsmen have entered such a sharp competition, that you cannot say a word in favour of the one, without the other being offended: that is why, in the end, nobody expresses his own opinion*"].

quarrel on the adjustment of the telescopes, and, whatever the setting up, both claim they could do better. During the "*comparisons*", some people happen to read all the words on the billboards—including the tiny characters—whereas Falconieri himself, and his servant, cannot distinguish a single word. Therefore, he suspects that those who read the sentences correctly, actually know all the words beforehand. The Campanis even move—to their advantage—the lanterns that light up the billboards. All of this is reported in the letters which the—despaired and depressed—Paolo Falconieri writes to his friend Magalotti.[21]

In this climate, measurements and comparisons are organized in various places in Rome: Collegio Romano, the Medicis house at the Navicella, S. Pietro in Montorio, Palazzo Pamphili, Piazza Navona, Montecavallo (at the time, the Quirinale Hill was called in this way) and the Palazzo di Propaganda Fide. They never reached a conclusion, because the dispute is so heated, that no "*comparison*" is accepted by both rivals. On the contrary, the fight is even fiercer, so that Falconieri fears that, one evening, if there had not been a few distinguished persons, Campani and Divini would have ended up knocking the living daylights out of each other.[22]

It is worth dwelling upon the contents of these messages, which reveal the feeling, jealousy and interests of two craftsmen who have entered into a ruthless competition against each other. These reports also reveal that, after Galileo, the opinion spreads that philosophers, and the highbrows in general, should compare their models with an experiment and, in the case of Astronomy, with observations. This is the scientific method, as well as a new awareness of the fact that, in order to obtain a significant observation, over and above an astronomer observing the sky with a spyglass, you need good engineers, skilful opticians and mechanics who may realize a state-of-the-art instrument. The creation of a group with such varied skills is very expensive. Therefore, those who wish for an advancement of

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[21] P. Falconieri, 1664, *Lettera a L. Magalotti*, in M. L. Righini Bonelli e A. Van Helden, *op. cit.* p. 67 "*…non è mia negligenza che di quegli* (telescopi) *del Campani sia presa la misura in un mo', e di quegli del Divini in un altro, perché l'uno e l'altro stima meglio di fare come si è fatto e io non ho voluto per questo starmi a rompere il capo con esso loro… non v'è vantaggio che i Campani non procurino, a segno, che mi fanno venire l'accidia, dove Eustachio quella sera non s'accostò mai ai lumi, né mai fiatò*" ["*It is not through my negligence that they measured Campani's (telescope) in one moment, and Divini's in another, since they both think this was right, and I did not want to quarrel with them …as soon as the Campanis gain a point, I feel slothful, while that night Eustachio never approached the lenses, and never said a single word*"].

[22] P. Falconieri, 1664, *Lettera a L. Magalotti*, in M. L. Righini Bonelli e A. Van Helden, *op. cit.* p. 143 "… *Io per me credo che stordirete come ho fatto, e fo' io quando vi rifletto su, che in otto dì non ho saputo concludere una cosa… si sono uniti Papi, Regine, Cardinali e Principi… e non m'è riuscito di farlo …et io di presente ho disposto il sig. Card. Chigi et il signor D. Agostino* (Chigi) *a fare alla loro presenza questo paragone perchè il rispetto delle persone impedisca una furia di Cazzotti, peraltro facilissima a succedere…*" ["*I think you will get a headache, like myself, if you think that in eight days I could get to no conclusion …today I asked Cardinal Chigi and Mr. D. Agostino (Chigi) to come and see this test, so that the respect towards these persons prevent a fight, which might easily take place…*"].

knowledge should be ready to invest money in this undertaking, while taking into account that the results may be uncertain and on a long-term basis.

Divini and Campani represent a portion of this change. Therefore, their disputes, and the little tricks they sometimes use to win over the opponent are symptoms of a climate of exciting novelty, which Rome witnesses in the seventeenth century.

How does the story of the two telescope-makers end? We may think it could have dragged on without either winners or losers, with both competitors and supporters still with their ideas. However, the famous Gian Domenico Cassini, the Director of the Paris Observatory, who uses Campani's telescopes, makes several important astronomical discoveries, such as Jupiter's red spot, the existence of Saturn's four satellites, the division upon Saturn's ring and so on. These discoveries make Campani so well-known in Europe, that he doubtlessly ends up winning the competition.

Giuseppe Campani, on the other hand, does not miss the chance to advertise the fact that one of the most important astronomers of the time is using his telescopes: "*…I had the chance to have as a witness to my observations Mr. Giovanni Domenico Cassini… who was looking forward to observing with my telescopes…[he saw] Jupiter, whose bands can now be observed as two long fields…, the Moon, whose circumference… is clearly not perfectly circular, but rather rugged and tortuous.*"[23]

In the war of telescopes that takes place in Rome, Cassini's role is important, also because of his relationship with Queen Christine of Sweden, who had abdicated in order to become a Catholic.

Christine, who lives in Villa Chigi, where she has realized a small astronomical observatory, seems to personify the idea of "the seventeenth century crossroads". Indeed, on the one hand, Christine assists Gian Domenico Cassini in the observations of the 1664 comet. On the other hand, she cannot resist the visionary spell of Father Kircher. Queen Christine hosts Cassini's telescopes and, since he observes in the month of December, she is worried for his health (even though they have the same age) and covers his head with her own shawl. Cassini, in exchange for her kindness, dedicates to her his pamphlet—"Theoria motus cometae"—to her and writes that the Queen herself has observed the comet with the 24-span telescope of Giuseppe Campani, as well as the 40-span telescope of Eustachio Divini.[24]

With an equal interest, Queen Christine visits Athanasius Kircher. The Queen is particularly intrigued by the chemical-alchemic laboratory of the Jesuit scholar,

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[23] Giuseppe Campani, 1664, *Ragguaglio di due nuove osservazioni*, Fabio de Falco, Roma, p. 38, "*…mi è sopragiunta fortunata occasione d'hauer per testimonio di queste mie osservazioni il Signor Gio: Domenico Cassini … il quale havendo havuto curiosità d'osservare co' miei Cannocchiali…[vide] Giove, le cui fascie con i miei Cannocchiali si vedono al presente in forma di due campi lunghi…, la Luna, la cui circonferenza… si vede essere non perfettamente circolare, ma scabrosa & anfrattuosa.*"

[24] G. D. Cassini, 1665, *Theoria motus cometae*, Fabio de Falco, Roma, pp. 46–47.

where "*She lingered for a while…….in order to take into consideration the plant called Phoenix, which blossoms in the water from its own ashes. She saw the fountains and the clocks, which are moved by the hidden magnetic force… they showed her various ingredients, such as herbs, plants, metals and gems, and other rarer elements which compose the theriac, as well as the balm of life… they also showed to her the alchemic method through which pearls and coral are melted. She saw sixty-five kinds of herbs being distilled in separate alembics on the one furnace… She also witnessed how ivory is philosophically calcified, and other similar processes. They also distilled in her presence vitriol, salt and nitric acid, and she admired the transformation of a whole earthenware jar of water being transformed into milk, the true remedy for asthma, through three drops of milk quintessence.*"[25]

The Queen of Sweden manages to adjust her interest in the astronomical discoveries of Cassini, which are radically changing the view of the Universe, with her curiosity for the magical and alchemical inheritance still affecting a part of society in the seventeenth century. "*They showed to her Moses' rod and Aaron's staff, … as well as the Table of the Last Supper…and the altar where Saint Peter celebrated Mass…*"[26] Kircher, out of respect and devotion, dedicates his book "*Itinerarium Extaticum*" to her in 1656.

As for the war of telescopes in Rome, probably, the quality of Campani instruments is not particularly different from Divini's ones, as several useless *comparisons* have demonstrated. However, Cassini's choice does make the difference: if Divini, instead of Padre Fabri, had had Cassini at his side, the competition would have probably ended in a different way.

Campani works in Rome until his death, in 1715. Divini instead, after a few years, retires, quiet and well-off, in San Severino, where he dies in 1685. Here, they gave his name both to a street and to a Technical Institute, since they still consider him one of their most illustrious citizens. Fair enough.

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[25] G. Gualdo Priorato, 1656, *Historia della Sacra Maestà di Cristina Alessandra di Svezia*, Bartolomeo Soliani, Modena, libro VII, p. 128, digitized by Google book "…*Si fermò… qualche tempo a considerare l'herba nomata Fenice, che a guisa appunto della Fenice, germoglia nelle acque perpetuamente dalle sue ceneri. Vidde le fontane e orologi, che dalla virtù dalla calamita con occulta forza si raggirano… gli fu mostrato l'apparato degli ingredienti di herbe, piante, metalli, gemme, altre cose più rare per comporre la teriaca e il balsamo della vita… Fugli fatto vedere il magistero di perle di corallo. Vide distillare col fuoco di un fornello medesimo sessantacinque sorti di herbe in altri tanti lambichi distinte… Gli fu fatta la calcinazione Filosofica dell'avorio e simili. Furono estratti gli spiriti del vitriolo, del sale, e dell'acqua forte, come pure ammirò una giara d'acqua pura con due sole gocce di quinta essenza di latte, trasformarsi in vero latte, medicamento unico per l'asma…*".

[26] G. Gualdo Priorato, *ibidem, p. 121* "…*le fu mostrata la Verga di Moisè, il pastorale di Aaron,… la Tavola dove Nostro Signore fece l'Ultima Cena… e l'altare dove celebrava S. Pietro…*".

Chapter 5
Lights and Shadows

> *He had a dream in which he saw a stairway resting on the earth, with its top reaching to heaven, and the angels of God were ascending and descending on it.*
>
> Genesis 28, 12 (Jacob's Dream)

Father Athanasius also engaged with lenses, both in telescopes and in refractors, but his goal is completely different from Galileo's own goal. Indeed, Galileo wants to realize an instrument in order to better investigate Nature, whereas Kircher only wants to discover and observe the infinite effects which, through light, Nature can create.

John Bargrave, canon of Canterbury Cathedral and a passionate antiquarian, owns a lens which can project in a *camera obscura* the enlarged image of far-away objects. He writes: "*The gentleman spoke bitterly to me against Father Kercherius a Jesuit I have met in Rome saying that it had cost him above a thousand pounds to put his optick speculations in practice, but he found his principles false, and shewed me a great basket of glasses of his failings.*"[1]

This negative advertising of Father Kircher should not be taken literally, since it probably is a consequence of a personal quarrel. In fact, scholars from all over Europe keep asking Kircher, throughout his life, information on various optical instruments, since his books on the study of light and shadows, such as *Ars Magna Lucis et Umbrae* (1646), show a remarkable familiarity with optical machinery, even though this was oriented more towards entertainment than towards a scientific study. On the other hand, if we go on reading Bargrave's account, we realize that the retailer expected from Kircher his speciality, namely a kind of lenses which could achieve surprising optical effects "*…He shewed me wonderful strange glasses, some oval, some round, some square, some convex, some concave, which produced strange deceptions of the sight, unspeakable. As I well remember, when I put forth my hand to one glass, there came an arm and a hand out of the glass, as long as mine; and when our hands met, I seemingly could put finger to finger, palm to palm; and when I went to clasp hands together, I grasped nothing but air.*"

There was another marvel in that workshop "*He had another large glass, which, being hanged at one side of the room, and a fair perspective picture of the inside of a church, with its arches and pillars, hanged at the other, at a due*

[1] J. Bargrave, 1660, *Pope Alexander VII and the College of Cardinals,* Pub. of the Camden Society, 1867, p. 134.

R. Buonanno, *The Stars of Galileo Galilei and the Universal Knowledge of Athanasius Kircher*, Astrophysics and Space Science Library 399,
DOI: 10.1007/978-3-319-00300-9_5, © Springer International Publishing Switzerland 2014

distance, the species do so strangely come out from the glass that you seem to be walking in a church. Remove that picture, and place in its room a fair garden, with oranges and lemon trees, and fountains and walks, &c., and by the reflex of that glass, in the middest of the room, one seemeth to walk in a garden, and so in a grove, &c…".[2]

If this man recurred to Kircher, it is probably because he is well known as a scholar of light sources, mirrors and lenses and is always ready to offer public shows of the magical effects of his experiments.

Kircher, who thus appears as a follower of the sixteenth century tradition of magic, aiming at both "*entertainment and wonder*",[3] becomes extremely popular, because, even when talking about "old" topics, he interprets and adapts them to teaching and catechism, explains them with his peculiar ingeniousness and uses them in order to warn the audience about the afterlife, with a stage effect which makes us forgive him a longwinded and pedantic prose.

Kircher's book about light, *Ars Magna Lucis et Umbrae*, is divided into ten chapters, where we are astonished by the mix of scholarly term and neologisms which fill the whole book, starting from the index. It is not difficult to imagine the reaction which Galileo and his followers have when reading words such as *Actinobolism, Photosophy, Sciasophy, Sciagrafic art* and so on, a demonstration of the remarkable gap between Kircher's allegoric and fantastic approach to science and Galileo's own sober and rigorous approach.

The somewhat stale topics range from the nature of light and shadows to the theory of colours and the propagation of light rays which, according to Kircher, is rectilinear, so that there is no way of mentioning diffraction, on which another Jesuit scholar, Francesco Maria Grimaldi, was studying at the time.

In the same way, Kircher says that he has observed the effect of refraction, which takes place when he projects pictures onto a screen and realizes that the letters, originally white, assume a coloured outline once they reach the screen. This observation, however, does not push Kircher to suggest an explanation, or, as we would say, to create a model, so as to organize all the phenomena appearing before his eyes. He is so convinced of the infinite possibilities of Nature that he simply writes: "*…we should note that, I do not know through what mysterious device of a painting Nature, the single letters appear full of different colors…*"[4] and takes comfort in the fact that this effect provokes the admiration of the audience. Kircher

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[2] J. Bargrave *ibidem,* pp. 134–135.

[3] "I. de Comitibus", 1647, Firenze, quoted in G. Baroncini, 1981,*"L'insegnamento della filosofia naturale nei Collegi italiani dei Gesuiti* (1610–1670): *Un esempio di nuovo aristotelismo*", in *"Ratio studiorum": Modelli culturali e pratiche educative dei Gesuiti in Italia tra Cinque e Seicento*, G. P. Brizzi ed., Roma, p. 188.

[4] A. Kircher, 1646, *Ars Magna Lucis et Umbrae,* Roma, Ludovico Grignani ed., digitized by ECHO.mpiwg-berlin, p. 912, *"Notandum & hic literas singulas nescio quo occulto naturae pictricis artificio omni colorum genere depictas videri…".*

is convinced that Nature is so flexible that the only task assigned to the scientist consists in making up a list of all observed phenomena, conscious of the fact that this only represents an insignificant share of the general catalogue which is kept by Nature itself.

Is Kircher a scientist? Yes, certainly, but not according to the contemporary meaning, namely an observer, who is ready to change his/her vision of the world if an experiment requires it. In fact, Kircher's science is also based on the experiment, but his deductions are always based on the certainty of living in a world endowed with rules, in which, however, Nature enjoys some freedom for the fantasy it sometimes gives voice to.

The fact that Kircher studies such a fundamental phenomenon as the light only as a stage effect doubtlessly represents a remarkable constraint for a scientist. However, Kircher realizes that the discussion on the nature of light is going to play a central role in the contemporary scientific debate, and, in such fundamental matters, he prefers to obey the directives of his Order, without embarking on a study of topics which may deviate him from orthodoxy.

On the other hand, the most embarrassing celestial phenomena for the Cosmology of both Aristotle and Ptolemy, such as comets, which seem to be piercing the crystal spheres, and Jupiters' satellites, which seem to reproduce a miniature Solar System, have been assimilated by the Cosmology of Tycho Brahe, a Jesuits' favourite.

Therefore, in the first half of the seventeenth century, there are not only astronomical problems which divide Galileian science from the Jesuits. It is Science as a whole, and Physics in particular, which comes up against new challenges, which had been left unsolved until then.

This is probably the age in which scientists realize that the cosmological system is—as it were—precarious, since, if you remove one of its elements, the whole system may fall down. As it happens for all ideologies on which societies are based, a single controversial element may spread around, and, even if people know very little about it, the whole thing provokes discussions and ends up involving aspects of the world which had not even been imagined beforehand.

Among these ideas, the nature of light takes up a central role in the contemporary scientific debate. Thus, diffraction, shadows surrounded by a coloured outline and strips of colour which appear as the light, is filtered by a thin glass: all these phenomena, which anyone may observe, should convince scientists that light has not a rectilinear propagation and colours constitute a feature of light, rather than of any coloured materials.

It may appear strange to us, but this is a remarkable point, since, at the time, the interpretation of the world was based on the concepts of *substance* and *accident.*

In order to clear up this point, we may recall that, for instance, when we talk about a blonde person, the colour of his/her hair certainly does not change the nature of this person, since, in Aristotle's terms, it is only an *accident*, which is certainly different from the essence of the person—his/her *substance*. Thus, according to Aristotle, *accidents* and *substance* make up real beings.

These same concepts had been used, in the middle of the sixteenth century, at the Council of Trent in order to rationalize the dogma of transubstantiation in the Eucharist: in other words, the consecrated bread and wine, which become the Lord's body and blood, keep the same *accidents*, namely the same colour and taste of bread and wine, while changing their *substance*. This happens, thanks to a miracle, which is repeated by divine intervention: by definition, it cannot be reproduced through a lab experiment.[5]

If we admit that colour is a property of light rather than of the body related to it, we must conclude that there are *accidents* which do not belong to a body. This brings up for discussion the very basis of the Eucharist (nowadays, the consequence is not urgent; in fact, there are many Catholic scientists believing in transubstantiation, while at the same time realizing that sunlight is constituted by innumerable wavelengths, that is by innumerable colours).

In order to emphasize the importance of this topic within the scientific debate of the seventeenth century, Galileo, in *Il Saggiatore* (*The Assayer*), had analysed the main concepts of Aristotle's physics, while challenging that *accidents* are not properties of the body showing them, but rather lie in the subject who perceives them "*… Therefore I am thinking that these flavours, perfumes, colors, and so on, which seem to us to belong to the subject, are actually mere names, inhabiting the sensitive body. Once removed the latter, these qualities seem to be cancelled…*",[6] and he goes on to the hypothesis that matter might be composed of atoms generating light "*… when getting to the last and highest resolution in indivisible atoms, light is created, through the motion—or better still—through the instantaneous expansion and diffusion. Light is capable, because of its subtleness, or rarity or immateriality—I am not sure—or else for yet another different and unnamed condition, of occupying a huge space*".[7]

Galileo's analysis is revolutionary, but can apparently be assimilated to an updated version of the Jesuits' *Ratio Studiorum.* In any case, Galileo does not seem worried about assuming a "political" attitude, as scientific evidences show more and more clearly that it is high time someone dismantled the suffocating framework of Aristotle's cosmology.

That is probably why—in the *Saggiatore*—Galileo does not miss his chance to deliver blows here and there, with a particular attention for the Jesuits, whom he

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[5] cf. M. G. Ianniello, 1986, *Kircher e l'Ars Magna Lucis et Umbrae,* in *Enciclopedismo in Roma Barocca,* M. Casciato, M. G. Ianniello, M. Vitale ed., Marsilio ed., Venezia, p. 223.

[6] G. Galilei, 1623, *Il Saggiatore,* Roma, Mascardi ed., digitized by Universiteitsbibliotheek Gent, p. 197, *"… Per lo che vò io pensando che questi sapori, odori, colori,* etc.*, per la parte del suggetto nel quale ci par che riseggano, non sieno altro che puri nomi, ma tengano solamente lor residenza nel corpo sensitivo, sì che rimosso l'animale, sieno levate ed annichilate tutte queste qualità…".*

[7] G. Galilei, *ibidem,* p. 201, *"… che poi arrivando all'ultima ed altissima risoluzione in atomi realmente indivisibili, si crea la luce, di moto o vogliamo dire espansione e diffusione instantanea, e potente per la sua, non so s'io debba dire sottilità, rarità, immaterialità, o pure altra condizion diversa da tutte queste ed innominata, potente, dico, ad ingombrare spazii immensi".*

considers as his privileged enemies. His main targets are Father Orazio Grassi, with whom he discusses for most of his essay, and Christoph Scheiner, a German Jesuit, with whom he competes for the primacy in observing solar spots. The controversy with Grassi, a Mathematics teacher at the Collegio Romano, almost becomes mockery, because the Jesuit had written an essay on comets, "*Libra astronomica ac philosophica*", and had signed it with the pseudonym *Lothario Sarsio Singesano,* which clearly is an imperfect anagram of *Horatio Grasio Savonensis*. Galileo, apparently unaware of this stratagem, even though the author admits he is a disciple of Father Grassi, writes "*..Even though I realized that this name, Lotario Sarsi, which I had never heard of before, is a mask for someone who wants to remain hidden to the world…*".[8] Galileo later strikes the final blow, with a *coup de théàtre*, and writes that he is pretty sure that professor Grassi would have neither said nor thought what Sarsi declares "*…I believe that the above-mentioned Father has never said, nor thought nor read these fantasies of Sarsi, since they are too far from respecting the doctrines which are taught at the Collegio where Father Grassi works as a teacher…*".[9]

It is true that Galileo states that his only wish is to live in peace "*… Even though these and other similar reasons, which were offered to me by these authoritative people, nearly diverted me from my firm decision not to write anymore, nevertheless my wish to live in peace, without disputes, finally prevailed…*"[10]—but the argument has become so heated that some even suspect (even though there is no proof of it) that Grassi actually decided to attack Galileo by accusing him at the court of the Inquisition as a supporter of Atomism, a concept which actually borders on heresy, inasmuch as it is incompatible with the dogma of the Eucharist. If this were true, that would be a very serious matter, not only because it concerns a fundamental dogma of the Catholic religion, but also because the idea of transubstantiation had been contested by Luther himself, who had replaced it with the concept of *consubstantiation*, namely the coexistence of bread and wine with the body and blood of Christ.

When Kircher writes *Ars Magna Lucis et Umbrae,* 23 years have passed from the publication of *Saggiatore* (*The Assayer*) and thirteen from the condemnation of Galileo to a retraction. However, the nature of light has doubtlessly remained a moot point. Nonetheless, if Kircher wants his essay to remain in the list of noteworthy scientific works, he cannot ignore this controversial question. Thus, he somehow chooses a low key and devotes a short paragraph to an analysis of the

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[8] G. Galilei, *ibidem,* p. 8, *"..E ben ch'io m'avvisi che questo nome, non mai più sentito nel mondo, di Lotario Sarsi serva per maschera di chi che sia che voglia starsene sconosciuto…".*

[9] G. Galilei, *ibidem,* p. 15, *"…tengo per fermo che il detto Padre non abbia mai né dette né pensate né vedute scritte dal Sarsi tali fantasie, troppo lontane per ogni rispetto dalle dottrine che si apprendono nel Collegio dove il P. Grassi è professore…".*

[10] G. Galilei, *ibidem,* p. 7, *"… E ben che tali e somiglianti ragioni, addottemi dall'autorità di questi signori, fusser vicine al distogliermi dal mio risoluto pensiero del non più scrivere, nulladimeno prevalse il mio desiderio di viver quieto senza tante contese…".*

nature of light—in Book II, with a significant title, "*On the nature of light: is it an accident or a substance?*".[11]

Confirming his limited interest in the fundamental topics of science, Kircher tries to save both positions, namely the tradition of Aristotle and the innovation of Galileo. In other words, he examines, without taking a definite stance, the reasons for considering light as an accident, "*…the rays are immaterial…*" and, "*…penetrate all bodies, even crystal…*" as well as the opposite reasons for attributing to light the nature of substance "*…the rays…are material, inasmuch as they can assume three dimensions…*"—and concludes that there must be a further category of beings which have neither substance nor accident, since "*…they exist in themselves and for themselves, as simple forms, which, however, are never detached from their origin—just as material beings without a body…*".[12]

In the same way, Father Athanasius remains neutral even when, in the first few pages of his book, he writes about Astronomy. Indeed, he explicitly takes sides with his Jesuit brother Scheiner, who "*with a huge effort*"[13] has made many observations and has published them in his *Rosa Ursina*. These observations have been widely recognized as fundamental for the study of the Sun; however, Kircher remarks that the surface of the Sun is not immutable, as in Aristotle's Cosmology, but rather variable "*today it's different from yesterday, and tomorrow it will be different from today*".

As for the colour of planets, as soon as you put your eye to the telescope, colours appear clearly enough: "*Saturn is dark grey like lead, Mars is red like the fire, Venus is like silver, Jupiter is shining*"—from which we infer that "*their color cannot derive from the Sun, because when the latter changes colour, all the planets should change accordingly, but this never happens*".[14]

Does Kircher show courage in rejecting details of Aristotle's Cosmology or is he exceedingly careful in not recognizing that the traditional classification is outdated? Probably, the answer is neither the one nor the other. Kircher simply wants to get rid of the theoretical problem in order to talk about what he really cares for, namely solar clocks and optical machines, topics which he can afford without questions about the nature of light. We must say that solar clocks are an old passion of Kircher, since his days at the seminary of Koblenz, where he had realized a meridian, complete with the signs of the zodiac, under which he had

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[11] A. Kircher, 1646, *Ars Magna Luci et Umbrae,* Roma, ex Typographia Ludouici Grignani, digitized by ECHO, p. 110, "*De radiorum entitate; an accidentia sint? An corpus?".*

[12] A. Kircher, *ibidem*, pp. 110–111, *"…inferius radios immateriales dixerimus… At quomodo corpora, si omnia etiam durissima cristallina corpora penetrant… At dices, forsan corporeos esse, in quantum trinae dimensionissunt capaces… ipsos à se, & in se subsistens, à fonte tamen nunquam separatas formas simplices, & substantias sine corpore corporeas".*

[13] A. Kircher, *ibidem*, p. 6, *"Herculeo sanè labore".*

[14] A. Kircher, *ibidem*, p. 14 *"..uti Saturni plumbea, Martis ignea, Veneris argentea, Iovis clara…Si enim ab Sole provenirent, eodem tempore, simili colore omnes planetae imbuerentur, & uno mutato omnes mutarentur…".*

written a warning: "*The shadow flees: it flees silently, just like Time*".[15] This was the first of a series of meridians, which Kircher realized in all German cities where he lived before fleeing to France.

It is therefore not surprising that Kircher devotes seven books of *Ars Magna Luci et Umbrae*, from the third to the ninth, almost entirely to solar clocks and optical machines. Kircher shows his usual infinite knowledge on these topics, always while reminding that this is a complex subject matter, such as *Progymnasmatica, Uranografia Gnomonica* and *Arti Anacamptica* and *Anaclastica*. Indeed, the generous usage of false borrowings from Greek, or grammar structures unrelated to classical Latin, are somehow signs of the modernity of the Jesuit scholar, who chooses an "easy" Latin, because this is commonly used in the discussions among scientists. However, this modernity is very far from Galileo who, even when writing in Latin, has used a logical framework constituted by facts and consequences, thus laying the basis for the creation of contemporary scientific prose.

On the other hand, Kircher is overflowing: while describing infinite clocks, he poses problems of Geometry, Optics and Astronomy, without giving up Astrology or the relationship between time as measured by clocks and the physical status of human beings. There are portable meridians, complete with correction tables, so as to provide a sort of absolute time according to the place in which you are. There are also meridians which project the shadow of the gnomon upon a cylinder, so that the clock becomes small enough for your pocket. There are clocks constituted by a simple cube, in which the gnomon is made of a ray of light entering from a hole, as well as clocks which measure the height of the Sun on the line of the horizon, in order to infer the time and so on (Fig. 5.1).

Even when talking about clocks, Kircher does not forget that one of the tasks of a good priest consists in thinking (and making people think) about the afterlife and therefore creates a clock, which may constitute a discreet *memento mori*. The solar clock is a cylinder—therefore portable, to be looked at anytime—and realized with a black semi-transparent gauze with a cardboard skeleton outside, complete with sickle. The clock works by exposing the image of the skeleton towards the Sun, so that the shadow projected onto the cylinder can be seen from the outer side, and the tip of the sickle will constitute the gnomon of the meridian, on which we can read the words *Mors ultima linea* (*Death is the last line*), just in case the message were not clear enough!

The *Ars magna Lucis et Umbrae* is probably one of Kircher's most successful works, because it mixes his technical skill with his passion. All the clocks described by Kircher are worth a special attention. Even if we simply run our eyes on the pages of this book, we are caught by some solutions, such as, for instance, many "simultaneous meridians", realized by using the acronym which is the

[15] F. Reiffenberg, 1764, *Historia Societatis JESV ad Rhenum Inferiorem*, Cologne, Vol. I, p. 257, quoted by J. Fletcher, 1970, *Isis*, vol. 61, n. 1, p. 53, *"Ea fugit umbra: fugit tacito pede et Annus et Aetas"*.

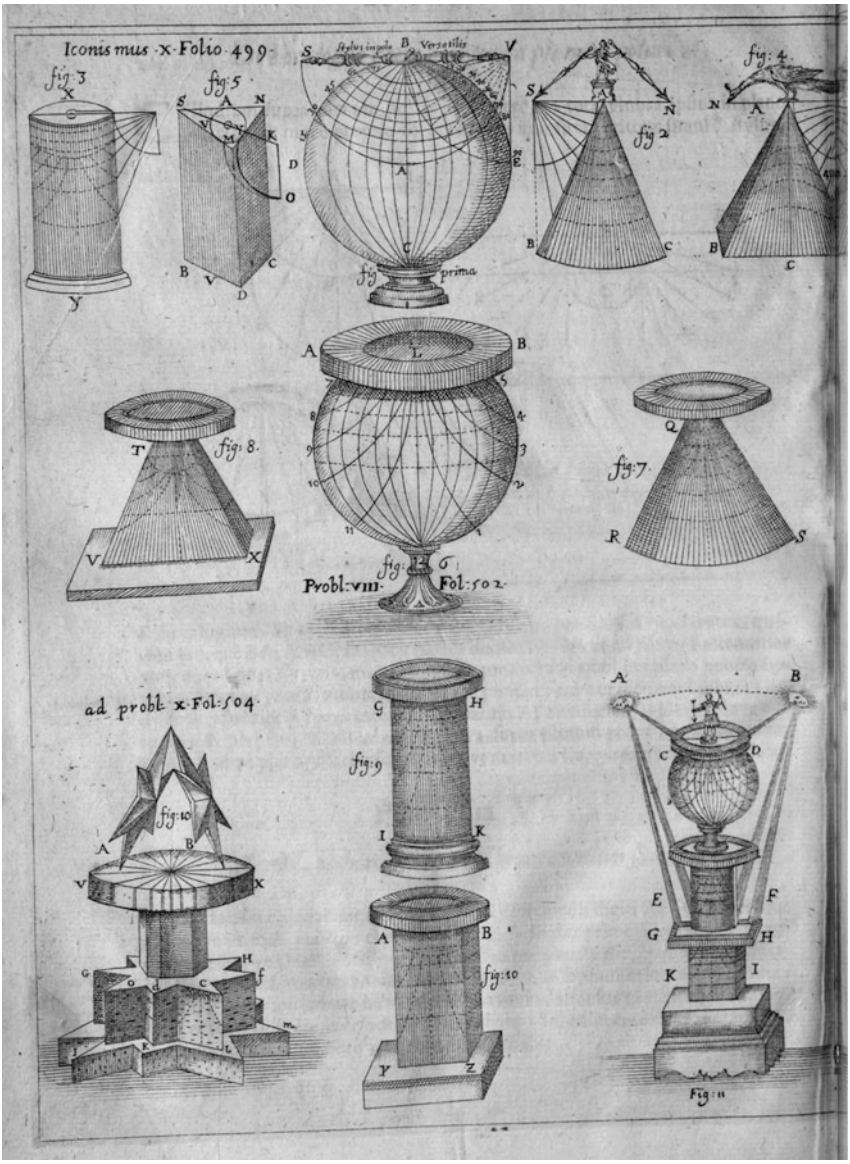

Fig. 5.1 Meridians (from A. Kircher, 1646, *Ars Magna Luci et Umbrae*, Roma, ex Typographia Ludouici Grignani, p. 499). Following Kircher's irregular numbering: *fig. 1* (*centre*) spherical astrolabe, *fig. 2* (*right*) cone with a double style, *fig. 3* time cylinder, *fig. 4* Pyramid with a double style, *fig. 5* clock upon a parallelepiped, *fig. 6* gnomonic globe with a comb-like style, *fig. 7* cone and comb-like style, *fig. 8* pyramid with a comb-like style, *fig. 9* cylinder with a comb-like gnomon, *fig. 10* (*centre*) cube with a comb-like gnomon, *fig. 10* (*left*) clocks on various surfaces and *fig. 11* a number of clocks with a comb-like gnomon

symbol of Jesuits, IHS or the name of the Emperor Ferdinand II (Fig. 5.2). These clocks appear fascinating from the very first moment, because of their luxuriousness and the artistic quality of the image. Secondly, they show a certain liveliness and creativity in technical solutions, which capture the observer's eye.

Another clock worth mentioning, since it is a proof of Kircher's idea of the scientist as a creator of surprise, is the helio-acoustic clock, namely a clock producing both visual and acoustic effects.

It is a metal semisphere, inside which runs the Sun's path in the various months of the year, with a lens at the centre, usually constituted by a glass ball. It works in a fairly simple way: the lens concentrates the Sun's rays upon the timeline carved inside the semisphere; at the chosen time, (if the lens is big enough), the heat of the rays sets fire to the gunpowder inside a deep track. This makes some crackers explode: in turn, they hit a bell which rings. Smokebells, fire and bells: the audience will certainly be entertained!

Probably, the most spectacular effect is reached by a clock, which Kircher created in order to reproduce the prodigy of an ancient talking statue mentioned in a legend. The Jesuit scholar refers in particular to the myth of Memnon, son of Eos, the goddess of dawn, killed during the war of Troy. According to the tale, the statue of Memnon, which was near the city of Thebes, in Egypt, emitted semi-human sounds each morning at sunrise, to celebrate the arrival of his mother, who brought the light to humankind. Kircher seems to realize that the clock he reconstructs on the basis of the legend (Fig. 5.3) is little more than the sketch of a project. That is why he somehow safeguards himself by assuring that in his next book, he will provide a more detailed description of the mechanism and promises he will explain how to endow the statue with a human voice. He should have waited for a more complete project rather than describe it in such an approximate way, but the fact of being almost capable of reproducing a prodigy handed down from a legend is too strong a temptation for Kircher, who cannot resist it.

Chapter Ten of *Ars Magna Lucis et Umbrae* is largely devoted to optical machines. Its contents are even more fanciful than the preceding chapters. Here too, the importance of the text is surpassed by the image, since the latter, according to Kircher, transmits a global, immediate message, which the prose cannot communicate.

It is not easy to find a common goal in these machines: one may perceive a religious aim when observing that the devices planned by Kircher often present a warning, but this is almost constantly accompanied by technical rigour. As a consequence, Kircher's audience is made of people attracted by the show, while at the same time capable of appreciating the religious aim he proposes as, for instance, he introduces the image of Christ, suspended in the air while ascending in glory. A great show of illusionism, clearly not magic, since this is considered devil's work.

The most realistic illusion realized by Kircher probably is the portable dark-room (Fig. 5.4), which consists of two rooms, one inside the other, where the viewer enters, and suddenly thinks he/she is outdoors. The idea is not original:

Fig. 5.2 Para-equinotial Meridian (from A. Kircher, 1646, *Ars Magna Luci et Umbrae*, Roma, ex Typographia Ludouici Grignani, p. 497). In the equinotial meridian, the gnomon is parallel to the Earth's rotation axis, and the plane is parallel to the Equator. In this meridian, Kircher manages to draw 25 separate meridians, using the letters of the name Ferdinandus as meridian plane, and some holes in the upper part of the letters themselves as a luminous gnomon. Some of them, such as *F* and *E*, are actually equinoctial, whereas others are oblique. Even the Imperial eagle, with two heads, feathers, beak and claws, is used to obtain more meridians through the use of small mirrors

Kircher honestly admits he has seen it in Germany, as created by a *well-known inventor* and keeps praising it "*…you could see mountains, fields, woods, men, animals, hunting scenes…*", underlining that the machine allows to see the movement of the subjects outside "*…apart from the show, there were the gestures of individuals staying all around outside… as well as birds flying. These birds were represented in such a pleasant manner, that I cannot remember ever seeing anything so beautiful in my whole life…*".[16]

In fact, such a darkroom should not have raised such marvel, since the pictures produced by the pinhole are upside down. However, we may suppose that Kircher uses lenses placed on the pinhole, thus obtaining the further effect of increasing the brightness of the pictures. We do not know whether Kircher has ever thought of organizing shows outside the darkroom, but, if he did, we may imagine that he offered his audience the chance to enjoy a cinema show in advance of times.

If the darkroom is probably the optical machine in which Kircher gives more space to the wish of pleasing his audience, the magical lantern carries a more explicit warning.

The entertainment obtained by this machine is similar to that of the darkroom, but, while the latter houses one viewer at a time, the magical lantern offers the chance to project—in front of a big audience—a series of pictures painted upon glass, just like a modern slide projector, whose light bulb has been replaced by a lamp. Probably, Kircher, over and beyond entertaining his audience, also thinks of giving his contribution to the activities, which his brothers are carrying out in the missions in Asia and in the Americas: the magical lantern probably represents the solution to the problem of finding a universal language, which may be understood by all human beings—a problem which the Jesuit scholar has studied in theory, while looking for a universal language, and will systematize in his book *Turris Babel* in 1679.

Kircher's detailed description of the magical lantern refers to a real model he installed at the Collegio Romano: "*… the light of the lamp, passing through a lens, will project upon the wall… the picture painted upon a smooth glass… a picture which, if placed on the glass upside down, will be projected on the wall straight and larger…*".[17] Kircher suggests that, in order to obtain a bright enough picture, one should place a metallic mirror near the flame of the lamp, so as to concentrate the light upon the lens. Although the projections thus realized were not really so bright, the system is effective, and Kircher can use it to charm and warn his audience about the afterlife, since the two pictures of the 1671 edition show—

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[16] A. Kircher, 1646, *Ars Magna Luci et Umbrae,* ex Typographia Ludouici Grignani, p. 812, "*Vidisses hic montes, campos, sylvas, homines, bruta, venationes… accedebat hisce gestus singulorum, hominum quoque forinsecus circumstantium facies, gestus, visus, loquela, motus dentium, volucrum volatus, qui ita viuum repraesentabantur, ut nihil tota mea vita iucundius me vidisse meminerim..".*

[17] A. Kircher, 1671, *Ars Magna Luci et Umbrae,* ex Joannem Janssonium Waesberge, p. 769, *"…in muro candido lumen lucernae vitrum lenticulare transiens imaginem in H vitro depictam (quae inverso situ in vitro ponitur) rectam & in muro grandiorem echibebit..".*

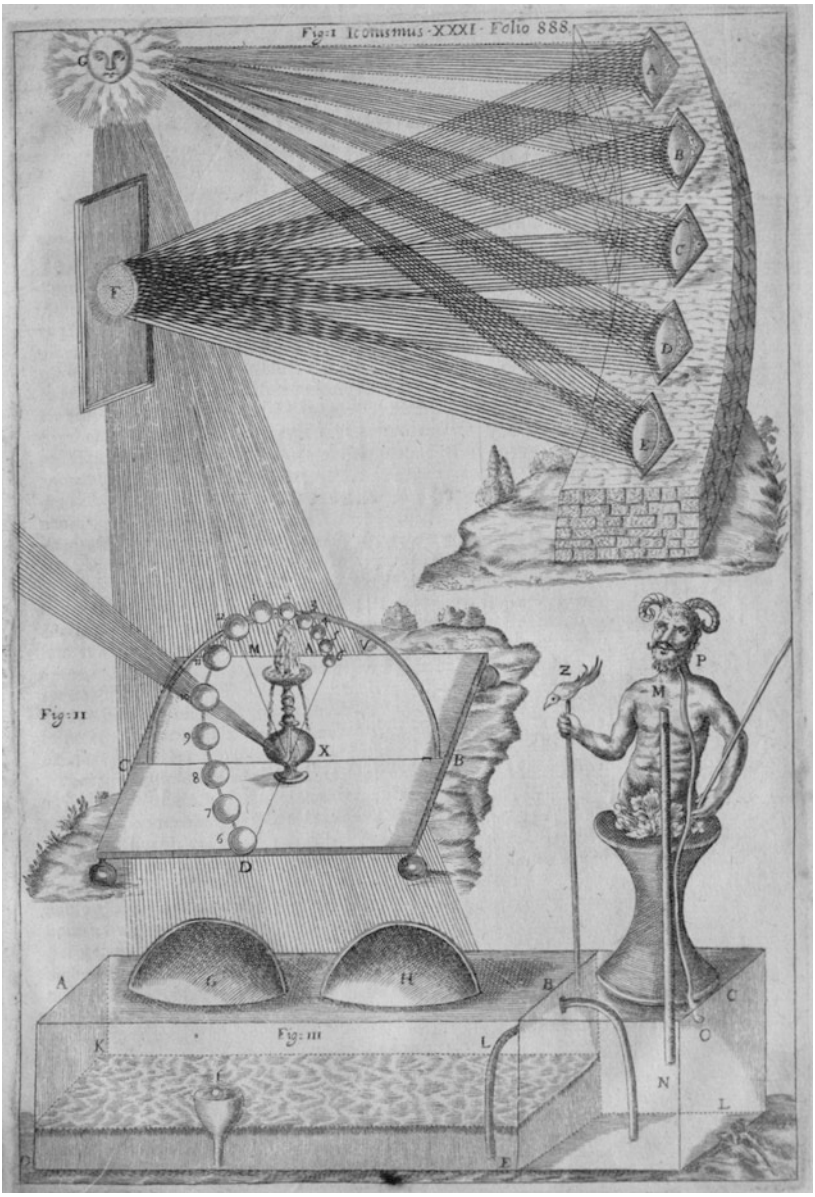

Fig. 5.3 Clock with the talking statue of Memnon (from A. Kircher, 1646, *Ars Magna Luci et Umbrae*, Roma, ex Typographia Ludouici Grignani, p. 888). The figure represents two different mechanisms of the clock. The first one is in the lower part of the figure, which Kircher indicates as *Fig. III*, and is based on the fact that solar radiation heats up the parallelepiped tank. This tank contains water in the left partition and air in the right partition. The partitions are linked by a small tube. Head and body of the statue of Memnon (who looks like a faun) are linked by two small tubes to the air space, and a third tube connects the space to the bird which Memnon holds

◀ on the stick in his hands. The two semispheres, placed on the upper part of the tank, increase the area of solar radiation, which heats up the water, which in turn increases the pressure of air in the right-hand tank. The hot air goes up (violently) along the three tubes. The first one will provoke guttural sounds from the statue's mouth (probably similar to the sound of a contemporary coffee machine), while the second will make Memnon's eye roll. Moreover, these eyes "have been realized so as to assume a threatening look", but there will be "a swollen tongue coming out of the mouth, producing a marvellous show" (A. Kircher, *ibidem*, p. 889, *"…oculos movebit factitios & ad imitandum aptos, industriosè insertos; linguam quoque inflatam extra os protrudet, mirum dictu spectaculum"*). The third tube will make a whistle come out of the bird's mouth. All these special effects will surprise and entertain the audience. The second mechanism is represented (in a rather confused way) in the upper part of the figure (which Kircher indicates as *Figs. I* and *II*) and shows the possibility of making the mechanism work in the different seasons of the year, when the Sun rises in different points of the horizon. The converging mirrors (*A*, *B*, *C*, *D*, *E*) gather the sunlight in the various season and make it converge upon the small tank X—*Fig. II*. (the plane mirror F has no function, apart from deviating the converging solar rays). The glass spheres, numbered from 1 to 12, work as lenses, which should improve the convergence of sunlight before it hits the tank. When the water inside the tank X has reached the right temperature, it will go up, thus producing a small fountain

respectively—the projection of a soul among the flames of Purgatory and a skeleton with a sickle in one hand and an hourglass in the other.[18]

The catoptric Proteus, i.e. exclusively based upon reflection, is a machine of which Kircher heard about. Even if he has never actually seen it, Kircher wants to show that he can reproduce it. This device is aimed at frightening the unaware viewer, who enters a special room, and suddenly sees him/herself with the head of a donkey (or of any other chosen animal).

Kircher seems to apologize because he proposes an experiment which apparently only aims at entertaining the audience and is probably not new for some of them (the Jesuit's audience is often made of well-known people, who have had the chance to travel around the world). However—he explains—he aims at showing that this is a simple artifice, thus discrediting the legend, according to which this effect was due to a sort of magic. Therefore, Father Athanasius confirms that his experiments are directed at unmasking many false magicians, even though he does not deny the existence of devilish spells. However, "*we shall fly from them, with oars and sails; we condemn and hate them deeply, together with the Holy Church*".[19]

Kircher reveals that the idea had been suggested to him by a relation of his, who had read somewhere that—in the sixteenth century—a benedictine monk, known as an expert in exoterism, Giovanni Tritemio, "*promised to transform any man into any animal*". Although Kircher did not really know the details, he admits that he is not so surprised by this, since he is convinced that "*…there are many incredible and paradoxical things in Nature, which can be realized by those who*

[18] *For a thorough discussion on Kircher's Magic Lantern, see* K. Vermeir, 2005, BJHS, 38, pp. 127–159 *and references therein.*

[19] A. Kircher, 1646, *op. cit.*, p. 908, *"ea nos remis velisque fugientes, meritò cum Sancta Matre Ecclesia damnamus, & execramur"* quoted by M. G. Ianniello, 1986, *op. cit.* p. 231.

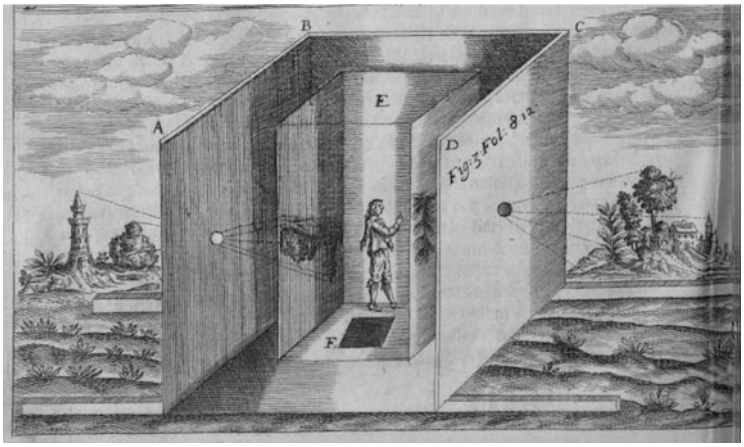

Fig. 5.4 The darkroom (from A. Kircher, 1646, *Ars Magna Luci et Umbrae*, Roma, ex Typographia Ludouici Grignani, p. 807. *Lower part* of the original figure). The device is constituted by two rooms, one inside the other. The walls of the inner room are semi-transparent, so that the viewer inside sees the picture projected by the pinhole of the outer room, without realizing where the picture comes from. In fact, the viewer gets the impression he/she is placed within the landscape outside. This light structure is easily portable

know the secrets of the Sun's nature".[20] Kircher wants to show this through the catoptric machine (Fig. 5.5) which—as he writes—he has built himself.

The description of the machine ends with a piece of advice which is worth quoting, since it gives an idea of Kircher's concept of entertainment: "*Moreover, if someone builds a skull, out of any material and empty inside, with holes instead of eyes, as well as a nose and sneering mouth, and will cover these hollows with a thin parchment dipped in oil, hids a lamp where I will say later on, you will certainly see a much more frightening show*".[21] Even though the description of how the *Proteus* work is rather approximate, Kircher does draw a hole on the left wall, from which a viewer (an eye in the figure) may enjoy the scene without being seen.

In the whole of *Ars Magna Luci et Umbrae* and in the section about iconography in particular, the Sun's image is everywhere, no matter what is the topic in discussion. In his preface, Kircher celebrates the Sun, whose light, "*arrives to us after crossing the crystal spaces, in order to give perfection, reality, life, and*

[20] A. Kircher, 1671, *op. cit.*, p. 901, *"… tantum dico multa esse in rerum natura, quae tamen a solis naturaearanorum conscijs facilè in effectum deduci queant"*.

[21] A. Kircher, 1671, *op. cit.*, p. 784, *"Si praeterea quispiam essormaverit ex quacunque materia caput mortui, intus vacuum, terebratosque oculos, nasum, rictum oris, subtili charta oleo tincta, dictis cavitatibus obduxerit, deinde intus designato loco, lampadem absconderit; videbitur haud dubiè spectaculum supra quam dici potest, formidabile"*.

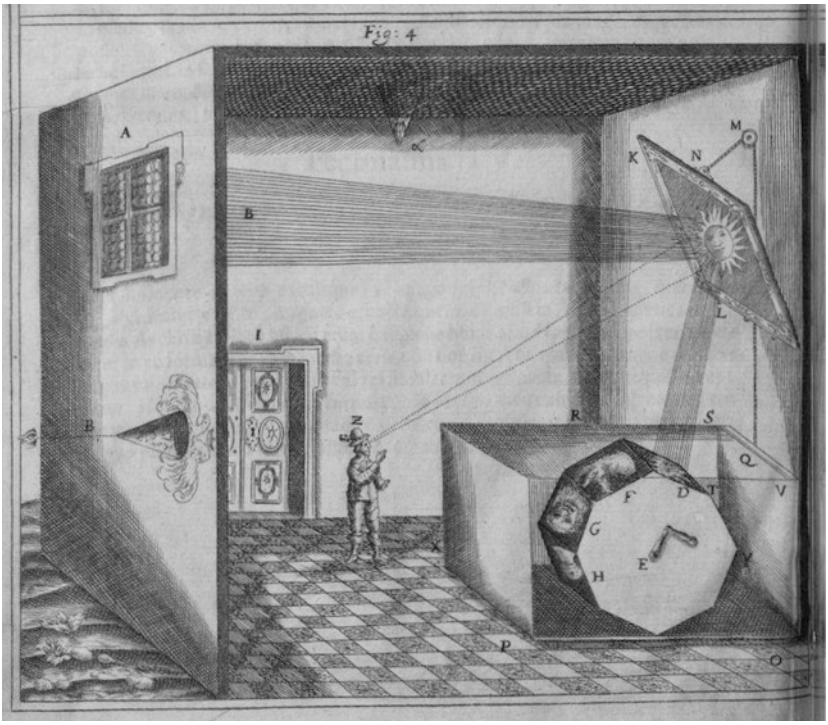

Fig. 5.5 The catoptric proteus (from A. Kircher, 1646, *Ars Magna Luci et Umbrae*, Roma, ex Typographia Ludouici Grignani, p. 901). The viewer sees him/herself reflected on the mirror upon the wall. The small pulley placed behind the mirror makes it slightly rotate without the viewer being aware of it. If we change the inclination, the mirror reflects one of the pictures painted upon the octagonal wheel, hidden to the viewer. With an accurate movement of the mirror, if the viewer is in the right place, he/she will see his/her own body with one of the animal heads painted instead of his/her own head (in fact, such a machine cannot work if you only use a plane mirror). The best effect can be obtained if—once the head appears—the animal cry is heard too

movement to everything…".[22] By quoting Plato, Ficinus and Plotinus, Kircher may be placed alongside the Renaissance Neoplatonic tradition, which indeed he does not disown. Rather, he integrates this inheritance into the Christian view of the world. His passion for Hermetism and Renaissance magic is always compensated by a reference to the empiric and natural investigation. In the same way, his exaltation of the function of the Sun, which he separates into *lux, lumen* and heat, ends up with a metaphor of the Christian Trinity.

[22] *Ibidem,* Praefatio, *"…ad nos per crystallina illa coelorum spacia, …omnibus rebus suam dari perfectionem, sensum, vitam, motum..".*

Chapter 6
Spots upon the Unchangeable Sun

A generation goes, and a generation comes, but the Earth remains forever.

Ecclesiastes (1, 4–5)

The lives of Galileo and Kircher cross each other in the summer of 1633, when the young Jesuit scholar is in Avignon and receives a long letter from Rome by his brother Christoph Scheiner, who tells him that he has written an essay, *Prodromus de sole mobili et stabili terra contra Galileum,* which is intended as the answer of the Catholic Orthodox party to the *Dialogue concerning the two chief World Systems.* The *Prodromus*, in which the author examines the nature of solar spots and the Sun's rotation around its axis, is aimed at defending the concept of the Earth's stability. The essay will only be published in 1651, and the reason for this delay is still unknown.

The most striking detail in the letter to Kircher is the satisfaction of Scheiner, which clearly transpires between the lines, at the news that Galileo, old and sick at the time, has just been forced to abjure Copernicus' ideas. This satisfaction, in itself, is a symptom of the current violent debate, which Scheiner will continue against Galileo for the rest of his life.

The conclusion of Scheiner's letter is significant, since it reads like a piece of news: "*A few days ago Galileo abjured and condemned his own statements concerning the still Sun and the moving Earth in front of the Inquisitor, and before at least 20 witnesses… His book will be banned*".[1]

Kircher, usually moderate in his opinions and averse to academic arguments, is nevertheless a young scholar who respects an older brother, a well-known Astronomy teacher. When he receives the first draft of the *Prodomus,* he comments on it with enthusiasm, in a letter addressed to his protector Fabri de Peiresc, who, being an old friend of Galileo, is certainly embarrassed by this. Indeed, a few weeks later, Peiresc confesses to his friend Pierre Gassendi his discomfort for the way Galileo has been treated, as well as his worry for the consequences which

[1] C. Scheiner, 1633, *Letter to Athanasius Kircher,* 16 July 1633, in 1966, *Le Opere di Galileo, vol. XV,* G. Barbera ed., Firenze, *"Galilaeus paucis ante diebus abiuravit et damnavit suam de stante sole, de motu terrae, sententiam, coram Inquisitore, in praesentia 20 testium, ut vocant de vehementi, laborans vehementi haereseos suspicione. Liber eius proscribetur".*

R. Buonanno, *The Stars of Galileo Galilei and the Universal Knowledge of Athanasius Kircher*, Astrophysics and Space Science Library 399,
DOI: 10.1007/978-3-319-00300-9_6,

the attacks of Scheiner, who is now a member of the group of mathematicians at the Collegio Romano, have on Galileo's future. Peiresc writes: *"…Scheiner cannot help attacking this poor old scientist, even after he has been humiliated and has risked a life sentence".*[2]

The controversy between Scheiner, who at the time was teaching Maths at the University of Ingolstadt, and Galileo, who had just come back to Florence and was very popular, dates back to 1611, when the Jesuit scholar had reported the dark spots on the Sun which he had observed. Galileo had confirmed the observation and declared he had observed the same phenomenon at the telescope a few months earlier than the German scientist. At the start, the discussion had been kept within the limits of a normal debate between two scholars. This rivalry became explicit hostility when Scheiner, in 1624, once arrived in Rome, gets the chance to read Galileo's preface to *Il Saggiatore ("The Assayer"),* which has just been published.

This is one of Galileo's best works, because of the pervading strength and irony; however, here, his *vis polemica* emerges with such impetuosity that he supports Aristotle's thesis in order not to admit the reasons of his adversaries. One of the motives for this dispute was the distance of a comet, which had appeared in 1577, a topic which involved the very nature of this celestial object.

Tycho Brahe, and later on, the Jesuit scientist Orazio Grassi, who writes about the comets of 1618, and measured their parallax, had rightly concluded that these objects came from regions beyond the Moon sky, namely from the immutable cosmos. Galileo, probably in order not to support Brahe's Cosmology which, in his opinion, was an obstacle to the acceptance of Copernicus' system, had said that comets are simple atmospheric phenomena. In order to keep the point, Galileo had been forced to take sides with Aristotle's followers, thus running up against a series of incoherences.[3]

What is more, Galileo decided to remove a thorn in his flesh. In the *Saggiatore,* he had written:

"*How many men attacked my Letters on Sunspots, and under what disguises! The material contained therein ought to have opened to the mind's eye room for admirable speculation; instead it met with scorn and derision. Many people disbelieved it, or failed to appreciate it. Others, not wanting to agree with my ideas, advanced ridiculous and impossible opinions against me; and some, overwhelmed and convinced by my arguments, attempted to rob me of that glory which was*

[2] N. C. Fabri de Peiresc, 1633, *Letter to Pierre Gassendi,* 6 September 1633, in 1966 *ibidem,* quoted in J. Fletcher, 1970, *Isis*, vol. 61, n. 1, *"… qu'il ne se puisse abstenir d'attaquer ce pauvre vieillard, aprez l'avoir terrassé à ses pieds et l'avoir faict mesmes condamner, oultre la retractation, à une prison perpetuelle…"*

[3] M. Guiducci, 1619, *Discorso delle Comete,* P. Cecconcelli, Firenze [Guiducci is a student and friend of Galileo, who, according to the historians, has certainly contributed to writing this pamphlet].

mine, pretending not to have read my writings and trying to represent themselves as the original discoverers of these impressive marvels."[4]

Indeed, Galileo's charge of plagiarism against Christoph Scheiner here is rather precise, even though some critics, referring to a later paragraph, say that Galileo is essentially talking about Simon Mayr from Gunzenhausen, the same German scientist Galileo had met when Baldassarre Capra (a dummy of Mayr) had tried to copy his military compasses. However, a second, more serious, case of plagiarism, concerns Mayr, who in the meantime has become an Astronomer at the court of the Margrave of Branderburgh. Mayr writes a short essay, *Mundus Iovialis,* where he says that he has observed Jupiter's satellites a few days before Galileo himself. Therefore, Galileo's resentment is justified, just like his answer to Mayr in the *Saggiatore* can be understood.

Only the specialists may say whether Galileo's argument is addressed to Mayr only, or to Scheiner too. What really matters is that the Jesuit scholar is convinced that the charge of plagiarism is against him, because of the old debate about the priority of the discovery of sunspots upon the surface of the Sun. The offense he thinks he has unfairly received from Galileo is so deep that, even after a certain number of years, Scheiner recalls it in his major work, *Rosa Ursina,* with a humiliated sourness *"…all these years, during my absence, I have been accused and attacked for stealing"*.[5] Whatever the reason for controversy, Galileo has acquired a fierce enemy in the very heart of the Academy of astronomical orthodoxy, the Collegio Romano. This enemy will transform his personal war into the war of his Order against Galileo. The same war will go on even after the death of both Scheiner and Galileo.

Of course, such a yearlong dispute gradually acquired further contents. In a period in which they debated on Copernicus' vision of the world, the question inevitably passes over the problem of who observed the sunspots first. Indeed, the two rivals refuse to budge from their respective standpoints: the heliocentric Galileo against the tychonic Scheiner.

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[4] G. Galilei, 1623, *Il Saggiatore, op. cit.*, p. 2, "*Le lettere sulle macchie solari Solari e da quanti e per quante guise fur combattute? e quella materia che doverebbe dar tanto campo d'aprir gl'intelletti ad ammirabili speculazioni, da molti, o non creduta o poco stimata, del tutto è stata vilipesa e derisa; da altri, per non volere acconsentire a' miei concetti, sono state prodotte contro di me ridicole ed impossibili opinioni; ed alcuni, costretti e convinti dalle mie ragioni, ànno cercato spogliarmi di quella gloria ch'era pur mia, e, dissimulando d'aver veduto gli scritti miei, tentarono dopo di me farsi primieri inventori di meraviglie così stupende"*. Selections translated by Stillman Drake, *Discoveries and Opinions of Galileo* (New York: Doubleday & Co., 1957), p. 231, http://www.princeton.edu/~hos/h291/assayer.htm.

[5] C. Scheiner, 1626–1630, *Rosa Ursina…,* Andream Phaenum Typographum Ducalem, Bracciano, Cap. I, pp. 1, II-2, I quoted in L. Ingaliso, 2005, *Filosofia e Cosmologia in Christoph Scheiner,* Rubettino ed., Soveria Mannelli, p. 121, *"per tot nunc annos etiamnum latitantem impeti, turpisque furti reum … animadverti"*.

If you suppose that this conflict is for or against Galileo, you will not catch the complex problems of contemporary politics and the mood of many key actors on the cultural stage. Inside the Jesuit Order, at least until the retraction imposed on Galileo in 1633, without doubt the idea went around that Copernicus' paradigm should be examined more closely and might even be adopted as a working hypothesis.

This is witnessed, for example, by Francesco Stelluti, a member of the Accademia dei Lincei, as well as an old friend of Galileo. In 1626, he tells Galileo that, according to their common friend Giovanni Fabri, Scheiner leans towards Copernicus' thesis, namely that the Sun is still while the Earth turns around it *"…The Jesuit Father Scheiner is here* (in Rome)"—Stelluti writes—*"I think he is going to publish his observations of sunspots; a few days ago, he asked Mr. Fabri what you were going to publish; Fabri said that he did not know; Scheiner replied that he had heard that you were going to publish an essay on high and low tide, that he wished to see it, and that he shares your opinion about the solar system"*.[6] This revelation, which Stelluti attributes to Fabri, though surprising, is somehow confirmed by a second letter. Here, Peiresc says that, in their latest meeting in Aix, Kircher had told him that the old professor at the Collegio Romano, Christoph Clavius, *"felt compelled to write in favour of Aristotle's theory, and that Father Scheiner himself supported them only out of duty"*.[7]

There are many opinions, many rumours, second-hand information and assumptions about the relationships between Galileo and the Jesuits at the Collegio Romano. Someone even raised suspicions (without any proofs) that either Scheiner or Grassi has played an active role in the charge against Galileo. However, let us follow the facts.

On November 12, 1611, Christoph Scheiner sends a letter to Markus Welser, duumvir of Augsburg and banker of the Jesuits, in which he declares that *"About seven or eight months ago* (i.e. between March 12 and April 12), *together with an assistant of mine, we pointed our telescope towards the Sun and noticed a few black spots…"*.[8] This letter, together with two more letters, respectively, written

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[6] F. Stelluti, 1626, *Letter to Galileo Galilei,* 10 January 1626, in 1966, *Le Opere di Galileo, vol. XIII,* G. Barbera ed., Firenze, *"…Si trova qui* (a Roma) *il Padre Scheiner Giesuita, che credo stampi le sue osservationi delle macchie solari; e disse alcuni giorni sono al nostro Sig.r Fabri, che cosa stampava di nuovo V. S.; a che rispose di non saperlo; e lui replicò c'haveva inteso che stampava del flusso e reflusso del mare, e che desiderava di vederlo, e concorre con l'opinione di V. S. circa al sistema mondano"*.

[7] N. C. Fabri de Peiresc, 1633, *Letter to Pierre Gassendi,* 6 September 1633, in 1966, *Le Opere di Galileo, vol. XV,* G. Barbera ed., Firenze, *"si sentiva obbligato e costretto a scrivere in favore delle teorie aristoteliche, e che lo stesso Padre Scheiner le supportava solo per senso del dovere"*.

[8] C. Scheiner, 1611, *Letter to Markus Welser,* 12 November 1611, in 1966, *Le Opere di Galileo, vol. V,* G. Barbera ed., Firenze, "*Ante menses septem, octo circiter, ego unaque mecum amicus quidam meus tubum opticum … in Solem direximus… et notavimus quasdam in Sole nigricantes quodammodo maculas"*.

on 19 and 26 December, is later published by Scheiner with a pseudonym, as usual for a Jesuit when handling sensitive topics. Therefore, Scheiner signs the three letters as *Apellis latentis post tabulam,* i.e. "Apelles hidden behind the picture", with reference to the legend, according to which once the great Greek painter Apelles, hidden behind one of his pictures, had heard a cobbler criticize a detail of a shoe in the picture. The painter had promptly corrected it and had exhibited the picture once again, hiding himself behind it. This time the cobbler, fortified by the preceding success, had extended his criticism to other details of the picture. At this point, the great painter, suddenly coming out from behind the picture, had struck him with these words: *"Do not go past the shoes, cobbler!"*

Scheiner's first letter shows how seriously he takes into consideration the observation of sunspots, since he analyses the phenomenon with a peculiar rigour. First of all, he wonders whether the spots are a physical fact, or rather an effect of his instrumentation. After deciding that they represent a real phenomenon, he concludes that *"they are either placed on the Sun or in some sky* (namely, in some crystal sphere) *outside the Sun"*.[9] Since the Sun, according to the postulates of the Scholastic Philosophy, is a perfect body, which cannot have imperfection, as a consequence, the dark spots can only be bodies, for example satellites similar to the Medici's, though in a much greater number than the four discovered by Galileo around Jupiter, which are placed between the Sun and the Earth.

Scheiner's conclusion might make him appear like an obtuse defender of an outdated Cosmology, but this is not really true. In fact, just after the publication of *Sidereus Nuncius,* Galileo's observations have been largely accepted by the cutting edge of orthodox philosophers, so much so that the existence of Jupiter's satellites is even used by Scheiner in order to explain the new observations of the sunspots.

On January 6, Welser, who knows Galileo as a scientist, sends him the letters, which *Apelles* has already published, because he hopes to raise his interest in this new astronomical discovery, and to know his opinion about it. Galileo will only answer three months later *"… I have chosen silence out of necessity, because of various accidents, in particular by a long illness, or rather by several long illnesses…"*, moreover, *"…I should be much more careful in announcing any kind of news, than many other people…"*.[10]

Though expressing the caution imposed by the circumstances, since Galileo realizes how many enemies are allied against him, he willingly comments what

[9] C. Scheiner, 1611, *ibidem*, *"necesse est ergo, illa esse vel in Sole, vel extra Solem in aliquo Caelo"*.

[10] G. Galilei, 1612, *Letter to M. Welser,* May 4, 1612, in *Istoria e dimostrazioni intorno alle macchie solari*, 1613, Giacomo Mascardi ed., Roma, p. 10, *"… essendo stato quasi necessitato a usare tanto silenzio da varii accidenti, ed in particolare da una lunga indisposizione, o, per meglio dire, da lunghe e molte indisposizioni…a me conviene andare tanto più cauto e circospetto, nel pronunziare novità alcuna, che a molti altri…"*

Apelles has written. First of all, about sunspots *"…they are doubtless real, rather than mere appearances or illusions of the eye or the crystal, as your friend shows in his first letter; I have observed them myself for the last 18 months, showed them to a few friends, and this time last year, I let various priests and gentlemen in Rome observe them…"*.[11]

Therefore, Galileo confirms what the fake *Apelles* wrote, but at the same time declares he observed the spots in the month of October 1610, i.e. 5 or 6 months before Scheiner, thus taking away from him the merit of the discovery.

Specialists should find out whether Scheiner or Galileo observed first the sunspots. However, it is likely that, as often happened in the history of science, the discovery took place independently, more or less in the same period. On the other hand, other scholars should compete for this record, for example Kepler in 1609, Harriot and Fabricius between 1610 and 1611. However, we think we can reduce the choice to Galileo and Scheiner, both for the later dramatic events, and because the debate between them is not simply limited to observations, but is extended to the interpretation of the phenomenon, with frequent reversals of right and wrong.

In the letter which Galileo sends Welser, we immediately suppose Galileo is right, as he examines *Apelles* reasoning on the fact that sunspots cannot lie on the surface of the Sun. Indeed—Galileo says with a surprisingly modern logic—we can say that the Sun has no spots if we *observe* that there are no spots—not viceversa *"…because if he says, as in the first motivation, that it cannot believed that there are dark spots on the Sun, though clear-headed… but if the Sun appears to us impure, with spots, why should we not define it stained and not pure? Definitions and adjectives should be adapted to the essence of things, not the other way round; since things were born before names"*.[12]

Galileo then analyses—admittedly less effectively—the nature of sunspots, and infers that they are atmospheric phenomena, just like the clouds upon the Earth, because he notices that *"sunspots are created and dissolved in shorter or longer times; some of them condense and move a lot within a day; they change their shape, mostly irregular, darker and lighter in parts… Now, we only know one type*

[11] *ibidem,* p. 11, *"… siano cose reali, e non semplici apparenze o illusioni dell'occhio o de i cristalli, non ha dubbio alcuno, come ben dimostra l'amico di V. S. nella prima lettera; ed io le ho osservate da 18 mesi in qua, avendole fatte vedere a diversi miei intrinseci, e pur l'anno passato, appunto in questi tempi, le feci osservare in Roma a molti prelati ed altri signori…"*.

[12] *ibidem,* p. 12, *"…perché il dire, come egli mette nella prima ragione, non esser credibile che nel corpo solare siano macchie oscure, essendo egli lucidissimo… ma quando ci si mostrasse in parte impuro e macchiato, perché non doveremmo noi chiamarlo e macolato e non puro? I nomi e gli attributi si devono accomodare all'essenza delle cose, e non l'essenza a i nomi; perché prima furon le cose, e poi i nomi"*.

of huge masses, which are created and dissolved in a short time, sometimes last longer, sometimes disappear soon, move and condense, and easily change their shape, and are partly denser, partly opaque: namely, clouds…".[13]

Therefore, Galileo, after excluding that sunspots may be due to the interposition of stars or satellites between the Earth and the Sun, and suggesting that sunspots may be assimilated to clouds upon the Earth, grants *Apelles* a sort of honours of war, by declaring *"It seems to me that Apelles, having a free rather than servile mind, capable of following true doctrines, moved by the force of so much novelty, is finally starting to listen and accept the new, true philosophy…".*[14]

The discussion between Galileo and Scheiner on the nature of sunspots, as well as on the supposed incorruptibility of the Sun, goes on for some time. The two competitors, though largely maintaining their respective positions, keep an academic correctness, so much so that Scheiner even submits to Galileo his work—*Sol ellipticus*—with a letter in which he writes *"Dear Sir, after my recent research, I am sending you my 'Sol Ellipticus' which, although it is only a short essay, I hope will not be unwelcome. If you have time and think it is worthwhile, please let me know your opinion about it. Please do not think I will be offended if your evaluation is for or against me, because the Truth is always welcome…".*[15]

This letter is important for two reasons: first of all, it shows that Scheiner thinks highly of Galileo, at least until 1615, the date of his letter, secondly, in this occasion, the Jesuit scholar is right and Galileo is wrong.

Scheiner explains that the Sun assumes an elliptical shape upon the horizon because, during their path, the solar rays curve when crossing the Earth's atmosphere. Since the rays coming from the upper region of the Sun are less curved than those coming from its lower region, due to differential refraction—an effect which in Scheiner's times had already been identified—the solar disk appears flattened. Galileo's opinion on this phenomenon is explained in the *Saggiatore* where, while discussing with Orazio Grassi, the well-known Lotario Sarsi of the comet, who defends Scheiner's thesis about refraction, states instead that the Sun

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[13] *ibidem,* p. 21, *"le macchie solari si producono e si dissolvono in termini più e men brevi; si condensano alcune di loro e si distraggono grandemente da un giorno all'altro; si mutano di figure, delle quali le più sono irregolarissime, e dove più e dove meno oscure… Ora, moli vastissime ed immense, che in tempi brevi si produchino e si dissolvino, e che talora durino più lungo tempo e tal ora meno che si distragghino e si condensino, che facilmente vadino mutandosi di figura, che siano in queste parti più dense ed opache ed in quelle meno, altre non si trovano appresso di noi fuori che le nugole…".*

[14] *Ibidem,* p. 17, *"Parmi per tanto di scorgere che Apelle, come d'ingegno libero e non servile, e capacissimo delle vere dottrine, cominci, mosso dalla forza di tante novità, a dar orecchio ed assenso alla vera e buona filosofia…".*

[15] C. Scheiner, 1615, *Letter to G. Galilei,* April 11, 1615, in 1966, *Le Opere di Galileo, vol. XII,* G. Barbera ed., Firenze, *"Post nuperas Disquisitiones, nunc Solem Ellipticum mitto tibi, sperans non ingratum fore, tametsi exile sit, munusculum. Quaeso, si vacabit et operae precium iudicabis, ne graveris sententiam tuam super eo ferre et mihi indicare: neque est quod offensam meam verearis; libenter audiam, sive pro me sive contra facias. Veritas enim uti neminem palpat, ita agnita, grata est…".*

appears elliptical because of a mere effect of perspective, as it can be easily verified by observing a circumference obliquely. Here, Galileo demonstrates that, as it happens to the best scientists, you can sometimes be wrong!

If we thought that the academic discussion between Scheiner and Galileo developed in a climate of willingness to understand the reasons of the others, we would not get a complete vision of that age, because, together with the group of scholars interested in interpreting the new observations, the party of irrational dogma starts playing its own game. A sinister clue for this is provided by a letter which Niccolò Lorini, chief preacher of the Dominican order, unexpectedly sends to Galileo to assure him that *"…the suspicion that, on the morning of All Souls' Day, I was talking of philosophy against someone, is false and entirely without foundation … not only I have never even dreamt of entering such matters, I have also never pronounced a word hinting at it … I wish to please and serve you as a master, and until you order something, as I wish, I pray for your material and spiritual happiness…".*[16]

To any experienced reader, this unctuous ending would appear particularly alarming. However, Galileo in this occasion seems to us a bit naive, since he simply realizes the meanness of the argumentation and tells Federico Cesi that the Dominican preacher in his letter, referring to Copernicus, called him "Ipernico", *"There has been a clumsy preacher in Florence, who expressed his hatred against the Earth's mobility; however, this good man knows so well the author of this thesis that he calls him Ipernico. You can see how poorly and by whom philosophy is handled…".*[17]

In this same period, Galileo makes the mistake of trusting the convincing logic of reasoning in order to reply to the adversaries' arguments, without wondering when logic has ever convinced a person in bad faith. His most reliable friends, such as Federico Cesi, realize that Galileo has taken a dangerous road, which may expose him to a threatening dislike, and suggest to him that he should not expose himself*"… I am pretty sure that everyone will share your opinion and will take sides against the adversaries; I have always thought you should not answer*

[16] N. Lorini, 1612, *Letter to G. Galilei,* November 5, 1612, in 1966, *Le Opere di Galileo, vol. XI,* G. Barbera ed., Firenze, *"…il sospetto che io la mattina de' Morti fussi per entrare a favellar in materia di filosofia contro di veruno, fu in tutto falso e senza veruno fondamento nè vero nè verisimile… e non solo non ho mai sognato di voler entrare in simil cosa, ma mai ho io profferito parola ch'habbia accennato quello… Io desidero di compiacer e servir V. S. come a mio padrone, e mentre che la non comanda qualcosa, come desidero, prego per l'agumento d'ogni sua felicità spirituale e temporale…".*

[17] G. Galilei, 1613, *Letter to F. Cesi,* January 6, 1613, *op.cit., "…È stato in Firenze un goffo dicitore, che si è rimesso a detestar la mobilità della terra; ma questo buon huomo ha tanta pratica sopra l'autor di questa dottrina, che lo nomina l'Ipernico. Hor veda V. E. dove e da chi viene trabalzata la povera filosofia…"*

personally, but rather let some of your young disciple answer them, so as to humiliate them: we could help them reply, or else they could sign your finished essay".[18]

However, Galileo is so convinced of the strength of his deductive method that he naively goes into a dangerous argument, namely the interpretation of the Holy Writ, where he risks a nasty fall. Galileo, who had never understood why the interpretation of the world should stop in front of one or two sentences taken from the Bible, out of context, decides to take the plunge and show that the sentence from the Book of Joshua *"So the sun stood still, and the moon stopped, till the nation avenged itself on its enemies"*[19] can be used to support Copernicus' hypothesis, thus cutting the grass under the feet of Aristotle's followers.

Galileo makes this dangerous move by writing to his former student, Father Benedetto Castelli, who is now a teacher in Pisa. From the very first, the letter mixes the respective positions of the adversaries, because it states that the Holy Writ can never be wrong, and what is reported there is always true. Sometimes—this is the main point—the literal meaning of the words used in the Bible must be interpreted correctly, since the Bible aims at being understood by everyone, even by ignorant people. Sometimes, it even happens—Galileo continues—that the literal interpretation seems to be attributing to God some human features which, obviously, are very far from His nature. Having thus started the treacherous path of the interpretation of the Holy Writ, Galileo even indulges in saying: *"I would believe that the authority of the Holy Writ was only meant to convince humankind of those sentences which, being necessary for their health and overcoming any human speech, could not by any other means be made credible, other than through the Holy Spirit itself".*[20]

The letter is only half way through, but it would already be sufficient for Galileo's enemies: a philosopher simply cannot claim the right to interpret the Bible, thus replacing the opinion of theologians. Galileo does not seem to realize the risk he is running and explains the meaning of the Bible's text where Joshua orders *"Sun, stand still!"*. This is one of the mainstays of Catholic Orthodoxy at the time: Galileo concludes that this really means that the Sun is still and the Earth turns around it. Worse still, his argument is flawless.

Indeed, if it is true that in Ptolemy's system—Galileo explains—the daily movement of the Sun is transmitted by the spheres of the upper planets, in this

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[18] F. Cesi, 1612, *Letter to G. Galilei,* October 6, 1612, *op.cit., "… M'assicuro, tutti sentiranno con V. S. e si moveranno contra suoi aversari; a' quali sempre è stato mio pensiero V. S. non risponda, ma si facci risponder da gioveni, per mortificarli: e quelli che faranno le risposte possono esser in parte, e anco in tutto, aiutati, et anco farli adottare l'opre compite".*

[19] Bible, Joshua, 10, 12–13.

[20] G. Galilei, 1613, *Letter to B. Castelli,* December 21, 1613*, op. cit. vol. V, "Io crederei che l'autorità delle Sacre Lettere avesse avuto solamente la mira a persuader a gli uomini quegli articoli e proposizioni, che, sendo necessarie per la salute loro e superando ogni umano discorso, non potevano per altra scienza né per altro mezzo farcisi credibili, che per la bocca dell'istesso Spirito Santo".*

system, it is impossible to stop the movement of the Sun without upsetting the balance of the whole planetary system. Moreover, since the motion of all spheres in which planets are set is transmitted from one sphere to the other, starting from the outermost sphere, which is the First Mobile, within a coherent Ptolemy's system, Joshua should have ordered, with evident irony on the part of Galileo, *"Stand still, First Mobile!"*.

In case anyone was incapable of catching the grotesque situation of a general who, out of respect for Aristotle's Cosmology, pronounced such a sentence in front of an army of soldiers who have no idea what he is talking about, Galileo sinks the knife in the wound in order to show that the sentence, on the contrary, does have a meaning within Copernicus' system and continues *"… I am asking my adversary whether he knows how the Sun moves"*.

Thus, Galileo prepares the final retort: let us assume that the Sun—rather than the Earth—is at the centre of the Universe. Since the study of sunspots—Galileo remarks—has showed that the Sun rotates upon itself in about a month, and we know that celestial motions take place by dragging, we should expect that all planets—including the Earth—rotate upon themselves, though at a different speed in comparison with the Sun.

Now, when the Lord decided to fulfil Joshua's request and stopped the Sun, He should have stopped its only movement—namely, its *rotation.* As a consequence, all planets, the Earth in particular, would have ceased turning upon themselves, and the Sun would never set. *"That's the way"*—Galileo concludes—*"in which, without confusing the various parts of the world and without changing the Bible's word, we can extend the day on Earth by stopping the Sun"*.[21]

The meaning of the Bible's sentence, used for a long time to support the immobility of the Earth, is thus twisted to support Copernicus' theory!

Without doubt, Galileo's demonstration is elegant and disarming, and yet, it may backfire on him because it offers his enemies on a plate the argument that he and his friends philosophers may want to replace theologians in the interpretation of the Holy Writ. On the other hand, Galileo, in his letter to Castelli, has already written: *"…it seems to me that in the disputes about Nature* [the Bible] *should be considered last"*—which sounds like an explicit disavowal of the interpretation which Roberto Bellarmino gives of the thesis of the Council of Trent, which forbid to comment on the Holy Writ *"against the common consent of the Holy Fathers"*.[22] Moreover, the free interpretation of the Bible has been one of the central issues of Luther's Reform. Therefore, Galileo seems certainly not worried about caution. He appears so convinced that his interlocutors may be persuaded by

[21] *ibidem, "Ecco, dunque il modo secondo il quale, senza introdur confusione alcuna tra le parti del mondo e senza alterazion delle parole della Scrittura, si può, col fermar il Sole, allungar il giorno in Terra"*.

[22] R. Bellarmino, 1615, *Letter to P. A. Foscarini, 12 April 1615, op. cit. vol. XII, "… contra il commune consenso de' Santi Padri…"*.

the logical coherence of his arguments that, after his new interpretation of the classic sentence *"Sun, stand still!"*, he decides to enter the even more treacherous path of retracing in the Holy Writ further passages, which may confirm the validity of Copernicus' Cosmology. Thus, in a series of letters addressed to Monsignor Piero Dini between 1614 and 1615, Galileo, though *"aiming at nothing but the dignity of the Holy Church and addressing all my weak efforts at this aim",*[23] ventures in the interpretation of Psalm 18. This is a real challenge, because, according to Dini, this Psalm is among *"the most repulsive"* for Copernicus' system. Galileo wants to demonstrate that, on the contrary, the psalmist refers to the heliocentric system, because, by correctly interpreting the passage, we find that the Sun *"makes all the other mobile bodies of the world rotate around themselves"*.[24]

In conclusion, Galileo makes two mistakes: first of all, as we have already remarked, he does not realize that the interpretation of the Bible's passages represent the very field in which orthodox theologians refuse confrontation, because they reserve to themselves the right to a correct interpretation. Secondly, Galileo chooses the wrong method because, if you look for support to Copernicus' theory in the Bible, you enter in contradiction with a fundamental thesis of Galileo's science, namely Science and Faith are distinct and separate, and one cannot be used to support the other.

Useless to say, even before the last letter has been written, the group of people who want to stop Galileo and his new ideas feel ready to attack him.

The first one who stands up is a Dominican preacher, Tommaso Caccini, who, in the month of December 1614, from the pulpit of the church of S. Maria Novella, quotes a sentence from the Acts of the Apostles, related to the resurrection of Christ, "*Viri Galilaei, quid statis aspicientes in coelum*" (Men of Galilee, why do you stand looking into the sky?), clearly hinting at Galileo, who is excessively engaged with celestial matters. He is followed by Niccolò Lorini, who earlier on, in a letter addressed to Galileo, had denied speaking badly of him and now does not hesitate to inform Cardinal Paolo Sfrondati, Prefect of the Congregation of the Index, of his fearing that Galileo and his friends may hold opinions contrary to the Holy Writ and, in particular, preach that—*"…when Joshua ordered the Sun to stand still, this order was only given to the first mobile, rather then to the Sun itself…"*.[25]

It is difficult to imagine a more insidious letter, since this requires—essentially—the intervention of the Holy Office, but it is also difficult to imagine a more hypocritical letter, mainly for its conclusion, where Lorini states *"I consider all*

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[23] G. Galilei, 1615, *Letter to Piero Dini,* 23 Marzo 1615, *op. cit. vol. V, "… non avendo mai altra mira che alla dignità di Santa Chiesa e non dirizzando ad altro fine le mie deboli fatiche*".

[24] *Ibidem, "fa raggirarsi intorno tutti i corpi mobili del mondo"*.

[25] N. Lorini, 1615, *Letter to card. Paolo Camillo Sfrondati,* 7 February 1615, *op. cit. vol. XIX, "…che quando Iosuè comandò al sole che si fermasse non si deve inten[de]re che il comandamento fussi fatto ad altro ch'al primo mobile, e non [all'] istesso sole…"*.

Galileo's good men and good christians, if somewhat wiseacre and stubborn; I may add that I'm only speaking out of zeal…".[26]

The situation is certainly not clear, since, at the same time of these charges, in Naples, the Carmelite theologian Paolo Antonio Foscarini publishes a short essay, written as a letter addressed to the Prior General of his Order the *Letter about the opinion of the followers of Pithagoras and Copernicus…*,[27] where the religious scholar takes sides for the defence of Copernicus' vision of the world, which allows him to explain Galileo's recent observations.

Cardinal Bellarmino, at this point, considers it necessary to intervene in order to clear up the facts of the matter with a letter addressed to Foscarini, in which he writes: *"It seems to me that you and Galileo should be more careful and limit themselves to talking 'ex suppositione' [as an hypothesis] rather than in universal terms…Because, if you say that you suppose that the Earth moves and the Sun stands still, you save face, better than theorizing on eccentrics and epicycles: it is well said and there is no danger, and that is enough for a mathematician. But if you state that the Sun really is at the centre of the world…, this is very dangerous, not only because you irritate all scholastic philosophers and theologians—you also represent a threat to Faith if you make the Holy Writ appear false"* and concludes *"…If it was actually demonstrated that the Sun does not surround the Earth, but rather the other way round, then we should carefully explain that the Holy Writ only seems to say the contrary, and we actually do not understand them, rather than what is demonstrated is false…".*[28] The definitive point of Bellarmino is clear: the Copernican system can be used by a good Catholic as a representation of the world and as a technique of calculation. If it ever demonstrated, *"…but I will never believe that this will be demonstrated, until it is shown",* that the Earth rotates around the Sun, it is not up to astronomers to interpret the Holy Writ, which seems to say the opposite. The most they can say is that they do not understand it.

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[26] *Ibidem, "Mi protesto ch'io tengo tutti costoro, che si domandono galileisti, huomini da bene e buon christiani, ma un poco saccenti e durettí nelle loro opinioni; come ancho dico che in questo servizio non mi muovo se non da zelo…".*

[27] P. A. Foscarini, 1615, *Lettera sopra l'opinione de' Pittagorici e del Copernico della mobilità della Terra e stabilità del Sole e del nuovo Pittagorico sistema del mondo,* ed. Lazzaro Scoriggio, January 1615.

[28] R. Bellarmino, 1615, *Letter to P. A. Foscarini,* 12 April 1615, *op. cit. vol. XII, "Dico che mi pare che V. P. et il Sig.r Galileo facciano prudentemente a contentarsi di parlare ex suppositione e non assolutamente…Perchè il dire, che supposto che la terra si muova et il sole stia fermo si salvano tutte l'apparenze meglio che con porre gli eccentrici et epicicli, è benissimo detto, e non ha pericolo nessuno; e questo basta al mathematico: ma volere affermare che realmente il sole stia nel centro del mondo…, è cosa molto pericolosa non solo d'irritare tutti i filosofi e theologi scholastici, ma anco di nuocere alla Santa Fede con rendere false le Scritture Sante…Dico che quando ci fusse vera demostratione che il sole non circonda la terra, ma la terra circonda il sole, allhora bisogneria andar con molta consideratione in esplicare le Scritture che paiono contrarie, e più tosto dire che non l'intendiamo, che dire che sia falso quello che si dimostra".*

According to Galileo, this letter means (or, at least, this is what he apparently believes) a sincere invitation to Copernicus' followers to offer the demonstration that the Earth rotates, a demonstration which he thinks he has found in the fact that tides exist.

Galileo's thesis is clearly exposed in a letter addressed to cardinal Alessandro Orsini, in which he writes that *"…the reason for high and low tides can be constituted by some movement of their containers…"* and attributes the cause for tides to the double movement of the Earth, which rotates upon itself, while it makes its annual revolution around the Sun.[29] Clearly, in a given moment—Galileo remarks—there will be a point on the surface of the Earth, which will move *"very quickly"*, because the rotation and revolution speed will be in the same direction. The sea water in that area of the Earth, by inertia, will be delayed in comparison with the Earth, so that, as a consequence, there will be water *"ebbing"*. The opposite situation will take place in a point on the surface of the Earth opposite to the first one: this will move *"belatedly"*, because the rotation speed is opposed to the revolution speed. As a consequence, sea water will precede the Earth's movement, thus showing a *"flow"*. Of course, 12 hours later, the situation will be the other way round and the alternance of ebb and flow will recur regularly.

Galileo concludes by saying that this explanation combines the Earth's movement and the tides, *"taking the former as reason of the latter, and the latter as a symptom and topic of the former"*. We know that tides are due to the combined action of the Moon and the Sun, which is much more effective than the one invoked by Galileo, but a concrete proof of the Earth's rotation, namely the Bible's passage of Joshua seems to contradict, at the time of Galileo cannot be found,[30] so that the scientist, while probably nurturing some doubts himself, stubbornly tries to demonstrate that there are two Earth motions, which can be observed, and this is after all the only thing he is really interested in demonstrating.

This contradicts atmosphere, in which scholars question Nature, and people experience within themselves the contrast between the new science and their faith, whereas obtuse people use both categories, thus hoping to oppose the change required by times, precipitates on 5 March 1616, when the Congregation of the Index publishes a bill in which heliocentrism is declared contrary to the Holy Writ and destroys all hope to compare the different visions of the world without dogmatism.[31] The same bill also condemns the work of Father Antonio Foscarini. The judgement, delivered exclusively on the basis of the theologians' opinion, is not

[29] G. Galilei, 1616, *Letter to Cardinal Alessandro Orsini "Discorso del flusso e reflusso del mare (Speech about sea ebb and flow)"*, 8 January 1616, *op. cit. vol. V.*

[30] The proof of rotation will be provided by GianBattista Guglielmini, only in 1791 through the fall of bodies from the Tower of the Asinelli in Bologna. Guglielmini's experiment is very delicate, so much so that it was reproduced only in our days. The main proof of rotation is constituted by Foucalt's pendulum introduced in 1851.

[31] The bill can be found digitized by IMSS-Firenze at http://brunelleschi.imss.fi.it/galileopalazzostrozzi/oggetto/DecretoCongregazioneDellIndiceLibriProibiti.html. For further details, see for ex., E. Festa, 2007, *Galileo, la lotta per la scienza,* Laterza ed., Bari.

aimed directly against Galileo and his works, but rather specifically against Copernicus' Cosmology, and resembles a warning.

Unfortunately, Galileo seems not to understand that the lesson he has been given should be taken very seriously.

The relationship between Scheiner and Galileo, which had been interrupted in 1615 before the condemnation of heliocentrism, gets worse and worse in 1624, when the Jesuit is transferred to the Collegio Romano in order to continue his studies on sunspots, which he had started in Ingolstadt. Unfortunately, this relationship gets worse because Scheiner, once in Rome, finds *"a book in Italian, which bore the title of Il Saggiatore and had been printed in Rome in 1623"*. Though initially Scheiner considered the *Saggiatore "a chance to learn some Italian"*, what he finds there is the worst offense which may be made to a scholar like him, namely that, after embezzling the discovery of sunspots, he then disappeared.[32]

This charge is so shameful, that Scheiner at first thinks it is impossible that Galileo is actually talking about him, since he believes his own behaviour has always been correct towards him. However, after having carefully read the essay, Scheiner is forced to conclude that he is actually the target of Galileo's charge. Years later, the consequences will be clear in *Rosa Ursina*, a book which Scheiner completes in 1630. A whole chapter of this book is devoted to his self-defence from the charge of plagiarism.

Surprisingly, this rancourous attitude is not shared, years later, by Orazio Grassi, the Jesuit scholar of the Collegio Romano, who had been the target of Galileo in the *Saggiatore*. Father Grassi had valid reasons to argue with Galileo: so much so that, as we have seen, someone suspected that he may even have denounced him to the Holy Office. However, there is no document proving this charge, whereas we have a letter where Grassi, after the defeat of his old adversary, expresses his empathy for his disgrace: *"As for the trial against Galileo, I sincerely tell you that I am really sorry, because I have always cared for him more than he has ever cared for me; since last year in Rome they asked my opinion about his book on the motion of the Earth, I made all possible efforts in order to mitigate the mood of his enemies and make them capable of understanding Galileo's effective topics, so much so that some of them were surprised by the fact that, though offended by Galileo, I spoke about him with such kindness"*.[33]

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[32] C. Scheiner, 1626–1630, *Rosa Ursina, op. cit., Liber I, Cap. 1, p. 1, "…oblatus inter caetera liber quidam Italico idiomate anno 1623, Romae impressus, cuius inscriptio, Il Saggiatore… diceres: (occasionem…coepi posse aliquid hac lingua scriptum intelligere…)"*. Quoted in L. Ingaliso, 2005, *Filosofia e Cosmologia in Christoph Scheiner,* Rubettino ed., Soveria Mannelli, p. 121.

[33] O. Grassi, 1633, *Lettera a Girolamo Bardi,* 22 September 1633, *op. cit. vol. XV, "Quanto alli disgusti del Sig.r Galileo, gli dico sincerissimamente che n'ho sentito grandissimo despiacere, perchè gli ho sempre portato assai maggiore affetto di quello che si sia degnato egli portare a me; et essendo stato richiesto in Roma l'anno passato che cosa mi paresse del suo libro intorno al moto della terra, procurai con ogni sforzo mitigare gli animi inaspriti verso di lui e renderli capaci dell'efficacia degli argomenti da lui apportati, tanto che si meravigliarono alcuni come io, stimato da essi offeso dal Sig.r Galilei e per tanto forsi poco ben affetto, parlassi per lui con tanta premura"*.

The *Rosa Ursina* (Fig. 6.1) is a respectable work, full of serious accounts of astronomical observations. Its first book, as we have seen, is entirely devoted to the argument with Galileo, whereas the second book is almost exclusively devoted to the study of instrumentation and observational methodologies, including the analysis of the physiology of the eye. The third book is the most interesting one from the scientific point of view, since it contains an impressive series of tables, which accurately reproduce an observational work which lasted almost twenty years, in which, over and beyond the sunspots, the Jesuit scholar describes faculae, *plagae* and *umbrae*. Finally, the fourth book contains the theoretical synthesis which Scheiner takes from the analysis of data examined under the light of science, philosophy and theology. This work is typical for the sixteenth century, since it is full of puns, symbolism and allusions, which Galileo mocks, starting from the analysis of the frontispiece *"Who won't be dumbfounded in considering the witty enterprise of the 3 she-bears in the 3 caves, one of which with a telescope receives sunspots, whereas the second one licks her cubs, and the third one sucks her own fingers? With 2 significant words and such a witty pun: Rosa Ursina/Ursa Rosina. But why record the dumb actions of this animal, since they are numberless?…".*[34]

Galileo shows a peculiar hostility towards Scheiner, a hostility which almost appears distilled, in the sarcastic letter addressed to his friend Cesare Marsili whom, even before the publication of *Rosa Ursina*, Galileo openly dispenses from reading: "*I have heard that the false Apelles is printing in Bracciano a long essay de maculis solis; since it is long, it makes me suspect that it may be full of nonsense, which, being infinite, may extend along many sheets, where the truth finds no space: I believe that, if he says something different from what I wrote in my solar Letters, he will only say vanities and lies".*[35]

Clearly, such a violent and persistent yearlong fight has deeper roots than the somewhat childish dispute about who observed sunspots first, also because both Scheiner and Galileo probably realize that neither the one nor the other can technically aspire to this record. Perhaps, Galileo considers Scheiner an authoritative representative of conservative Catholic ideology, whereas the Jesuit scholar surely feels a personal resentment towards Galileo. In any case, Galileo never misses the chance to criticize Scheiner's works, not only in various offensive letters, which sooner or later reach the Jesuit, but also in the *Dialogo sopra i due massimi sistemi (Dialogue concerning the two chief World Systems).* He keeps the

[34] G. Galilei, 1936, *Lettera a F. Micanzio,* 9 February 1936, *op. cit. vol. XVI, "E chi non trasecolerà nel considerar l'arguzia dell'impresa delle 3 orse nelle 3 caverne, l'una delle quali col telescopio riceve le macchie del sole, l'altra lambe i suoi orsacchini, e la 3a si succia le mani? con li 2 motti, tanto significanti e con sì bell'arguzia contraposti: Rosa Ursina/Ursa Rosina. Ma a che metter mano a registrar le fantoccerie di questo animalaccio, se elle sono senza numero?".*

[35] G. Galilei, 1629, *Lettera a C. Marsili,* 21 April 1629, *op. cit. vol. XIV,* "*Sento all'incontro che il finto Apelle stampa in Bracciano un lungo trattato de maculis solis; et quello esser lungo mi fa assai dubitare che non sia pieno di spropositi, li quali, per essere infiniti, possono imbrattare molti fogli, dove che il vero tien poco luogo: et io tengo per fermo che se egli dirà altro che quello che dissi già io nelle mie Lettere solari, dirà tutte vanità e bugie".*

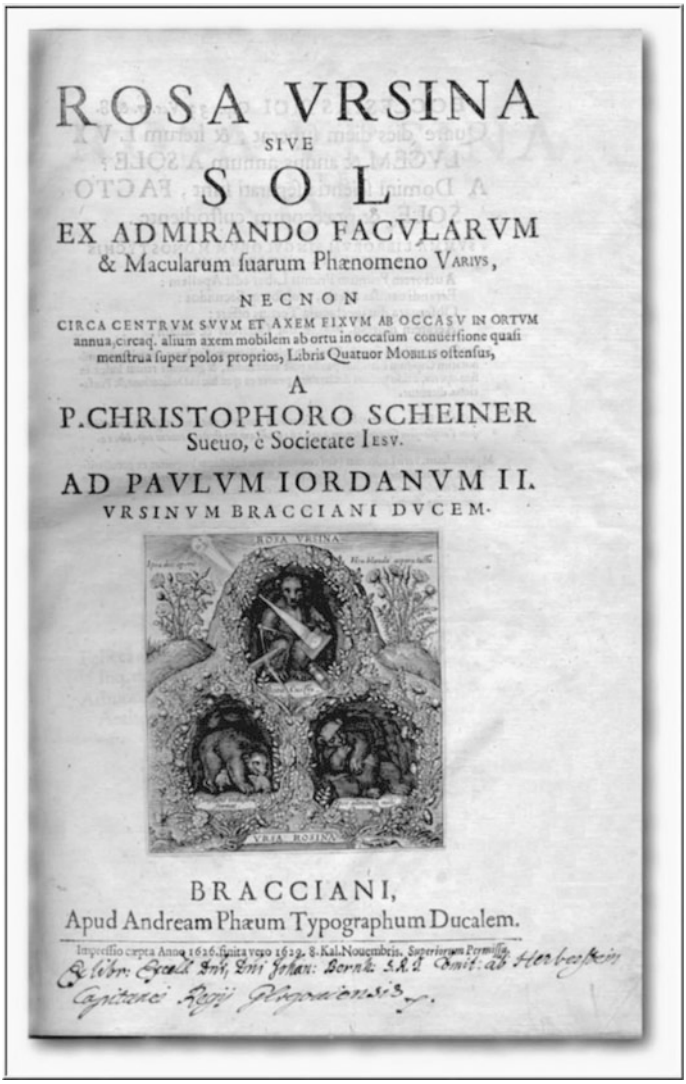
ROSA VRSINA
SIVE
SOL
EX ADMIRANDO FACVLARVM
& Macularum suarum Phænomeno Varivs,
NECNON
CIRCA CENTRVM SVVM ET AXEM FIXVM AB OCCASV IN ORTVM
annua, circaq. alium axem mobilem ab ortu in occasum conuersione quasi
menstrua super polos proprios, Libris Quatuor Mobilis ostensus,
A
P. CHRISTOPHORO SCHEINER
Sueuo, è Societate Iesv.
AD PAVLVM IORDANVM II.
VRSINVM BRACCIANI DVCEM.
ROSA VRSINA
VRSA ROSINA
BRACCIANI,
Apud Andream Phæum Typographum Ducalem.
Impressio cœpta Anno 1626. finita vero 1629. 8. Kal. Novembris. Superiorum Permissu.

Fig. 6.1 *Rosa Ursina frontispiece.* (C. Scheiner, 1626–1630, *Rosa Ursina sive Sol ex Admirando Facularum,* etc., Bracciano.) This book, which is 800 pages long, is dedicated to the Duke of Bracciano, Paolo Giordano II Orsini, who provided the money and allows it to be printed in his typography. The image uses a pun—*Rosa Ursina and Ursa Rosina*—both engraved in the rolls of the central picture. The she-bear in the cave above shows the technique of solar observation, by using a reflected image, and shows a pair of compasses, to measure the relative positions of the structures upon the Sun's surface. The she-bear in the lower cave on the left, who is taking care of her cubs, comes from a long hard work

argument alive by criticizing both *Rosa Ursina* and Scheiner's *Disquisitiones*. The Jesuit scholar, in his turn, will never forgive Galileo for his charge of plagiarism and will nurse such a persistent hatred that even Scheiner, after Grassi, has often been suspected of playing an active role in the charges against Galileo which are sent to the Holy Office. However, as we know, these suspicions have never been confirmed by documents, so that they are generally considered as unfounded.

Apart from inferences, it is interesting to analyse the debate on sunspots. As the two contenders measure each other, we may notice that the cosmological theory of the Jesuit scholar evolves in an anti-Aristotle direction, while Galileo, who grows more and more impatient, and cannot bear the caution of official culture, which only delays the official acceptance of Copernicus' theory. Scheiner's position is clearly expressed in his letters of 1611, in which he is forced to interpret sunspots as small satellites, similar to the recently discovered Jupiter's satellites, which lie between the Sun and the Earth. Indeed, Scheiner must save the hypothesis according to which the Sun, just like all celestial bodies, is perfect, since it is made of an unchangeable matter, which is completely different from the one we find on Earth.

This position is modified in the period between the first letters and the publication of *Rosa Ursina:* although still faithful to the theory of a still Earth at the centre of the Universe, Scheiner finally gets rid of the idea that the Sun is a perfect body. As a consequence, the Jesuit scholar, in the book *Rosa Ursina,* has no difficulty in accepting that sunspots and *faculae* are on the surface of the Sun, *"ipsae extra solem non sunt ponendae",* and corrects Galileo, who still thinks this confirms that sunspots reside in the atmosphere of the Sun and are just like clouds upon the Earth. Clearly, Scheiner is referring to the doctrinal choices of his Order and knows that a simple experiment or a mere observation with a telescope is not sufficient for a new construction of reality, because the world, which has been created by God, must be included in the description provided by the Holy Writ.

The procedure followed by a Catholic scientist in the seventeenth century, though apparently surprising, consists in believing that the observation provides a clue, which the scholar uses in order to create a theory. However, this is only an outline for a research, since a theory is trustworthy only when a passage in the Bible confirms it.

According to this criterion, Scheiner, in order to confirm that faculae are on the solar surface, finds a passage of the Ecclesiastes, which says that "*nothing is brighter than the Sun*". This passage seems ideal for the Jesuit scholar, because faculae appear—through the telescope—brighter than the solar surface, so that according to the Bible, one should infer that they really belong to the surface, or else we should conclude that in the Universe, there is something brighter than the Sun, and this goes against the Bible.[36]

[36] For a thorough discussion *see* L. Ingaliso, 2005, *Filosofia e Cosmologia in Christoph Scheiner,* Rubettino ed., Soveria Mannelli, pp. 200–245.

Perhaps we do not consider this as a good inference, but we cannot forget that Scheiner thus concludes that the sky is not unchangeable, thus overcoming one of the fundamental paradigms of Aristotle's philosophy. The other principle, namely the real existence of crystal spheres, has not been discussed by Copernicus.

Philosophers had different opinions about the real existence of crystal spheres, starting from Eudoxus himself and Ptolemy, who considered their own systems as simple means of calculus. In other words, it was not worth wondering whether they correspond to real or abstract entities: even Bellarmino himself, when he reconsidered the theses of authoritative Fathers of the Church as Saint Thomas Aquinas, had thought they were mere mathematical instruments, even though the more orthodox Christian cosmologists, perhaps without fantasy, considered the spheres as physical objects. They were challenged by the problem of souls' ascending to Heaven, but it was one of those cases where, in order to solve a problem of Physics (crossing a rigid body), they recurred to theology and miracles.

In the cultured Jesuit Order, the solution cannot be so modest—therefore, Scheiner tries to demonstrate that celestial spheres must possess an ethereal nature. If crystal spheres were solid—Scheiner says in *Rosa Ursina*—the light, crossing them, would be subject to refraction, and we would see stars in a confused manner, as if we looked at them through a window and—Scheiner goes on—the discovery of the Medici satellites has offered the definitive proof that the spheres are actually crossed one from the other, or else how could the four satellites rotate around Jupiter? Scheiner's attitude, in other words, is not the same as an obtuse bigot, who refuses to think about the consequences of the new scientific discoveries, but rather belongs to a man who, according to his own religious education, tries to renovate Cosmology inside the Christian tradition.

Naturally, the Jesuit scholar understands that, in order to realize such a delicate enterprise, he needs the protection of his Order and thinks he can obtain it through the prestige and the theological rigour of Roberto Bellarmino, whose memory, even several years after his death, still enjoys a remarkable esteem with all those who knew him. Scheiner therefore plans to ask Federico Cesi for a sort of posthumous witness. Cesi established the group of the Lincei, whom he contacts through a common friend, Giovanni Faber. The answer of Cesi, who regularly saw Bellarmino when alive, is the one Scheiner expected, because the prince confirms in a letter that the cardinal has supported the theory of the liquid nature of the sky. Therefore, Scheiner does not hesitate to include the whole letter in *Rosa Ursina,* so as to reassure the censors of the Order that they should give their *imprimatur* to the book *"…Here is my witness of the truth: the memory of my Lord and mentor Cardinal Bellarmino is very dear to me. He often used to ask me about my writings; when I informed him of my book about the sky, and in particular that I thought the sky was fluid, an opinion which seemed to me confirmed by the Holy Writ and by the authority of the Holy Fathers… he was very happy about this, and*

he told me that, according to him, this was in accordance with the Holy Writ and the interpretations of the Holy Fathers, no doubt about it…".[37]

The relationship between Scheiner and Galileo, even though it was certainly marked by a deep antipathy, offers a glimpse of the scientific and ideological contents which pervade the atmosphere of the age. Clearly, if you try to place the fight of these two scientists within the historical scheme of the seventeenth century, starkly divided into Galileo's followers and their dogmatic adversaries, you cannot understand the motivations, at times even the suffering of the protagonists. In this framework, Christoph Scheiner suitably represents the scientist who, while honestly debating his ideas within the reference ideology, unfortunately does not manage to get updated and change his concept of the world with the swiftness required by that age.

It almost seems that Scheiner, through the letters he sent to the young Father Athanasius, wants to entrust him with the task to keep the hostility against Galileo alive. However, Kircher, who belongs to the generation after both Galileo and Scheiner, appears far removed from the violent disputes we have described above. Once arrived in Rome, in fact, Kircher totally obeys the dictates of his Order, without officially taking part in the argument. He is not merely careful: rather, he feels that he has even too many things which engage his mind. Doubtless, Father Athanasius appreciates the work of his authoritative brother; however, he thinks that the Sun, to which he devotes a realistic illustration in his book *Mundus Subterraneus* (Fig. 6.2), represents only a small percentage of the things created by the Lord, so much so that in his work, Kircher finds the suitable space for the picture of the Sun, but together with other topics which are dear to him, such as fossils and the remains of the giants—demons, underground animals, astrological medicine and so on.

Here emerges the difference between Kircher and Scheiner. The latter was rigorous, but also monomaniac and full of resentment. He was capable of concentrating on one goal only for his whole life. The former considered worthy of his attention any detail within a unitary universe and ends up replacing scientific investigation with an uncritical gathering of information, which necessarily become contradictory and superficial.

Mundus Subterraneus, which Kircher first published in 1665, but had already sketched during his journey in Southern Italy in 1637, is significant in this sense. Since it is no longer convenient to think about the structure of the sky, the young Jesuit scholar, charmed by the spectacle of the eruption of the volcanoes—Etna as

[37] F. Cesi, 1628, *Lettera a Giovanni Faber,* 1 June 1628, *op. cit. vol. XIII, "…Quello ch'io posso testificar per la verità è questo: che essendo la felice memoria del Sig. Cardinal Bellarmino molto mio Signore e che mi portava particolar affetto, voleva spesso sentir da me delli miei studii e compositioni; e dandoli ragguaglio della mia opra del cielo, e particolarmente ch'io tenevo che fusse fluido, qual opinione mi pareva molto ben confermata dalla Sacra Scrittura e dall'auttorità de' Santi Padri… ne mostrò grandissima allegrezza, e mi disse che questo haveva tenuto lui sempre come conforme alle Sacre Carte et interpretationi de' Santi Padri, e che in ciò non haveva dubio…",* quoted in C. Scheiner, *Rosa Ursina, op. cit. pp. 731–732.*

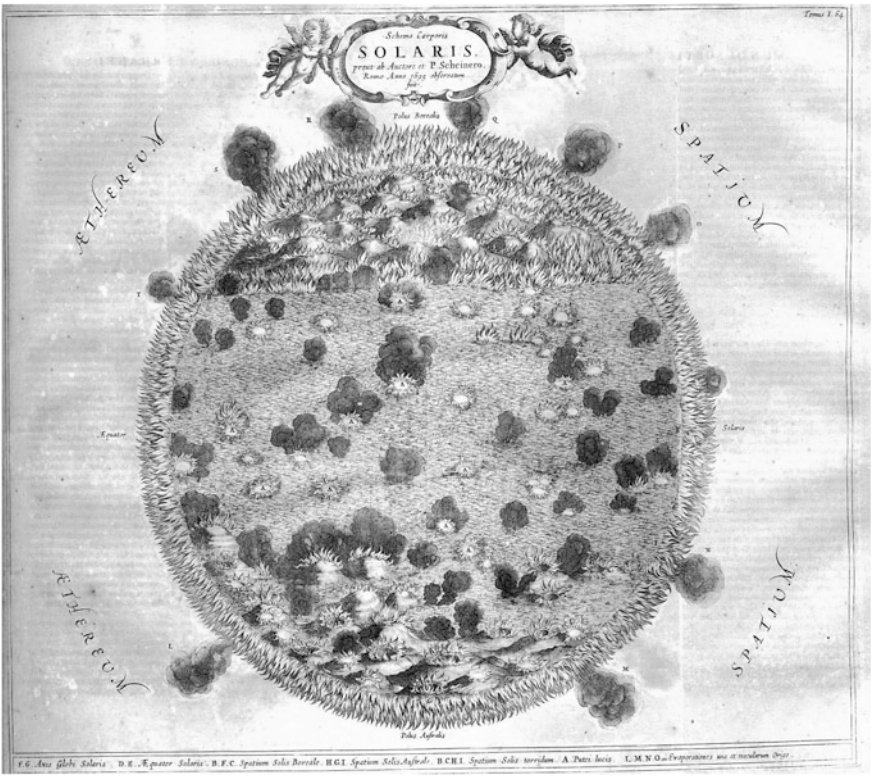

Fig. 6.2 *The Sun.* (A. Kircher, 1665, *Mundus Subterraneus, in XII libros digestus… Tomus I, Amstelodami, Apud Joannem Janssonium à Waesberge and filios, p. 64.*) Beautiful engraving of the Sun, which is no longer seen as a perfect, immutable sphere, is a sign of the overcoming of Aristotle's philosophy. The surface appears like a sort of rough sea, where faculae appear like bright fires and spots like clouds of dark smoke. Volcanoes, chams and vapours complete the picture. In the scroll supported by two angels, we can read the following title: *Schema Corporis Solaris, prout ab Auctore et P. Scheinero, Romae Anno 1635 observatum fuit*, which attributes the observations to Christoph Scheiner and to Kircher himself. Out of the scroll, we can read the words: *Spatium Ethereum*

well as Vesuvius—which he actually saw, decides to study what lies underground. The marks of the Creator's work can be identified—not only in the sky, but also in what Kircher defines "geocosmos"—in which you can find extraordinary clues for understanding Nature's work. Even fire and water, living together inside the Earth, for example, are nothing but a terrestrial analogy of the Sun and the Moon in the sky. Just like Scheiner introduced in orthodox Cosmology the concept that skies are not unchangeable, Kircher shows that the opposite is also true, namely that even in our own world, which is by definition corruptible, you can find clues of the celestial cosmic design.

Chapter 7
The Deluge

You found the Earth upon its
basis, and it will stay there
motionless forever and ever.

Book of Psalms (104)

When Galileo, in 1612, faced the problem of why things keep afloat, he could never imagine that he was leaving a message to Athanasius Kircher, who posed himself the same question 60 years later.

As it sometimes happens when talking about ancient events, the relevance of the motives cannot be easily understood. However, it is a fact that the controversy between Galileo and the party of orthodox academics who challenged him to explain the floating of some objects risks the credibility of Aristotle's thought. Indeed, according to Aristotle's synthesis, Physics and Mathematics are so strictly connected to both Geometry and Logic that, if it turns out that one principle is groundless, the whole *Weltanschauung (Vision of the world)*, though centuries' old, might be jeopardized.

In Aristotle's Physics, the floating of objects starts from the concept of hot and cold, which affects the behaviour of matter. Indeed, if an object expands or contracts because of a higher or lower temperature, then as a consequence, everything, water included, will acquire a higher density when they reach a lower temperature. Upon this very idea, in the summer of 1611, a debate flared up between Galileo and the followers of Aristotle in Florence on the topic "*why does ice float upon the water?*".

Since, according to the principle of cold and hot bodies, the density of ice (cold body) must be higher than the density of water (hot body), the conservative academics are forced to maintain that ice sheets, in spite of their higher density, float because of their form, which is wide and flat. Galileo, who, during his stay in Padua and Venice observed ice of all shapes floating on the water, said instead that it cannot be the shape which allows ice to float, thus implicitly saying that Aristotle's principle is contradicted by experience. Following the request of the Grand Duke of Tuscany, Galileo decides to write down his opinion in a small book, *About things floating on the water or moving into it.*[1] This work represents the start of the most violent dispute between the Aristotelians and Galileo.

[1] G. Galilei, 1612, *Discorso intorno alle cose che stanno in su l'acqua o che in quella si muovono*, Giunti, Firenze, digitized by ETH-Bibliothek, Zurich.

R. Buonanno, *The Stars of Galileo Galilei and the Universal Knowledge of Athanasius Kircher*, Astrophysics and Space Science Library 399,
DOI: 10.1007/978-3-319-00300-9_7, © Springer International Publishing Switzerland 2014

The traditionalist academics of both Florence and Pisa, in trouble, form an alliance against Galileo's opinion. One of them, Lodovico Delle Colombe (whose nickname among Galileo's friends is "*il Pippione*", a pet name which means both *pidgeon* and *fool*), challenges Galileo with an experiment, by showing that pieces of ebony sometimes float, sometimes sink, according to the shape one chooses to give them.

Clearly, the experiment only shows that ebony has a specific gravity which is slightly higher than that of water, and therefore, sometimes floats because of the surface tension of water. Naturally, surface tension was not an acquired concept in the seventeenth century, but a scientist endowed with curiosity might have wondered why one should use ebony in order to show Aristotle's thesis and conclude that the Nature of the object, rather than its temperature, plays the main role in this experiment.

Galileo, realizing the inconsistency of these arguments, might have probably kept detached, but when Delle Colombe wrote that Galileo "*wants to convince people with his words, rather than with facts*",[2] he decided that he had to answer, and using the old trick of asking a friend, Benedetto Castelli to act as a his figurehead, attacked *Pippione.* "*If I had to show and teach him all that he does not manage either to see or to understand, I would never complete my work…*".[3] Thus, Galileo puts an end to the question of ice floating on the water.

The truth is that Galileo had been studying this topic since he was a boy, when he wrote, in 1586 *La Bilancetta* (*The Small Scales*), where he had imagined that the old Archimedes had used the concept of the specific gravity of different materials, concluding that bodies sink when they weigh more than the volume of water they move when immersed, and that probably he is not interested in wasting time on this matter. On the other hand, since the Grand Duke himself wants to know his opinion, Galileo, as soon as he gets back to Florence, cannot refuse. Therefore, as in 1612 he publishes the *Discorso intorno alle cose che stanno in su l'acqua,* he almost apologizes to his readers and assures them that he will soon go back to his astronomical discoveries "*Because I know, Your Majesty the Prince, that the publication of this essay, which handles a topic so different from the topic most readers are expecting and which, according to my statement in the Starry Messenger (Sidereus Nuncius), I should have published beforehand, might make the public think that I have left aside my sky gazing, or that my astronomical*

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[2] L. Delle Colombe, 1612, *Discorso apologetico d'intorno al discorso del S. Galileo Galilei,* in *Opere di Galileo Galilei, Nobile Fiorentino, vol. Terzo, Società Tipografica de' Classici Italiani, Milano 1809*, p. 10*, "…vuol far credere col discorrere quello che non può far vedere col senso…".*

[3] B. Castelli, 1615, *Risposta alle opposizioni del S. Lodovico delle Colombe e del S. Vincenzo di Grazia contro al Trattato del Sig. Galileo delle cose che stanno in su l'acqua,* Giunti, Firenze, in *Opere di Galileo Galilei, Nobile Fiorentino, vol. Terzo, Società Tipografica de' Classici Italiani, Milano 1809*, p. 420, digitized by Google Book *"S'io avessi a mostrargli e 'nsegnargli tutto quello che non vede e non intende, non verrei mai a fine di quest'opera…".*

studies are too slow; I simply thought it would be better to explain why I postponed those studies and published this essay instead…".[4]

The thing is—Galileo goes on—that astronomical measurements take all your time, so that you cannot practise a parallel activity, but I shall soon go back to another astronomical phenomenon, namely "*the observation of some small dark spots, which can be seen upon the solar surface: by moving on that surface,… these spots let us suppose either that the Sun turns on itself, or that perhaps other stars, such as Venus and Mercury, if they go round the Sun, are invisible in other moments for their small movements—smaller in the case of Mercury…*".[5] Sunspots, namely according to Galileo, represent a question as important as Jupiter's satellites, which cast some light upon the reasons for his discussion with Scheiner.

It can be easily imagined that nothing is farther away from Kircher's mind than the debate upon floating, which goes back to many years before, and probably also the question of sunspots, when in 1640, the centennial of the establishment of the Company of Jesus, he is asked to present a report on the Bible's episode of Noah's Ark. Therefore, by a historical coincidence, Kircher is going to write about the same topic—things floating on the water—on which Galileo had written years before.

This task soon appears rather difficult, since the tale proposes a number of question marks, for instance assessing whether the Ark was really floating, since the text is extremely detailed, so much so that the Lord assumes a human appearance—he almost sounds like an architect—more than in any other circumstance in the Bible "*The Lord said to Noah: ≪This is the end of humankind, because the Earth, because of men, is full of violence; I shall destroy them together with the Earth. Build an ark out of cypress wood; you will divide the ark into compartments and will cover the keel with pitch. Here is how to make it: the ark will be 300 cubits long, 50 cubits wide and 30 cubits high. You will make a roof and finish it off a cubit higher than the roof; there will be the main door on one side. The ark will have three floors: ground, middle and upper floor…≫*".[6]

Kircher, as usual, is convinced that the Bible words should be interpreted in the literal meaning, but is aware that, this time, he is facing an unprecedented challenge, since the way in which the Lord entrusts his will to Noah might reveal some

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[4] G. Galilei, 1612, *Discorso intorno alle cose che stanno…*, *op. cit.* p. 1, "*Perch'io so, Principe Serenissimo, che il lasciar vedere in pubblico il presente trattato, d'argomento tanto diverso da quello che molti aspettano e che, secondo l'intenzione che ne diedi nel mio Avviso Astronomico, già dovrei aver mandato fuori, potrebbe per avventura destar concetto, o che io avessi del tutto messo da banda l'occuparmi intorno alle nuove osservazioni celesti, o che almeno con troppo lento studio le trattassi; ho giudicato esser bene render ragione sì del differir quello, come dello scrivere e del pubblicare questo trattato…*".

[5] G. Galilei, 1612, *Discorso intorno alle cose che stanno…*, *op. cit.* p. 2, "*…l'osservazione d'alcune macchiette oscure, che si scorgono nel corpo solare: le quali, mutando positura in quello… porgono grand'argomento, o che 'l Sole si rivolga in sé stesso, o che forse altre stelle, nella guisa di Venere e di Mercurio, se gli volgano intorno, invisibili in altri tempi per le piccole digressioni e minori di quella di Mercurio…*".

[6] Bible, Genesis, 6:13–15.

contradiction among the orders He gives. It is therefore indispensable to examine the problem in detail. The Jesuit scientist soon realizes that the task is particularly complex, because it is not only a matter of telling a well-known episode in the Bible, but also to look into all its consequences. This commitment must have been really relevant to Father Athanasius, so much so that, a few years later, he decides to report the result of his work in one of his most famous works, *Arca Noë in tres libros digesta*[7] [*Noah's Ark in three volumes*].

Kircher starts his study by trying to fight the idea that the story of the Ark is little more than a myth. In order to convince his readers that this is a true story, he realizes the book with a structural, almost scientific method, by listing, and later denying, all the possible arguments in favour of a fable. First of all, the Jesuit scientist denies that Noah could not possess the technical skill necessary for the realization of such a difficult construction. Indeed, he suggests that the Lord, when giving this order, gave Noah the necessary skill to build the Ark. Since the work came from the divine will, it cannot surprise us that the result was something unprecedented. Rather, we can reasonably assume that the Ark was actually the eighth marvel of ancient times.

At this point, the Jesuit scientist calculates the dimensions of the Ark. Here in the Bible there is no ambiguity, since it provides the exact dimensions of the Ark. However, Kircher, well experienced in ancient languages, compares the versions of Genesis in Hebrew, Greek, Arab, Syrian and Chaldean languages and, while calculating that the Egyptian cubit does not differ much from the Babylonian and the Hebrew cubit, concludes that the Ark must have been 135 m long, more or less a football field, 22 m wide and 13 m high. In the same chapter of Genesis, there is an unexpected obstacle in the dimensions of the Ark's guests more than of the Ark itself: "*At that time there were giants on the Earth, and they remained later on, as the sons of God approached men's daughters, who gave them children*".[8]

Of course, this is an obstacle which should be removed immediately, because, if Noah and his family had been giants, the Ark, which already had problems of space, would have been really too small.

The existence of giants had to be taken seriously, not only because the Bible cited them, but also because they had discovered their remains. Even an influential scholar, such as Giovanni Boccaccio, writes that he has witnessed the discovery of a giant skeleton 200 cubits, namely about 100 meters tall, in a cave near Trapani (unfortunately, as soon as the skeleton came in contact with the atmosphere, it was instantly reduced to dust, and only a few huge teeth were kept in a small church nearby).[9] Kircher is charmed by this story, which he connects with the Cyclops

[7] A. Kircher, 1675, *Arca Noë in tres libros digesta, Quorum I. de rebus, quae ante Diluvium, II. De iis, quae ipso Diluvio ejusque duratione, III. De iis, quae post Diluvium a Noëmo gesta sunt. Quae omnia Nova Methodo, nec non Summa Argumentorum varietate, explicantur, et demonstrantur*, Amstelodami, Apud Joannem Janssonium a Waesberge, 1675.

[8] Bible, Genesis, 6:4.

[9] A. Kircher, 1678, *Mundus subterraneus*…. Amstelodami, ex Officina Janssonio-Waesbergiana, digitized by ECHO.mpiwg-berlin, pp. 56–59.

myth and, as soon as he gets the chance, he goes to Trapani in order to visit the cave indicated by Boccaccio. This visit is disappointing, since the Jesuit scientist can find no trace of the giant, but the journey is in any case fruitful because, when coming back, he visits some caves near Palermo, where he finds some petrified skulls and limbs, which to his eyes, bear no resemblance to human beings. In those same caves, he finds also peculiar rocks, some of which look like giant bones and teeth, which crumble as soon as he touches them. They are something halfway between rocks and skeletons, which Kircher does not know how to classify, but look like badly made creatures. Kircher is satisfied with this explanation and decides that probably giants did exist, since the Bible cites them, but they had vanished by the time of the Deluge. Therefore, the dimensions of the Ark given by the Bible were the right ones. Moreover, its proportions correspond to Solomon's temple (which, in its turn, had been inspired by the Lord), as well as to those of the human body with open arms, as in the well-known drawing by Leonardo, which we now find on the one euro coin. Somehow we can infer that Noah could not be a giant, otherwise he could not have entered the Ark.

The Lord's orders go on: "*A window shalt thou make to the ark, and in a cubit shalt thou finish it above; and the door of the ark shalt thou set in the side thereof; with lower, second, and third stories shalt thou make it*"[10] and Kircher, while following the Bible word by word, represents the Ark as a sort of long building with a sloping roof (since they expected heavy rain), inside which you enter a series of small rooms through five dedicated corridors. Noah's family and birds are housed on the upper floor, while all the provisions for so many guests are kept on the middle floor. All the other animals are on the ground floor. All the waste which cannot be disposed of immediately is put in dedicated spaces under the ground floor.

Because of this realistic approach chosen by Kircher, a question can be posed at once: "Can this huge, weighty box sail?". Father Athanasius certainly knows the *Discorso intorno alle cose che stanno in su l'acqua o che in quella si muovono,* which in that moment constitutes the most complete essay on the topic of floating, where Galileo has supported the Archimedes' principle against the Aristotelians and concludes that, even if the Ark cannot be considered a proper ship, it could certainly float, carried away by currents and waves, thus fulfilling the mission which the Lord had entrusted it with. In these considerations, the Jesuit scientist is comforted by the fresco on the ceiling of the Sistine Chapel, in which Michelangelo represented the Ark, by closely following the Bible and has probably inspired the iconography which, in Kircher's book, reminds us of the fresco.

A second question emerges: how could Noah and his family look after so many wild and aggressive animals? Here Kircher can only invoke God's help, for a sort of temporary peace during the journey on the Ark.

At this point, Kircher examines the next steps of the Bible's order "*And of every living thing of all flesh, two of every sort shalt thou bring into the ark, to*

[10] Bible, Genesis, 6:16–18.

keep them alive with thee; they shall be male and female. All birds according to their species, all livestock according to their species. And take thou unto thee of all food that is eaten, and thou shalt gather it to thee; and it shall be for food for thee, and for them".[11] About this, the Jesuit scientist must admit his difficulties, because the Bible's text is not so clear about which animals should be saved. Kircher, convinced that, in order to solve a complex problem, the safest solution consists in turning to ancient scholars, uses his culture, and, while recalling Plinius, divides the animals which should enter the Ark into insects, quadrupeds and birds (fish and animals living in the water are excluded from the very first moment).

Kircher cancels from this list of candidates both insects and "inferior" species in general because, according to Aristotle, they were born out of mud and decaying matter, thanks to the "panspermia", the universal seed which pervades Nature.[12]

Towards the middle of the seventeenth century, there was indeed a widespread belief that some species were generated spontaneously by matter, even though there were scholars, who, once they had acquired Galileo's lesson, applied it to all fields of knowledge. For instance, there is a scholar in Arezzo, a member of the *Accademia del Cimento*, Francesco Redi, who, as doctor and biologist, states that it is not possible, as some people maintain, that frogs may be born out of mud: it simply happens that—Redi says—when it rains, those frogs which were hidden in the grass come out in the open.[13]

Some of Kircher's brothers at the *Collegio Romano* do not agree with him, even though many of them think that the topic should be studied in depth, and therefore organize an experiment in the courtyard of the *Collegio*. They scatter earth and sand on the floor and wait for a storm in order to check whether frogs might "be born" there, where nobody had seen them before. In fact, it happens that, after the storm, they do find some frogs which had not been there earlier on.[14] The Jesuits' report sounds so sincere and convinced that someone, years later, tried to understand the results of this experiment and assumed that the storm had been so heavy that frogs had really been found where there was none before, but only because a tornado had brought them there.

Whatever the explanation, a few years before his study on Noah's Ark, Kircher had taken up the role of spokesman of those who believed in the autogenesis of inferior animals and devoted a whole chapter of his work *Mundus Subterraneus* to the birth of frogs from mud and rain. The debate on the creation of frogs from mud represents indeed only the tip of the iceberg, since it went on for decades and also concerned mice, which, according to some, were born spontaneously inside ships' storerooms. In the same way, scorpions could be born out of rocks, heated from

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[11] Bible, Genesis, 6:19–21.

[12] A. Kircher, 1678, *Mundus Subterraneus…. op. cit.* Liber Duodecimus, pp. 347–373.

[13] F. Redi, 1668, *Esperienze intorno alle vipere,* All'insegna della Stella, Firenze, p. 64.

[14] Raffaello Caverni, 1891, *Storia del metodo Sperimentale in Italia,* vol III, p. 468, in *The sources of Science,* no. 134, Johnson Reprint Corporation, N. Y. London, 1972.

the Sun, while insects could be generated from both putrefied meat and mud, and so on.

Francesco Redi multiplies experiments and demonstrations in order to support his thesis. For instance, he chooses some frogs, just "created" by the storm and shows that their intestines contain grass and droppings.[15] This shows that they were born some time before; he also shows that rotten meat does not generate grubs if it is covered with a gauze so that other insects cannot lay their eggs there. However, Redi does not seem to realize that he cannot convince the Jesuit scientist in this way, since Kircher is sure of his own argument, corresponding to his general vision of Nature, that, when someone observes that mice mate like the rest of mammals, he says this is only a relief from the itch they feel behind….

The relationships between Francesco Redi and Athanasius Kircher are direct. The latter, following the baroque belief in the most fanciful stories on the wonderful properties of roots, animals and exotic objects, writes a couple of letters to the Tuscan doctor in order to inform him that he has carried on "*two healing experiences in Rome*" which would demonstrate the incredible property of a stone found inside the head of a mysterious snake in India, which we can maybe identify with a cobra (Fig. 7.1).

The two experiments were carried out in 1663 and consist of taking a dog, which had been bitten by a viper (on purpose) and applying the snake's stone upon the wound. The same treatment had been administered to a poor farmer who had been (accidentally) bitten by a snake. As many people may have witnessed, both the dog and the farmer were healed. Therefore, it has been demonstrated that this stone—Kircher confirms with enthusiasm—has a wonderful healing property for all animal poisons.[16]

Redi answers these letters with a 40-page essay which starts with "*Reverend father. The unexpected honour of receiving your letters has filled my soul with unspeakable happiness; although I believe that the praise you give me are only due to your goodness…*"[17]—and he goes on like that for a whole page, with such exaggeration that one doubts this is sarcasm rather than sincere consideration. This suspicion is confirmed, if need be, by the rest of the essay, which is entirely devoted to curbing the Jesuit's enthusiasm. Redi writes that he has carried on this kind of experiments as well, using one of the snake's stones brought to Pisa by "*three fathers of the venerable order of Saint Francis, popularly known as*

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[15] F. Redi, 1668, *ibidem.*

[16] A. Kircher, 1663, *Letter to F. Redi,* in *Esperienze intorno a diverse cose naturali e particolarmente a quelle che ci son portate dall'Indie, fatte da Francesco Redi scritte in una Lettera al padre Atanasio Chircher della Compagnia di Gesù, 1686,* Piero Matini all'Ins. Del Leone, Firenze, p. 2.

[17] F. Redi, 1671, *ibidem* p. 1 , *"Reverendissimo padre. L'onore che mi avete fatto d'inviarmi vostre lettere, siccome da me non era mai stato sperato, così arrivandomi improvviso mi ha ripieno l'animo d'una indicibile contentezza; ed ancorché io creda che quelle lodi che mi date sieno figliuole non di merito mio alcuno, ma bensì della vostra bontà e della vostra gentilezza…".*

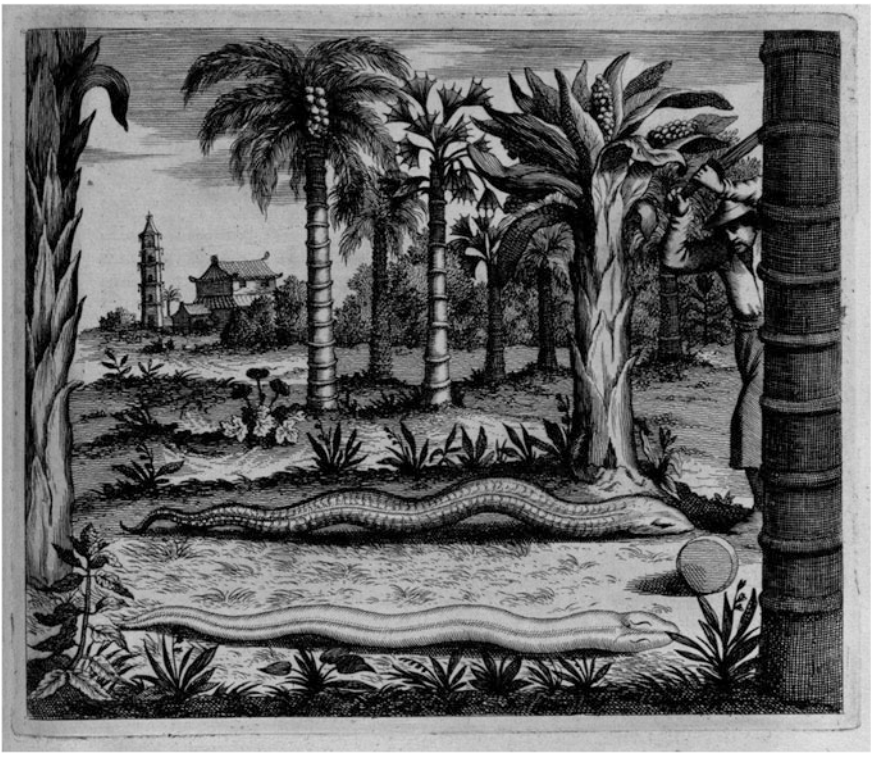

Fig. 7.1 Hunting the cobra in order to take the healing stone from its head (A. Kircher, 1667, *China Monumentis, qua Sacris qua profanis, nec non naturae et artis spectaculis, aliarumque rerum memorabilium argumentis illustrata*, Amstelodami, Apud Jacob de Meurs, p. 81). According to a legend, the stone generated inside the head of these huge exotic snakes fights the poison of other snakes. Moreover, Kircher reports the story of his brother Enrico Roth, who has witnessed a scorpion healed and a bubo disappear thanks to the healing action of the snake's stone

Zoccolanti (*clogs-wearing friars*)". The experiment—Redi goes on—had been made in front of "*many of the wisest and most reliable philosophers and doctors in Pisa, who wished to witness the demonstration of the theories of those friars*".[18] The experiments had consisted in wounding a cockerel's leg and pouring various poisons on the wound. Soon after, they had put the healing stone on the wound, but the poor cockerel had died shortly afterwards.

In the essay, one can infer Redi's subtle satisfaction in dwelling on the details of counterchecks: they changed both cockerel and poison, one animal is treated

[18] F. Redi, 1671, *ibidem* p. 3–6 , *"…tre padri del venerabile ordine di San Francesco volgarmente detti Zoccolanti"… "molti de' più savi e dei più accreditati filosofi e medici dello Studio di Pisa, desiderosi di vedere per opra ciò che quei padri con parole davano ad intendere…".*

with the healing stone and another is left to Nature's devices, until they discover that the only cockerel who survived the experiments had not been treated with the snake's stone! Redi's detailed description of his experiment may appear pure scientific cruelty towards another scholar who has made a blunder, but we can understand it better if we consider that Redi, together with other doctors, is worried by the fact that the Jesuits, who have so far been engaged in spreading the Christian doctrine, start meddling with Medicine. The danger is that conflicts may be generated in this area, as it has already happened in the fields of both Physics and Astronomy. This risk is concrete, since missionaries are forced to study diseases in the countries where they travel: inevitably, they get to know traditional remedies of primitive peoples, which they later tend to import while praising their properties without suitable checks.

Kircher is not indifferent to Redi's argument, but he lacks a rule of conduct to refer to, and therefore answers the experimental objections of the doctor blaming him, since he does not manage to reproduce an experiment which succeeded at the *Collegio Romano*, and was witnessed by influential people.

The spontaneous genesis of insects is an extremely simple experiment, and Kircher does not hesitate to describe his procedure for the creation of flies: just mix dead flies, water and honey into a container, heat it and a few days later you will see that small worms will be born from that mush: they will become flies.[19] The experiment succeeds just as well if you sterilize both container and mush (unfortunately, he does not mention putting a lid on the container). Finally, Kircher brings out the final proof against the thesis of his enemy: in the Bible, there is no mention of insects and at least in one instance, they appear as coming out of the dust when "*Aaron did this: he struck the dust on the ground and mosquitoes flew over men and cattle; all the dust of the country had been transformed into mosquitoes all over Egypt*".[20] In conclusion, it seems clear that the insects we see nowadays were born spontaneously *after* the Deluge!

Once again, we can see that Kircher puts Revelation before knowledge, since the whole world appears to him as moulded by the Lord. The most important sign of His presence is life springing up all over the world: since this is part of the Lord's design, no wonder that life assumes different shapes.

The Jesuit scientist had realized that life is an abstract concept for an audience interested in letting in the Ark all kinds of living creatures. Several years earlier, indeed, he had already turned to a more effective concept: life is the expression of a vital force, *panspermia rerum*, spread by the sunbeams which make the soil fertile.[21]

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[19] A. Kircher, 1678, *Mundus Subterraneus…. op. cit.* Liber Duodecimus, p. 381.

[20] Bible, Exodus, 8: 13.

[21] A. Kircher, 1641, *Magnes, sive de arte magnetica,* Romae, Ex Typographia Ludouici Grignani, p. 717, *"sciendum est, terram, uti communis rerum mater est et matrix, ita rerum omnium quoque semina in se continere"*.

What was *panspermia* made of when the Lord created it, probably before the world itself? "…*In my opinion*"—he explains—"*it was a material spirit* (!), *made of an evanescent celestial aura, or a mixture of salt, sulphur and mercury which, coming into contact with vapour and heat, created all living creatures in the world*".[22]

Kircher, once introduced this concept, had brought forward the idea of *panspermia* with determination because it had become a fixed point in his *Weltanschauung*. The Lord Himself has used *panspermia* in order to transform the primordial chaos into the well-ordered Universe we know, from celestial sphere to the stars, from stones to plants and animals.[23] This vital force of Nature is not limited to the Earth surface: rather, it seeps into its inner core, where it takes the shape of *succus lapidescens*, namely a "petrifying juice", which creates all kinds of stones and rocks. Crystals, gems and stalactites, which, as anyone can see, are created and grow inside all caves, are produced by this petrifying juice.

Kircher had also felt the need to provide proofs of his statements and reminded the reader that the creativity of Nature does not only give life to gems and stones with incredible colours, but also shape impressing images which reproduce biblical and sacred figures of Christendom. Useless to say, in order to reinforce his thesis, Kircher had published the reproductions of several drawings, both profane and sacred, which can be found on the stones: owl heads, small frogs, Saint John the Baptist and even Christ crucified (Fig. 7.2).

Sometimes, it seems that Father Athanasius is so much taken by his fantasies that he cannot stop exploring the most incredible possibilities of Nature. Thus, he wonders whether the petrifying juice also acts upon animals' bodies. Over and above the well-known stone inside the head of the Indian snake, he relates the news of stones inside toads, hedgehogs and even in eagles. Just as the snake stone cures poisoning, it seems that the eagle stone is used by women who have a difficult delivery.[24]

From the stones which Nature draws in order to reproduce sacred images, to stones-in-animals which are endowed with healing properties, Kircher cannot avoid examining one of the most debated issues of the seventeenth century, namely the Nature and the origin of fossils reproducing animals. At the time, there was already an academic tendency to classify fossils as organic creatures going

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[22] A. Kircher, 1678, *Mundus Subterraneus…. op. cit.* Liber Duodecimus, pp. 347–348, "*Dico fuisse, spiritum quendam materialem seu ex subtiliori coelestis aurae sive ex elementorum portione compositum, suisseque vaporem quendam spirituosum Sulphureo-salino-mercurialem, semen universale rerum, Elementis à DEO concreatum, origine omnium eorum, quae in Mundo condita sunt…*".

[23] A. Kircher, 1678, *Mundus Subterraneus,* … Amstelodami, Apud Joannem Janssonium et Elizeum Weyerstraten.

[24] A. Kircher, 1678, *Mundus Subterraneus…. op. cit.* Liber Duodecimus, pp. 50–58. Kircher offers *"Tabula Combinatoria, in qua breviter omnium lapidum pretiosorum formae & virtutes exhibentur, alphabetico ordine disposita"*, i.e. a table with the names and virtues of a large number of stones, in alphabetic order, pp. 83–85.

Fig. 7.2 Images engraved on the stones (A. Kircher, 1678, *Mundus subterraneus*…. Amstelodami, ex Officina Janssonio-Waesbergiana, p. 39, digitized by ECHO.mpiwg-berlin). The table reproduces some of the most significant images which Nature has drawn upon the stones. *1* An old man holding a baby, *2* a baby held by a pregnant woman surrounded by unidentified angels (comment of the author), *3* a man covered with hairs, probably Saint John the Baptist, *4* Saint Jerome found on a stone in a Bethlehem cave, *5* a Christ crucified who is in the Carthusian Monastery in Switzerland, *6* the Madonna of Loreto, engraved in marble, inside Saint Peter's Cathedral in Rome

back to remote times, but a number of fossils of unknown animals, with unthinkable dimensions are found just in this period.

Therefore, the problem assumes a dimension, which we cannot easily understand nowadays. If one admits the existence of forms of life now disappeared, one might infer that the Lord made a mistake when he created species which have not survived long enough to get on Noah's Ark. This was not such a long ago time (for us at least), because the literal analysis of the Bible brings us to the conclusion that Creation took place about 4,000 years before Christ and fixes the date of the Deluge to 2,349 before Christ.

Father Athanasius is upset by the idea that some species, now extinct, may have existed once, because the Bible describes the world created by God as essentially identical to the world we can see nowadays, with the same plants, animals and humankind. It is true that the Deluge has probably modified some aspects of the Earth surface, but the world, from Kircher's point of view, is an essentially static work.[25] The temporary aspect of our world belongs to individuals, not to the species, which, on the contrary, are unchangeable. Of course, in this framework, there is no space for the existence of fossils: how can we believe that some animals may have lived, grown and become extinct, leaving their images engraved on the stones? Doubtless, fossils look like plants, or animals, some of which have never existed, but this does not mean that real plants and real animals have actually petrified! And yet, this thesis will survive for a long time, since—a century later—a philosopher—J. B. Robinet—writes: "*We shall laugh about the naivety of a savage who, ignoring the art of painting, would say in front of a faded portrait: there has been a man, made of flesh and bones, just like myself, but the passing of time—together with some other element which I can infer rather than ascertain—destroyed the substance of this man, and we can only see his delicate features…. Why is it impossible for any stone to carry by nature the picture of a fish or of a man?*". [26] If it is difficult for us to believe that there was a rock similar to a shell, would it not be equally difficult to think that a shell or a fish had been filled by a sort of petrifying juice which transformed them into stone?

If these arguments do not convince us, it is because in our time we have assimilated the idea that scientific research is not linked to religious beliefs. The situation was completely different for a Jesuit scientist living in the seventeenth century. Since it was beyond dispute that the Bible told the exact truth, the scholar

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[25] P. Rossi, 2003, *I segni del tempo*, Feltrinelli ed., Milano, p. 48; see also P. Rossi, 2009, *Il tempo profondo: rocce, fossili, pensieri nella scoperta della storia della Terra,* Conference held at the Università Firenze, 6 February 2009.

[26] J. B. Robinet, 1766, *De la Nature,*van Harrevelt ed, Amsterdam, pp. 212–213 *"Nous ririons de la simplicitè d'un sauvage qui ignorant absolument l'art de la peinture, diroit à la vue d'un portrait enfumè: Il y a eu là un homme d'os & de chair comme moi, mais le temps aidé de quelque cause que je suppose sans pouvoir l'assigner, a detruit la substance de cet homme& il n'en reste que des linéaments delicates… Pourquoi une pierre quelconque ne pourroit-elle pas porter naturellement l'image d'un poisson come celle d'un homme?".*

could only fit his observations into a preordained metaphysical framework and sometimes resort to subterfuges. One can imagine, for instance, that unknown species did not really become extinct, but rather live in some unknown region of the world. It was easy to believe that fossil shells had been displaced by a seaquake to places far from the sea, or even that they were simply the remains of travellers' meals, heaped up with the passing of time.[27] From a scientist's point of view, one may assume that the *vis plastica* of *panspermia* may copy on the stones the pictures of real plants and animals, rather like the peculiar shapes of clouds.[28]

Coming up once again at the crossroads of knowledge, Kircher thinks he can maintain both positions and divides the fossils into two categories: those reproducing the shape of existing animals, such as leaves, shrimps and shells, which are organic remains modified by some natural petrifying juice, and natural products, such as petrified trees and bones of giant animals, just like those found in the caves near Trapani. In a sense, Father Athanasius is right when he relies on Nature's inventiveness in order to explain the existence of giant fossils. Indeed, the remains of these strange animals, which are found in various parts of Europe, seem so different from one another, in shape and dimensions, that it is difficult to imagine (at least, at that time) that the Earth in its past had housed such a huge quantity of animals, which later vanished mysteriously.

We may easily realize Kircher's wish to overdo things, which leads him to get interested in so many different topics, so much so that he sometimes risks trespassing into heresy. However, Kircher escapes this danger by using his vast learning and quoting—whenever he gets the chance—a phrase or an episode from the Bible, where he finds the ideas he wants to express in that moment.

The world is exactly as the Lord wanted it to be: the curiosity of the contemporary scientist, after Galileo, collides with Kircher's certainty of the lack of contradiction in Nature, since everything is part of God's project.

However, it is difficult to have certainties in the seventeenth century. On the one hand, one should solve the problem of spontaneous generation and of the fossils' Nature. On the other hand, it is more and more difficult to ignore the news coming from China. In particular, there are reports from a Jesuit brother, Father Martino Martini, who informs his superiors that he has reached the conclusion that human history must be older than the 5,500 years inferred from the Bible. This missionary father in China even published a book, *Sinicae Historiae Decas Prima*, where he lists several documents kept in the Chinese archives. These documents are still preserved and allow us to state that Chinese emperors and populations existed at least 1000 years before the flood.[29]

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[27] P. Rossi, *op. cit.* p. 9.

[28] A. Kircher, 1678, *Mundus Subterraneus…. op. cit.* p. 6 quoted in P. Rossi, *op. cit.* p. 26.

[29] M. Martini, 1658, *Sinicae Historiae Decas Prima,* Typis Lucae Straubii, impensis J. Wagner and Bibliopolae Monacensis, p. 3 , *"illud pro certo compertum, Sinensem de Diluvio historiam non multum à Noetico abesse, quippe quae ter mille circiter annis vulgarem Christi epocham praegreditur"*. Digitized by Google Books.

The consequences of this conclusion are incalculable both for the Deluge and the Ark. Indeed, if we admit that there are documents older than the Deluge, we must conclude that the punishment was not really "universal", but rather limited to the area where Moses and his family lived. Moreover, if the Bible defines as "universal" an episode concerning only a specific geographic area, as a consequence, the value of the text loses its universal character and is only the account of the history of the Hebrew people.[30]

This is why the study of chronology, which had been until then limited to retired canons dedicated to summing up the ages of all Biblical characters, suddenly becomes a sort of minefield where one should move with great caution.

The age of the world now seems like Pandora's box.

If the age of the world goes further back, the risk is the exhumation of the Aristotelian idea of an eternal Universe. The idea that the Universe is essentially an aimless structure follows the fact that it has always been there. That is why this notion of eternal existence is the only one in Aristotle's Physics which has never been accepted by Christian Cosmology, and it is extremely dangerous to rediscover it just when atheistic and materialistic ideas are breaking through among the scholars. There is even worse to come.

A Calvinist scholar in Bordeaux, Isaac La Peyrère, starting from the ancient roots of the Chinese population, as from the works of Father Martini, and suspecting that even the American populations might be as ancient, makes a simple deduction. If documents show that Chinese emperors reigned at least a thousand years before Adam's creation—La Peyrère says—the only way to avoid contradicting the Bible consists in admitting that some populations were older than Adam's offspring, the so-called *pre-adamites*, who—we infer—while having had their own history, did not experience the Original Sin, and therefore did not need Christ's sacrifice.[31] La Peyrère realizes the danger of his guesswork and soon writes a sort of recantation, in order to explain that even pre-adamites, somehow, could have been subject to the Original Sin and, by adopting a procedure which the Jesuits used at the time, quotes Saint Paul to take his part. Indeed, in his *Letter to the Romans,* Saint Paul wrote "*Until the law indeed there was sin in the world, even though a sin cannot be ascribed to anyone when there is no law, and death reigned from Adam until Moses…*".[32] According to La Peyrère, that hint about the existence of sin in the world before the law was imposed upon Adam becomes a proof that there were people who did not know God's law before it was given to the Hebrews "*The interpreters were tormented by the expression—'until the*

[30] P. Rossi, *op. cit.* p. 169.

[31] I. La Peyrèr, 1655, *Praeadamitae sive Exercitatio super Versibus duodecimo….* Amsterdam, published anonymous and without the name of the typography. Digitized by Google Book.

[32] S. Paul, Epistle to the Romans 12–14.

law'… *if you interpret this as Adam's law*, *you are saying that sin existed in the world before Adam, and that, before Adam, a sin was not something wrong*…".[33]

La Peyrère has probably got good intentions, since his interpretation allows him to solve both the problem of the ancient roots of some populations, which has been by now well documented, and the problem of how Noah's offspring may have populated the whole Earth in about 4,000 years. However, the French scholar does not really care about the horrified reaction of the orthodox Catholics, because he knows that even theologians sometimes are forced to change their opinions. He remembers that, in ancient times, one excluded the possibility that other men might live at the antipodes, whereas this possibility has been later accepted.

It is not surprising that La Peyrère, who expresses such revolutionary opinions, lives a busy life: he leaves his Calvinist country, moves to the Netherlands, where he becomes a friend of Queen Christine of Sweden, who helps him publish a book with his unorthodox ideas, follows the Spanish mercenary troops of the Prince of Condé, until he is arrested in Brussels by the Spanish Inquisition.

In the meantime, a certain number of pamphlets had been published against the ideas of pre-adamites, so that Peyrère, who does not possess the firm character of Giordano Bruno (nor can one claim it), finally turns Catholic and formally renounces his ideas about pre-adamites.[34]

The Copernican revolution was therefore accompanied by this chronological revolution which is contrasted once again, with the same methods, by the religious authorities. Orthodox scholars thus face at the same time the fact that the Earth is placed at the edge of the Universe and that the world, since its creation, has undergone deep changes, even the extinction of some animal species. Finally, there is no book telling the whole story of all the populations on Earth, and there is a dreadful time chasm between ourselves and the Creation.

Kircher solves these new problems with a particular stubbornness. He is convinced that it is possible to track down the knowledge the Lord handed on to Adam in Paradise. As a consequence, he spends most of his life looking for this ancient knowledge, which constitutes the key to overcome the apparent contradictions of contemporary culture. This knowledge, according to Kircher, was attained by ancient Egypt, which in turn passed it on through the hieroglyphs, a form of writing which can only be understood by the initiated. After all, the Bible itself recommends that the truth should only be told to those who can understand it: "*Do not give holy things to the dogs, do not throw your pearls to the pigs, lest they trample down on them, then turn to tear you to pieces*".[35] Even non-European cultures, such as the Arab culture, and those emerging in the seventeenth century, for instance Mexico and China, carry on the ancient knowledge of Adam. That is

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[33] I. La Peyrèr, 1655, *op. cit*. pp. 25–26, *"Angebantur enim undique in explicatione huius loci 'usque ad Legem'… Si lex illa ilntelligebatur de lege data Adamo statuendum erat, peccatum fuisse in mundo ante Adamum & usque ad Adamum: peccatum vero ante Adamum non fuisse imputatum"*, quoted by P. Rossi, *op. cit.* p. 162.

[34] D. Bernino, 1733, *Historia di tutte l'heresie,* Baglioni, Venezia. p. 644.

[35] The Gospel according to St. Matthew 7, 6.

why the activities of Jesuit missionaries in these countries must be protected both as religious activities and as cultural research of the common roots of all human religions.

In this framework, where all religions are recognized their dignity, Kircher cannot be sympathetic towards heretic assumptions, such as the existence of pre-adamites which, among other things, contain the seeds of racism.

Father Athanasius, in a context where many old certainties are vanishing, remains faithful to the task he has been given and does his best to pack all animals into the Ark. After excluding from the Ark uncontrollable animals such as insects, he has already solved part of the difficulties which he had faced, like Noah. However, Kircher is still far from a definitive solution, because there are infinite problems. For example, there is the problem of sirens, a kind of sea-monster Kircher knows very well, since he keeps its tail and skeleton in his museum.[36] Sirens are a source of embarrassment for Kircher, because in his essay they are exclusively represented as females: how could one keep a specimen of each sex? However, after a careful check, he decides to leave them to their fate, since they can manage on their own in the sea. Next, Kircher does not really know what to do with large amphibians, such as seals, beavers, otters and hippopotamus—animals which would certainly encounter problems in a water world. However, since these animals would require large spaces and water pools for survival, Kircher decides that Noah left them on the ground.[37] In any case, Kircher, unaccountably, favours dogs of various species by devoting five compartments to them.

Though somewhat incoherent, Kircher starts listing animal species to be embarked in the Ark, according to their size. He starts with the elephants and goes on with camels, oxen, unicorns, rhinoceros, buffalo, elks, lions, deer, horses, donkeys, wild donkeys, tigers, bears, leopards, panthers, wolves, dogs, pigs, foxes, cats, goats, sheep, rabbits, hares, squirrels, badgers, beach-marten, mice, porcupines, monkeys and so on, which Noah should have admitted in couples on board the Ark. Father Athanasius almost plays the role of Noah's assistant and takes stock of the guests of the Ark with accurate drawings, which betray the educational aim of his work.

The criteria he uses for admission are rather flexible. For instance, although most reptiles are left out of the Ark because they are considered capable of being generated spontaneously from the mud, Kircher thinks he must make an exception for snakes which, though dangerous, are received on the Ark to remind humankind of the Original Sin, in which the snake has obviously played a relevant role.[38] Moreover, snakes, notwithstanding their negative role in the Bible, present some positive feature, because *Theriaca,* a universal antidote for poisons, is taken from the viper's flesh.

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[36] A. Kircher, 1675, *Arca Noë in tres libros digesta, op. cit.* p. 73.

[37] A. Kircher, 1675, *ibidem,* p. 72.

[38] A. Kircher, 1675, *ibidem,* p. 54.

In any case, so as not to increase the number of animal species on board the Ark, Kircher only admits snakes living in our continent since, as it can be reasonably supposed, a European snake had tempted our progenitors in Heaven. As for snakes living in the New World, one can trust a spontaneous generation from the decomposition of organic matter, whereas we should not be concerned about embarking large Indian snakes, since they grow so much only because of the Sun, which is particularly hot down there.[39]

Filing all the animals of the world is such an impressive task that we can forgive Kircher when he forgets an incoherence in the inventory of species on board the Ark. For instance, Kircher includes fantastic animals, such as the unicorns, which Kircher considers real, since Queen Christine of Sweden gave him a horn, or the griffons, quoted by his Jesuit brothers in China. There are also arbitrarily doubled species, such as leopards and panthers, and species which are strictly related among each other, such as rabbits and hares, which might have saved him space on the Ark, if he had admitted that species may evolve in function of their environment. This is a price which, as we shall soon see, the Jesuit scientist finally had to pay.

Of course, all these are details, since even if Kircher managed all spaces strictly, doubtless the known species and the emerging species of the New Continent represent a formidable challenge to someone who wants to embark them all aboard a huge ship. We should mention the fact that Australia at the time had not been discovered as yet, otherwise there would have been no solution to this problem. Moreover, we should not forget that, together with all the animals, there should have been space for the food destined to them. However, Kircher, who gradually becomes the new architect of the Ark, manages to locate a dedicated hold for leaves, wheat and oats on the second floor, so as to respect the tastes of herbivores as much as possible. In the same way, Kircher reserves a space for a *gallinarium* and one for a *palumbara* in order to satisfy the needs of carnivores and for Noah's family (of course, the animals to be sacrificed are separated from luckier couples of chickens and doves destined to populate the Earth after the Deluge).[40]

Kircher therefore completes the inventory of the species saved by Noah. Probably satisfied for fulfilling the mission entrusted to him by his superiors, he realized a picture of the universal zoo, as he imagined it (Fig. 7.3).

In fact, at the end Kircher realizes that his task is hopeless. He does admit that it is not reasonable to think that all animal species in the world may have been embarked on the Ark "*…illas omnes intra Arcam introductas fuisse non est verisimile…*"[41] and understands he's only got one solution: if he cannot enlarge the Ark, he'll have to limit the number of animals on board.

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[39] A. Kircher, 1675, *ibidem,* p. 56.

[40] A. Kircher, 1675, *ibidem,* p. 106–108.

[41] A. Kircher, 1675, *Arca Noë in tres libros digesta, op. cit.* p. 67.

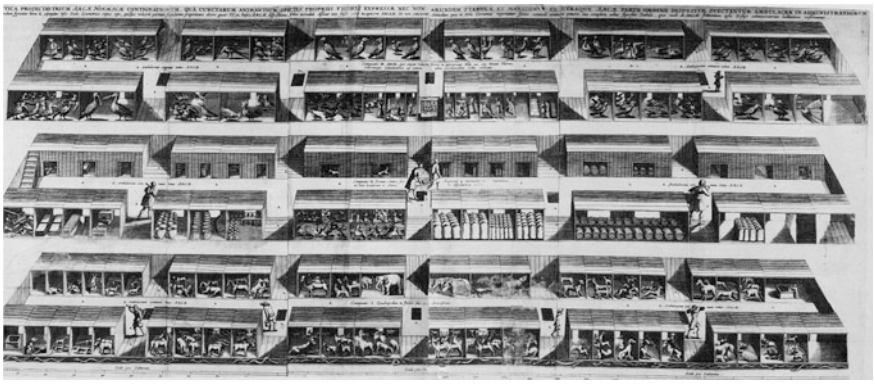

Fig. 7.3 Arrangement of animal species in Noah's Ark (A. Kircher, 1675, *Arca Noë in tres libros digesta*…. Amstelodami, Apud Joannem Janssonium a Waesberge, pp. 116/117). This picture shows the three floors of the Ark in perspective. The corridor at the centre of each floor allows a passage for Noah's family to feed the animals. Quadrupeds are on the ground floor, birds on the third floor, while food and tools occupy the whole second floor. The animals we can see at the centre of the second floor are chickens and doves—food for the carnivores (indeed, chicken and doves as couples to populate the world are on the third floor). The snakes, which were embarked to remind humankind of the Original Sin, and can be used in order to extract an antidote for poison, are in the bilge

As one could expect, Kircher excludes hybrid species, such as mule and hinny, but this alone cannot solve his problem. Therefore, he goes on with his exclusions, without too much emphasis, trying to find out more surprising crossbreeds, which must necessarily be born after the Deluge.

Kircher starts excluding the giraffe who, as its Latin name says, *camelopardus* is a crossbreed between a camel, from whom it inherited its long neck, and a leopard, which caused its spots. Then, Kircher proceeds with the *Tragelaphus* (a sort of antelope), which is also called *Hircocervus*, and therefore is a clear crossbreeds between a goat (hircus) and a stag (cervus)…. No doubt this approach to zoology may appear rather naive. However, as usual, we should not judge the past from the cultural reference point of our age.

According to Kircher, language is directly connected with God's design, as shown in the Creation. Therefore, each name is essentially a representation of reality. As a consequence, a crossbreed must necessarily have a name which describes its own origin, since words mirror the Nature of things. Such a wonderful correspondence must have existed when humankind spoke a language which the Lord had originally given to them, a language with a series of grammar rules one can still study through the combinatorial art Kircher excelled in at the time. Kircher's skill in using his culture within a coherent framework is really impressive: indeed, starting from a problem of architecture and logistics, he recurs to zoology, grammar, mathematics and Bible study in order to avoid conflicts within his infinite knowledge.

The Jesuit scholar proceeds with the same logic in listing other crossbreeds, singled out through their names, and finds more between horses and deer, horses and leopards, foxes and monkeys, even between a lion (*leo*) and a panther (*pardus*), which generates a leopard, which Kircher, evidently, considers different from a panther.

As for the armadillo, unknown in Europe at the time (Kircher proudly kept one in his museum), it is obviously impossible to reconstruct its origin by analysing its name. Kircher can only guess that it might be a crossbreeds between a porcupine and a tortoise.

Despite his rich imagination, Kircher realizes he cannot reduce the pre-Deluge species to a reasonable number: he must resort to further expedients. At this stage, he starts saying that the Deluge was not really "universal": it simply flooded the region inhabited by those people the Lord wanted to punish. This solved several difficulties: first of all, Asia might have become an excellent reservoir for the species which could not be on board the Ark; in the second place, there would be no need of imagining the possibility of a huge flood invading Europe, Asia and the Americas. Unfortunately, this assumption had already been defined as a heresy from the Holy Office.

Therefore, Kircher can only say that the animals saved on the Ark are mere archetypes of all the species we find nowadays on Earth.

The Jesuit scholar, who did not want to give up either his religious or his cultural role, almost unintentionally paves the way to a concept which will be developed two centuries later and will be strongly opposed by Christian orthodoxy, namely the evolution of animal species. Thus, in order to explain the difference between the American and the European bison (since the former could not be on the Ark), Kircher imagines that "*A cattle race must have been transformed in this way through some particular influence from the sky, or because of the nature of both place and climate, as it happened for almost all the American animals*".[42] Kircher realizes the possible consequences of this argument, and, according to his usual procedure, he immediately finds support to his idea by remembering that in the Bible you can trace this concept of evolution if you consider that the phrase "*Grow and multiply*" is not only addressed to individuals, but also to the various animal species which, when following this commandment, peopled the whole world.

Apparently, the analysis of the Bible episode of the Deluge is particularly fruitful for a scholar like Kircher, who obtains a certain number of *bonus*, namely unexpected results from his study. For example, the Deluge might explain the reason why there is no sign of the location of Heaven on Earth, since such places were destroyed by that cataclysm, together with the four rivers of Eden, which originated Tigris and Euphrates.

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[42] A. Kircher, 1675, *Arca Noë in tres libros digesta, op. cit.* p. 70 *"Bovinae speciei animal, vel coeli influxu peculiari, aut climatis locique natura, uti fere omnia animalia Americae in hanc formam transmutatum fuisse"*.

The Deluge, according to Kircher, could even explain the strict diet of the Jewish people. Indeed, the Lord, having realized that the habit of eating the meat and blood of animals excited the wicked, had imposed constraints on the slaughtering of animals, so as not to cause another Deluge on Earth. Naturally, all Christians, thanks to the coming of Christ, have later been exempted from such strict diet rules.

As we have seen, there have been many consequences of Kircher's attempts to save the literal truth of the Bible episode of the Ark. So much so that as he got to the end of his task, Kircher (probably relieved, we guess) makes a mistake. Since he had to illustrate the stage of the stranding, Kircher does not realize there is a typo, since the picture shows *first* the Ark stranded on the top of Mount Ararat and, *then*, the Ark still adrift under a grey sky (Fig. 7.4).

Once the water has receded, Kircher's task has not yet ended, because he still has to solve his last problem, namely "*Quomodo animalia in universas globi terreni regiones et insulas devenerint*"[43]—since the Ark was stranded between Europe and Asia, how did the primeval species move to the other continents? Africa does have a connection with Europe, the old continent, but it appears extremely difficult to populate the Americas and the islands near the various continents, such as the Philippines, Japan and Madagascar.

In order to explain the existence of animals even in the most secluded islands, Kircher resorts once again to graphics and he shows, under the title "*Conjectural Geography of the Earth after the Deluge*",[44] a very accurate map of the continents where we can see that several areas now occupied by the ocean, had been mainland, just before the Deluge, with trees and vegetation. This *conjecture*, supported by the opinion of other ancient authors, as we can read on the scroll of the map, is reinforced by the existence of shells and remains of small fish, which were found in places far away from the sea. On the one side, this confirms that some portions of the current mainland were submerged in the past. On the other side, it shows that Kircher, partly recovering the concept that fossils are remains of real animals, is forced to recur once again to the concept of a changeable world.

Naturally, Kircher does not imagine the idea of continents adrift. Neither does he imagine that they move by floating on the fluid part of the Earth. Rather, he assumes that continents have detached from one another following those cataclysms and landslides which he himself experimented as a young man during his journey in the south of Italy.

Because of the central role which the structure of the Earth plays within Kircher's cosmic vision, he had dedicated his *Mundus Subterraneus* to the interpretation of landslides, to the function of volcanoes and to the circulation of waters, thus trying to identify the cause of the violent changes the Earth undergoes.

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[43] A. Kircher, 1675, *Arca Noë in tres libros digesta, op. cit.* p. 195.

[44] A. Kircher, 1675, *Arca Noë in tres libros digesta, op. cit.* p. 193, "*Geographia conjecturalis de Orbis Terrestris post Diluvium*".

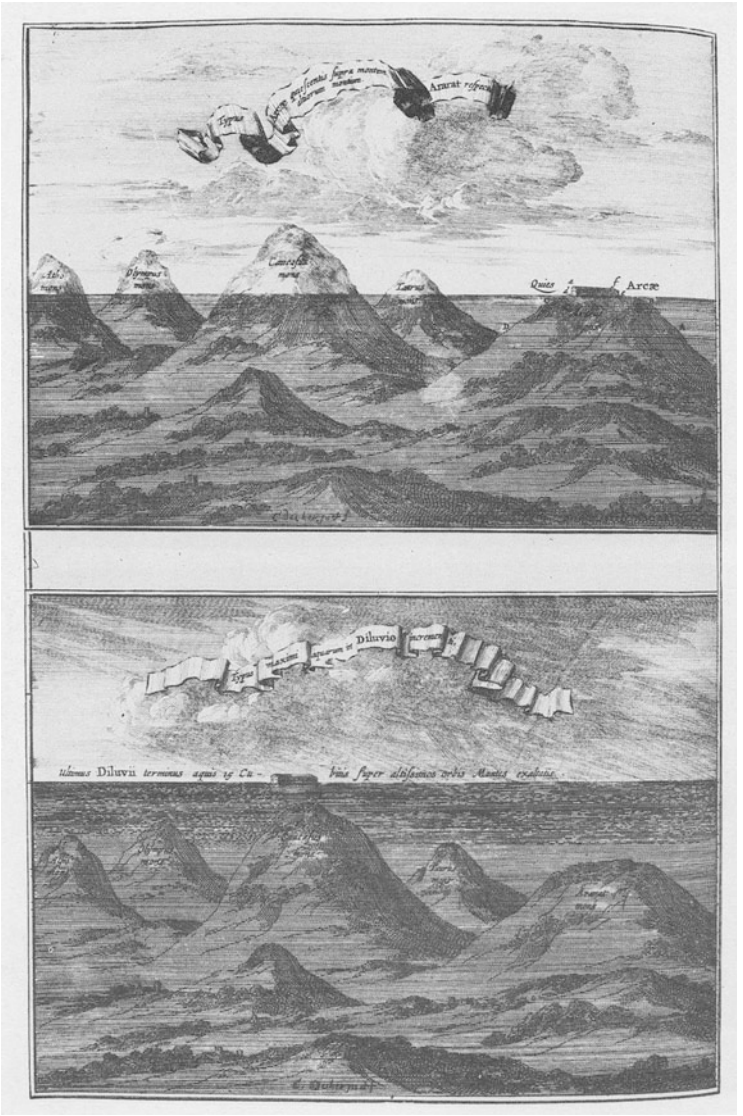

Fig. 7.4 Noah's Ark in the submerged world (from A. Kircher, 1675, *Arca Noë in tres libros digesta*…. Amstelodami, Apud Joannem Janssonium a Waesberge pp. 158/159). In the picture below, one can see deep waters, 15 cubits above the highest mountains, as from the inscription in the centre of the picture. There are a few names: Mount Caucasus, Mount Olympus and Mount Ararat. The Ark, though stable, appears at the mercy of the waves. On the other hand, in the picture above, water has ebbed away by 60 cubits (more or less 26 m) and the Ark is lightly settled on the top of Mount Ararat: the sky has cleared up. The two pictures appear chronologically inverted in the original book

Still following the idea that the Universe comes from a divine design ruled by rationality and harmony, the Jesuit scholar first imagines that the world is a sort of musical instrument, with underground pipes and siphons producing a sound we hear on the surface, then apparently realizes that the violent episodes which must have modelled the world require a very different mechanism, and soon figures out the globe as a living organism, in which the circulation of underground waters works just as the circulation of blood in the human being. The heart of this system is constituted by a central fire which, by heating up inner waters, grants their flowing, somewhat like inside the human body. On the other hand, volcanoes free the Earth from vapours generated by the huge central heat. Moreover, this central heat makes the air inside underground caves warm, so as to provoke further fires. The fumes of these underground fires, without an outlet, crash with violence against the caves' walls, thus provoking landslides on the surface. However, sometimes the pressure of these fumes is so strong that these gases manage to open huge rifts in the ground above and come out with roars and rumbles, until the landslides calm down.

Giving into his own nature, which makes him consider a test like an entertainment, Kircher wants to carry out an experiment in order to validate the ideas he has described in his book *Mundus Subterraneus.* He gives someone the task to create for him small glass balls, partially filled with nitrous acid (a mixture of nitrogen and water). When Kircher wants to impress a visitor, he puts these balls upon red-hot coals, so as to show that—after a while—the vapour breaks up the balls. Thus, he proves his theory on the cause of landslides and at the same time manages to entertain his guests with the bursting of those glass balls.[45]

The empirical results and the conjectural models Kircher develops are inevitably placed within the framework of Aristotelian knowledge. However, we can detect his wish not to blindly reject the proof of natural phenomena observed with a new objectivity, thus preceding the approval of the scientific method on the part of Catholic authorities.

It may appear surprising that some of the most revolutionary ideas of Science in the nineteenth century, namely the evolution of the species, the detachment of continents and *panspermia* itself, which was proposed once again by the Nobel Prize-winning scientist Arrhenius in the twentieth century, may have been somehow already perceived by the middle of the seventeenth century through unorthodox methods. In fact, a perception is quite different from a scientific theory, so much so that the history of Science is full of people who "imagined"

[45] *A. Kircher, 1678, Mundus Subterraneus, in XII libros digestus…, Tomus I, Amstelodami, Apud Joannem Janssonium à Waesberge & filios,* p. 241, *"Curo ego fieri globulos parvulos ex vitro conflatos magnitudine cerasorum, quos prius ad medietatem usque aqua nitrosa impleo; hi ardentibus superimpositi carbonibus, ex vapore intus acquae rarefactae dum exitum quaerunt, nec inveniunt, ruptis obstaculis violentissima eruptione tantum excitantfragorem, ut sclopi exonerati bombos si non superare saltem aequare videantur, omnibus praesentibus ad tam insolitum sonum attonitis & veluti costernatis: hoc festivo sonorum applausu Magnates in meo Museo excipere soleo".*

(not "predicted"), through a sort of shortcut on the path of research, a phenomenon which was observed decades later. In any case, we can say that the attitude of those launching in these fantastic theories is usually more fruitful of the attitude of those opposing new interpretations of reality because of mere conservatism and lack of fantasy.

However, amid rushes of fancy and systematic daily work, we must note that the frontier of research always moves forward. This is proved nowadays by the fact there is not one scientist who still wastes time in trying to stow all living creatures on board a ship 300 cubits long, 50 cubits wide and 30 cubits high.[46]

[46] O. Breidbasch & M. Ghiselin, 2006, *Proceedings of the California Academy of Sciences,* vol. 57, n. 36, p. 991.

Chapter 8
Hieroglyphs and the Dream of Universal Wisdom

In the year 1500 of our salvation, near Atheste, while farmers were digging the earth more deeply than usual, they found a clay urn, which contained a smaller urn which, in turn had a lamp inside, still burning between two phials, one made of gold, the other made of silver, both full of a clear liquid, thanks to which they think that lamp had been burning for years. They even believe that it would have kept burning, if it had not been discovered

Fortunio Liceto, 1652

De Lucernis Antiquorum Reconditis, ex Typographia Nicolai Schiratti, p. 15. "*Nam annum circiter millesimum quigentesimum nostrae salutis iuxta Atestem, municipium Patavinum, dum soteretur a rusticis terra solito altius, reperta est urna fictilis, et in ea altera urnula; in qua erat Lucerna adhuc ardens inter duas ampullas; quarum altera erat aurea, altera vero argentea, purissimo quodam liquore plenas; Cuius virtute Lucerna illa per tot annos arsisse creditur; et nisi retecta fuisset, perpetuo arsura*".

(a) *The Celeberrimum (well known) Museum of the Collegio Romano*

One of the most popular pictures of Athanasius Kircher is the one in the "*antiporta*"—illustrated page preceding the frontispiece—of the catalogue by Giorgio de Sepi.[1] In this picture, we see him welcoming two visitors of his Museum, which, by the middle of the seventeenth century, has become a traditional destination for all those who travel to Rome (Fig. 8.1).

The Collegio Romano had had few available spaces for years, and even more so after the small church of Annunziata, which had been housing students since the establishment of the Collegio, had been replaced by the Church of S. Ignatius which, with its apse, had occupied a part of the teaching rooms.

In this situation, Kircher, with his passion for ancient and mysterious things, could do nothing but transform his own study into a sort of personal museum, where he gathered evidences of faraway, mysterious civilizations, sent by his

[1] G. de Sepi, 1678, *Romani Collegii Societatis Iesu Musaeum Celeberrimum,* Janson-Waesberg ed., Amstelodami.

R. Buonanno, *The Stars of Galileo Galilei and the Universal Knowledge of Athanasius Kircher*, Astrophysics and Space Science Library 399,
DOI: 10.1007/978-3-319-00300-9_8, © Springer International Publishing Switzerland 2014

Fig. 8.1 The "Celeberrimum" Museum of Athanasius Kircher, from the catalogue of Giorgio de Sepi (antiporta). The Museum of the Collegio Romano constitutes the archetype of modern scientific museums. Together with works of art and archaeological finds, you can also see machines built to rouse astonishment in the audience and stimulate their wish to learn more. The Museum also offers materials of interest for Natural Sciences, which missionaries abroad have sent from all over the world and provides brothers who are going to leave for missions with the necessary knowledge to face their hard task.

missionary brothers. There must already have been a good number of people visiting this small museum if the Jesuit scholar, in order to avoid going up and down the stairs to welcome the visitors, had installed a long pipe which, from his own room, allowed him to talk directly with the porter's lodge and give the necessary directions. This device must have been particularly effective, since, a few years later, Kircher decides to use it in order to make his machines more realistic.

However, in 1651, the nobleman Alfonso Donini, secretary of the "Senato Capitolino", decides to give the Collegio Romano his collection of ancient finds, which had been till then kept in the Capitol. The Jesuits take this chance to establish the Museum of the Collegio Romano, putting together the Donini donation, as well as the zoological and geological collections, which were already housed in the Collegio, and entrust them to Father Kircher. This Museum becomes his main task for the last 20 years of his life. Little by little, Kircher transforms the museum into a projection of his own personality, so that, within a few years, the Museum is commonly defined as "*il Kircheriano*" (*the Kircherian*) and assumes a peculiar renown among many other European Museums of Marvels. The Museum of the Collegio Romano, just like Kircher's books, contains objects which can be called marvellous both for their beauty and for their singularity. The Museum also offers devices showing extraordinary phenomena, talked about at the time. The visitors of this museum do not only look at the exhibits—they also talk about them directly with its Director, who offers them his own knowledge in order to illustrate the principles, which inspire his fantastic experiments.

The popularity of the Kircherian museum is also due to particular historical circumstances. Pope Alexander VII reacts against the attacks of the Protestants by following the policy of his predecessors, namely by trying to give back to Rome a central role within European politics. In other words, the Pope would like Rome to become, once again, "the world's theatre". As a consequence, huge funds are invested to embellish the city and endow it with modern services, while art is protected, so as to attract intellectuals from all over Europe. Kircher's museum shows a lively city and a progressive Catholic Church. In 1655, Queen Christine of Sweden arrives in Rome: the Queen was one of the few Protestants converted to the Catholic Church, and therefore, she abdicated and moved to Rome, a city which her informers described as a centre of art and culture, a cosmopolitan city with a baroque culture. One of the first places Queen Christine visited in Rome as a very welcome guest was, of course, the Museum of the Collegio Romano.

This meeting increases the popularity of Kircher, who receives from Queen Christine a horn, which—according to her—belonged to a unicorn. In return, Kircher gives her a small wooden obelisk, which he built himself. On the base of the obelisk, Kircher engraved the following words in 33 languages: "*To the great*

[2] G. de Sepi, 1678, *op. cit.*, p. 12, "*Magnae Christinae, Isidi Redivivae, Obeliscum hunc arcanisVeterum Aegyptiorum notis inscriptum Erigit, dicat, consecrat A.K.S.J.*"

Christine, Isis restored to life, I dedicate this obelisk, decorated with the mysterious signs of the ancient Egyptians—A.K.S.J.".[2]

An obelisk is a particularly significant present for a Queen, since the original Egyptian obelisks hide a deep cosmological meaning. Obelisks, according to Father Athanasius, were realized as an imitation of the structure of Plato's cosmos: on top of it, we find the archetypical world, namely the first cause of subordinate motions; just below we find the intellectual world, directly emanated by the former, basis of *Geni secondi (Minor propitious gods*); in the third place, the visible universe, constituted by stars and planets. The lowest place is occupied by the elementary world of matter, which receives its own reason of life from higher hierarchies.

Because of their cultural background, the origin of obelisks—according to Kircher—dates back to the mythical Hermes Trismegistus, who was "*the first man who erected those columns which are called Pharaoh's needles, and engraved his knowledge upon them*".[3] Since then, Kircher does not miss a chance to advertise his friendship with Queen Christine, so as to show the relevance of his Museum. When he publishes one of his major works, *Itinerarium Exstaticum,* he is authorized to dedicate it to the Queen.

As a consequence of this popularity, on the occasion of the Jubilee of 1675, there are so many visitors at the Museum, that Kircher is worried, and tells his friend Hieronymus Langenmantel that he has difficulties in receiving "*a great number of visitors, dignitaries, men of letters, who come to me everyday to visit my museum. I get so busy that I have very little time left for my studies, as well as for my normal spiritual duties*".[4]

The importance of the Kircherian museum is underlined by the elegant *antiporta* of the Catalogue by De Sepi, which represents the spaces of the Museum in a way that someone defined as unrealistic and somewhat exaggerated, since nobody has ever recorded spaces with such huge vaults inside the Collegio Romano. However, there are clues to the faithfulness of the engraving, at least as far as contents are concerned. For instance, we can identify the small human skeleton, which is nowadays on display in the Museum of the Visconti Lyceum; the rostrum of saw fish and the walrus tusk, which are now in the Museum of Comparative Anatomy of the University "La Sapienza" and the Roman busts from the Donini donation.

The walls show a real picture gallery and apparently form, together with statues and potteries, a true art gallery. De Sepi reports: there is a "*..picture of Christ the Saviour… signed by Guido Reni. There are also a few sculptures, one of which, realized by the well-known architect and sculptor cavalier Bernini, represents a*

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[3] A. Kircher, 1650, *Obeliscus Pamphilius, hoc est, interpretatio Nova…,* Roma, Typis Ludovici Grignani, p. 45, "*Hermes autem primus fuit, qui erexit Columnas illa, quas Acus Pharaonis dicunt, & in iis insculpit quas invenerat scientias*".

[4] P. Findlen, 2001, in *Il Museo del Mondo,* Edizioni De Luca, p. 39.

[5] G. de Sepi, 1678, *op. cit.*, p. 15.

child trying to catch a cicada… a great quantity of plates and clay vases, fine works by Raffaello d'Urbino…".[5] A giant armadillo hangs from the ceiling. According to some, it was a source of inspiration for Gianlorenzo Bernini, in order to realize the drake which, in the Fountain of the Rivers in Piazza Navona, emerges from a cave under the giant representing the Rio della Plata, a metaphor of all mysterious animals which were discovered at the time in South America.[6]

The zoological section of the Museum is certainly remarkable, and the various specimens are described by De Sepi in detail, even though the disciple, in following the master, always focuses the description of the finds on their most impressive features. For instance, the *mermaid powder* (the Museum holds the tail of one of these sea monsters) has a peculiar anti-haemorrhagic property. On the other hand, the crocodile is a horrible creature, which, however, "*seems to feel an understanding for humankind, since, as it catches someone, he torments him for such a long time and squeezes him between its paws until it suffocates him, but when it realizes its victim has died, at first it is sorry for him, then it devours him*".[7] The elk nails possess the enviable property of killing a wolf by simply brushing against it. Moreover, the nails of this animal constitute an excellent remedy against epilepsy: in fact, it is worth making a ring out of them and wear it on the ring finger of your left hand, rather than on any other finger. Some people say that the hippopotamus tusk "*contrasts the effect of poison and heals haemorrhoids*" (a small fragment is enough). The magpie from Brazil has peculiar properties because "*if we believe the reverend fathers coming and going to India, it is an antidote against any kind of poison*".[8]

Even though De Sepi goes into details, especially on the properties of exotic animals, he does not forget that the marvellous things offered by Nature can also be appreciated in our country since, for instance, even European birds possess properties which deserve our attention. For example, the stork has bones and a beak from which we can obtain powders which cure apoplexy and paralysis. From skylarks, sparrows and bats, we can get drugs useful for colic; from the oriole, we obtain a medicine for jaundice, whereas the skin of vultures, swans, pelicans and eagles, when applied on the stomach, makes digestion easy. From magpies, we obtain, in small doses, a cure for heart palpitations and so on. Moreover, if we observe the behaviour of birds, we get useful indications for various kinds of diseases, because "*…we learn from swallows that the celandine eye lotion is useful for eyesight. On the other hand, we learn from kites that we can cure*

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[6] E. Lo Sardo, 2001, in *Il Museo del Mondo,* Edizioni De Luca, p. 15.

[7] G. de Sepi, 1678, *op. cit.*, p. 24, *"bestia est maximè Nili fluminis incola, quae homines amore deperire videtur, quos, cum arripere ei contigit, tam diu deprimit, pedumque unguibus astringit, donec examinet, ubi vero exanimatum videt, prius moerore percussum deplorat, demum sibi et in escam devorat".*

[8] *Ibidem,* p. 31-32.

[9] *Ibidem,* p. 32, *"ab Hirundinibus Chelidoniam visui prodesse docemur; a Milvo nobis Rhamno mederi, à Turdo Myrti ramo; ab Ardea Cancro; a Merula Lauro; à Gruibus palustri junco".*

ourselves with lye, from thrushes we learn the use of myrtle, from herons the use of prawns, from blackbirds, the use of laurel, from cranes the use of bulrush".[9]

In order to understand the spirit of the Museum, we should take into account a detail: in the caption of the *antiporta*, this museum is defined a *Kircherian house* and *theatre of Nature,* a theatre which aims at the representation of all displays of Nature in the juxtaposition of stuffed animals, fountains, perpetual clocks, fossils, mysterious machines, tricks of lights and mirrors. The goal is the creation of a domain of marvels, a sort of show which is at the same time impressive, naïve and entertaining.

"*You can see*"—De Sepi tells us—"*the glass of Tantalus, which still contains the dregs of the red wine from Falerno, so much so that you would believe the glass is full to the brim, whereas, if you turn it upside down, not even a drop does fall*."[10] There are also small coloured balls and a cylinder, containing minuscule figurines in a liquid, which can move up or down according to the higher or lower pressure provoked by a hole covered and uncovered by a finger. The author guarantees that visitors enjoy the show.

These famous machines, however, constitute the real difference between Kircher's museum and any other museum in Europe. The machine which De Sepi considers the most spectacular is the *Delphic Oracle*, namely a device made of a long pipe shaped like a snail, which Kircher had invented to save himself the continuous effort of reaching the porter's lodge from the office in which he usually spent his days. This machine had already been described in *Phonurgia Nova.* The *Oracle,* in the Kircherian museum, aims at surprising all naive visitors, since it can speak, imitate animals and even sing, but it also shows the device used by ancient Greek and Egyptian priests; indeed, they used a normal statue as if it was an oracle predicting the future and warning people, so as to obtain offerings and presents from them. The trick is inside the spiralling pipe which, starting from a room beside, gets to the head of the would-be oracle: in this way, sounds and words emitted by somebody at the far end of the pipe appear as uttered by the dummy.[11] Two elements impress those who talk to the oracle of the Collegio Romano: first of all, the dummy can rotate his eyes; secondly, the oracle can answer in any language the question is posed (that is why Father Kircher is so busy with the *Oracle*).

The *Dove from Archita* is another interesting piece for the Museum visitors. Kircher describes it in *Magnes, sive de Arte Magnetica.* This device creates the illusion of a cardboard dove flying inside a closed room, by using magnetic attraction, a topic which has always attracted the attention of Kircher. The device is made of a metal surface hanging from the ceiling, with a magnet above which, being connected with a rotating mechanism hidden from the observer, regularly

[10] *Ibidem,* p. 14, *"…hic cernis Tantali poculum… intra cuius latentes anfractus purpureus vini Falerni latex, captivus haeret, adeo ut credas scyphum ad summa labra repletum, qui tamen inversus ne guttulam dimittat".*

[11] *Ibidem,* p. 60.

crosses the metal surface. In the middle of the room, a raising must be realized, upon which he puts a pivoting cardboard dummy. This dummy represents the philosopher Archita, who, according to the tradition, actually invented this trick. "*Now make a dove out of a very light material*"—Kircher goes on—"*and pierce its body with a magnetized steel wire, which will reach Archita's hand*". The steel wire gets near to the surface high up: behind it, we find the rotating magnet. As a consequence, the magnet will drag both the dove and Archita himself, who will rotate together with the magnet, thus giving the impression that the dove may support itself in the air.[12] With this method—as Kircher's helper reveals—you can also imitate the statue of Daedalus walking on its own, Serapide's chariots, Bellerophon's Pegasus and other ancient inventions.

Probably, De Sepi wants to create a catalogue of all the things contained in this marvellous Museum just because he realizes that this is strictly connected to the extraordinary skills and unbeatable memory of the Jesuit scholar. In his preface to the catalogue, the author gives a clue of his worry for the future of the Museum. "*The uncertainty of human life*"—De Sepi writes—"*does not guarantee anything still and durable. In the same way, everything is reduced to nothing, little by little, since, with the passing of time, it is submitted to the changeable wheel of fortune…*".[13]

De Sepi presents Father Kircher who, now past his seventies, wonders more and more often about the future of those objects, which he gathered with so much effort. Perhaps, in order to save his creature from an imminent oblivion, Kircher opens his museum to the largest possible number of visitors, thus making it almost an *ante litteram* museum. The soundness of this worry about the future of the Museum is confirmed in a letter, which Francesco Baldigiani, former disciple of Kircher, writes to Francesco Redi in that period: "*Poor old Father Kircher is sinking fast. He's been deaf for more than a year, and has lost his sight and most of his memory. He rarely leaves his room except to go to the pharmacy or to the porter's room. In short, we already consider him lost since he cannot survive many more years*".[14]

De Sepi easily predicts the future: about ten years later, in 1689, when Gottfried Leibniz gets the chance to visit the Museum, he finds it practically destroyed,[15] and Pope Clement XI—in vain—writes a brief, threatening sanctions, even the excommunication for anyone breaking into the Museum of Kircher.

Therefore, in order to console his old master, De Sepi lists all the machines—the pride of the Museum—and even describes some other machines, which have actually never worked. For instance, he tells that, on the window, "*you can see an*

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[12] *Ibidem,* p. 19.

[13] *Ibidem,* page without number "Curioso Lectori", *"Quemadmodum instabilis rerum humanorum vicissitudo nihil nobis firmum, solidum & constans pollicetur, ita quoque more suo omnia vix orta cum tempore fallacibus fortunae rotis subjecta…".*

[14] A. Baldigiani, 1678 (about), *Letter to Francesco Redi,* quoted in P. Findlen, 2004, *Athanasius Kircher, The last man who knew everything,* Routledge ed., p. 1.

[15] P. Findlen, 2001, *op. cit.,* p. 46.

oroscòpio, which follows the light, floating on the water, supported by cork and made of a peculiar material, known to its author only, a remarkable work of Nature".[16] However, this indication, which does not explain whether this is a sunflower or its seeds, with a magnet hidden somewhere, is so generic that we might think that this *exhibit,* perhaps, has never actually been there.

The same may be said about the *Proteo catottrico,* which has already been so approximately described in the *Ars Magna Luci et Umbrae,* that the reader may think this machine has never really worked. In a way, De Sepi lists them only to pay homage to the creations and the fantasies of his master. On the other hand, in Kircher's mind, Mechanics has a special value, not only because he is convinced that the first experts of technique were the ancient Egyptians, especially those from Alexandria, whom he considers as the holders of real knowledge, but also because he attributes to all machines an important educational goal. Indeed, through the machines, you can unmask magicians, who, playing on popular superstition, boast supernatural virtues, which are in fact mere tricks. Kircher devotes most of his life, sometimes enjoying this task, to fight against superstition, a human frailty on which the devil hatches his plots.

The Catalogue by De Sepi, which represents the interests cultivated by Kircher, underlines once more the chasm between his own philosophy and Galileo's. If you examine the *antiporta* of the catalogue, which is so rich in details, you are reminded of a passage from *Considerations upon* "*Jerusalem Delivered*", in which Galileo argued with Torquato Tasso. He could have said the same about Kircher's Museum, if he had been able to visit it "…*it seems right to me to enter in the small study of some curious person, who has filled it with ancient or peculiar objects, actually without any value, just like, for instance, a petrified crab, a dried-up chameleon, a fly, a spider in jelly inside a fragment of amber, some of those clay dummies which they say can be found in the ancient tombs of Egypt*…".[17]

The *antiporta*, which doubtless Kircher must have approved before its publication, looks like a stage hosting a comedy, in which Father Athanasius plays the main role. In fact, almost all of Kircher's works present a scenographic frontispiece with allegorical pictures, which often relegate the text to a caption. When pictures alone are not enough, the author adds scrolls and sentences which make it easier to work out the meaning.

This is miles away from the sober introductions to Galileo's works, which leave large spaces to the description of the contents, but can even become an index, as in the case of *Sidereus Nuncius.* Even allegories, as in *Saggiatore,* where we meet Natural Philosophy and Mathematics, or in the *Dialogue upon the two Chief World Systems*—where the characters correspond, respectively, to Aristotle, Ptolemy and

[16] G. de Sepi, 1678, *op. cit.*, p. 1 *"…sympathicae materiae species, soli authori nota, aquae subere sulta innatans, horoscopium, lucis dominum sequi visitur; magnum naturae opus."*

[17] G. Galilei, ed.1793, *Considerazioni al Tasso e discorso di Giuseppe Iseo,* Pagliarini, Roma, p. 7.

[18] For a comparative analysis of the frontispieces, see L. Tongiorgi Tomasi, 1986, in *"Enciclopedismo in Roma Barocca",* Marsilio, Venezia. p. 165.

Copernicus, are an explicit reference to the content, rather than a simple suggestion of revealed mysteries.[18]

If we compare the presentation of their respective works, we realize the non-communication between them: Galileo wants to understand the world, Kircher wants to study those ancient peoples who had already understood the world.

(b) *The fantastic Egypt of Father Athanasius*

The *antiporta* of *Romani Collegii Societatis Iesu Musaeum Celeberrimum* presents in the foreground the obelisks Kircher himself had built for teaching, which also constitute the most concrete reference to his life.

The study of the ancient Egyptian culture, passing through the interpretation of hieroglyphs, occupies most of Kircher's life. Indeed, Kircher, following the tradition of the Renaissance hermetic philosophers, shares with them the conviction that the ancient Egyptians possessed the original knowledge, which was handed down to humankind, from Adam onwards. The idea that knowledge can only be handed down through techniques reserved to the initiates—just like hieroglyphs, remained deep-rooted throughout the Middle Ages and reached the Renaissance, as it is proved by the large diffusion of the *Corpus Hermeticum,* which Marsilius Ficinus translates at the middle of the fifteenth century, while attributing it to Hermes Trismegistus, who had established the Egyptian religion.

On the other hand, Ficinus's translation had been preceded by a manuscript, written by the Egyptian Horapollo, and entitled *Hieroglyphica.* Many critics think that the code is not as old as they would claim, but rather that it was written in the first centuries of the Christian era, when both the Egyptian language and writing had been lost, but the Neoplatonics are still convinced that, even so, the author, on his turn, might have obtained information from ancient texts, so that the content is worthy of attention.

Unfortunately, Horapollo (or whoever might be the author of the manuscript) puts would-be interpreters of hieroglyphs on the wrong track, because his text is addressed to a symbolical interpretation of this writing. Therefore, each picture is attributed a variety of meanings, within a game of deductions which, though charming, shows that it is impossible to understand a hieroglyph unambiguously.

The vulture, for example, indicates the mother, the sight, the ending, the prediction of the future, as well as the year, the sky, the mercy, Minerva, Juno and even two drachmas. How can one go from "vulture" to "mother" to "two drachmas"? In ancient Egypt—Horapollo explains—the female vulture was associated with the concept of mother, because this bird takes a particular care of its newborn. Moreover, since the two drachmas were the fundamental currency, they were considered mothers of other quantities of money—and so on, with a series of "creative" deductions.[19]

According to Horapollo, even numbers are used in hieroglyphs. For example, the number 16 expresses pleasure, because at this age, men start their sexual

[19] D. Hoeschelio, 1595, *Hieroglifica Horapollinis,* Augustae Vindelicorum, pp. 16–18.

activity: sexual intercourse (which involves pleasure shared by two people) is expressed by repeating twice the same number 16. In the same way, the number 1095 expresses the concept of "silence" or "dumbness", because it sums up the number of days in three years. At three years of age, children learn to speak. Starting from the idea of children who still cannot speak and cannot reason, this number also indicates the concept of impossibility.[20]

Kircher is obviously fascinated by this game and devotes some space to it in *Arithmetica Hieroglyphica*, where he warns the reader that the numbers he is talking about do not have a mathematical meaning, namely they are not used for calculations, but rather are esoteric symbols of mysterious divine truths. At this point, Kircher obviously refers to Pythagoras' concept of numbers as symbols of a mystical universal harmony. However, what Kircher is really interested in is a sort of bet, namely finding a good reason to attribute a particular meaning to a certain picture: this shows the rational way of thinking of contemporary European people, as opposed to the rich imagination of ancient Egypt.

Kircher is a master of deduction in linking various meanings: the hippopotamus, for example, indicated in Egypt "the passing of time", because this animal remains in the water during the day and browses in the meadows at night, but it could also indicate "spring", because in that season, meadows become green and the pasturing times are regularly defined.[21]

However, this is not only a *divertissement,* because Kircher, a priest, has a specific reason for the interpretation of the hidden message of hieroglyphs. His logic is simple: if the Lord wanted to confuse all languages of the world at the time of the Babel Tower, this means that, beforehand, everyone spoke the same language; as a consequence, the cultures of all populations share the same roots which, according to the Holy Writ, have a divine origin. In this way, Kircher gets the chance to offer an historical support to the universal yearning of the Church of Rome, which, in a period rich of extraordinary geographical discoveries, risks to be put under discussion.

Through the study of Egyptian hieroglyphs, Kircher also senses a chance to incorporate into the Bible's history the Chinese civilization, whose antiquity remains a serious obstacle for the reconstruction of history according to the Jesuits' rules.

The fantasy tale starts from Cam, one of Noah's sons, who, after the deluge, establishes colonies in China, where he hands down both Adam's original knowledge, which he himself had learnt from his father, and the hieroglyphs, which he has directly learnt from Hermes Trismegistus. However, while the Egyptians have maintained the symbolic value of hieroglyphs, the Chinese have later transformed it into a writing like any other, in which signs correspond to either sounds or syllables. Thus, Hermes becomes somehow the inventor of

[20] C. Marrone, 2002, *I geroglifici fantastici di Athanasius Kircher,* Stampa Alternativa e Graffiti, Pavona (RM), pp. 65, 107.

[21] C. Marrone, *ibidem*, p. 98.

Chinese ideograms too, which, together with the hieroglyphs, become a further object of study for Kircher, who, as he claims himself, is learning Chinese.

It is fascinating to see that some historical events, affecting the lives of many people, are sometimes based on a series of misunderstandings, just as Kircher's effort for the interpretation of hieroglyphs. Ficinus himself tells us that Cosimo de' Medici, after obtaining a copy of the *Corpus Hermeticum* in Greek, ordered him to abandon all his studies and to devote himself only to the translation of this text. The priority which Cosimo gives to this translation is not surprising, because—at the time—people in Western Europe thought that the author, Hermes Trismegistus, belonged to a generation of wise men who lived even before Moses. They also believed that later philosophers, such as Plato and Pythagoras, have derived their philosophy directly from the ideas of the *Corpus.* This ancient origin strikes the imagination of Christian Europe, since this book describes the creation of the world and the ascent of the souls to Heaven in terms similar to the Bible, thus strengthening the opinion that Hermes Trismegistus had really existed, and his works contain ancient truths coming from *Prisca teologia*. On the other hand, this opinion was shared by remarkable protagonists of the ancient world, such as Cicero, who in *De Natura deorum* explains that Mercury personified brought divine knowledge to Egypt. In the same way, some authoritative Fathers of the Church also shared the same opinion, such as Augustine and Lattanzio: the latter even considered Hermes as a sort of pagan prophet, who had predicted the coming of Christendom.

Since the times of the early Christians, the Egyptian culture, just like other ancient civilizations, was considered as rich in knowledge. The Romans, following a Greek tradition, had identified the god Hermes—Mercury for the Romans, with Thoth, the Egyptian god who oversees culture and wisdom. Since, according to the tradition, Hermes had given the Egyptians both laws and arts, he was often attributed the adjective Trismegistus, i.e. three times great.[22]

This is the cultural ambience Kircher finds as he flies from Wurzburg, from the waste of the 30 Years' War. Kircher arrives in the month of October 1632 at the Jesuit college of Avignon, already known as an expert of Eastern culture. Even if his name is still unknown in the "Republic of the Arts", such reputation is worth an invitation by Nicola-Claude Fabri de Peiresc, who, like many other contemporary intellectuals, is attracted by the possibility of discovering the secrets of the ancient Egyptians. Even Copernicus before him, in *De Revolutionibus orbium coelestium* had quoted Hermes Trismegistus "*…the Sun is right in the middle of everything. Who else, in such a splendid temple* [i.e. the Universe], *who put this lamp in another, or in a better place, whence it can illuminate everything at the*

[22] in F. A. Yates, 1985, *Giordano Bruno e la tradizione ermetica,* Laterza ed. Roma-Bari, p. 11 and ff. original edition *Giordano Bruno and the Hermetic Tradition* (The University of Chicago Press: Chicago and London. 1964, repr. 1991, p. 2 and ff).

[23] N. Copernicus, 1543, *De revolutionibus orbium coelestium*, Norimberga, 1543, folio 9 verso *"In medio vero omnium residet Sol. Quis enim in hocpulcherrimo templo lampadem hac in alio vel meliori loco poneret, quam unde totum simul possit illuminare? Siquidem non inepte quidam lucernam mundi, alii mentem, alii rectorem vocant. Trismegistus visibilem Deum…".*

same time? Not by chance does somebody define the Sun as the world's lamp, or the world's mind, or its ruler. Trismegistus calls it the visible god…."[23]

Kircher is conscious of the interests of the French philosopher and shows his trump card, saying that he has a book, which will allow him to decipher the hieroglyphs. Peiresc is obviously attracted by the idea and writes to the Dupuy brothers, who had established a scholars' club in Paris: "*We have had here a German Jesuit… who claims he has found, in the library of the Prince Elector of Mainz, an Arab manuscript on the interpretation of the hieroglyphs of Egyptian obelisks… apparently, he is translating this essay which will certainly shed light upon these mysteries*".[24]

Peiresc is so excited by the news of the manuscript that, on the one hand, he tries to obtain a copy of this essay, whose author—according to Kircher—is a mysterious Rabbi from Babylon, called Barachias Nephi. On the other hand, he tries to arrange a meeting in his house in Aix, so as to introduce this extraordinary Jesuit scholar to his eminent colleagues.

Several seventeenth-century scholars, Kircher in particular, consider the study of hieroglyphs worth any sacrifice, because they had been established by Hermes Trismegistus, who had handed down the divine knowledge to all ancient philosophers.[25]

The faith of many hermetic scholars in Hermes had staggered when the Swiss Isaac Casaubon, in 1614, published *De rebus sacris et ecclesiasticis,* where he questioned the authenticity of the *Corpus Hermeticum* with a simple argument. First of all—Casaubon remarked—no ancient author ever mentions Hermes Trismegistus. Secondly, the book contains Platonic concepts, such as the Demiurgus, the Mind, the Infinite, and even Christian concepts, such as the Word, the Son of God and so on. This makes us conclude that the *Corpus* cannot be as ancient as they would make us believe—namely older than Moses. Rather, it should date back to the first centuries of the Christian era.[26]

Casaubon's analysis is rigorous and convincing, so that the construction of Neoplatonism is at risk, and Kircher is the most suitable interlocutor. After a few years of research, indeed, Kircher's answer arrives with the publication of *Obeliscus Pamphilius.*

Even if some aspects of Casaubon's analysis appear convincing—Kircher writes—they are not crucial. First of all, it should not be surprising that we cannot see the original copy of a work as ancient as the *Corpus Hermeticum,* but rather a later adaptation of a preceding work which, originally written in the Egyptian language, was later translated into Greek, with the introduction of some spurious elements. Secondly—here Kircher shows off his learning—it is not true that

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[24] N. C. Fabri de Peiresc to J. Dupuy, 11 Ottobre 1632, in D. Stolzenberg, 2004, *Egyptian Oedipus: Antiquarianism, Oriental Studies & Occult Philosophy in the Work of Athanasius Kircher* (PhD Dissertation, Stanford University) p. 24.

[25] D. Stolzenberg, 2004, *op. cit.*, p. 254, quoting A. Kircher, 1652, *Oedipus Aegyptiacus,* Rome.

[26] A. Grafton, 1994, *Defenders of the Text: The Traditions of Scholarship in an Age of Science, 1450–1800*, Cambridge, Harvard University Press, pp. 149–151.

Hermes Trismegistus is not mentioned by ancient sources. The thing is that different populations refer to him under different names: when an Arab scholar mentions Idris, a Phoenician one mentions Tauti and an Egyptian mentions Theuth; in fact, they are all talking about the author that we know under his Greek name, i.e. Hermes Trismegistus.[27]

Whether these arguments are convincing or not, probably many scholars would never give up the chance to understand the contents of the inscriptions made by Egyptian priests. Peiresc, who is among them, does everything he can to organize a meeting, in order to introduce the young German Jesuit to his Paris colleagues.

However, the relationship between the French scholar, who looks forward to a key to interpret the hieroglyphs, and Kircher himself, who claims he will face this challenge, but in fact constantly delays the meeting, becomes embarrassing for those who, like us, read their exchange of letters. Peiresc, however, maintains his trust in the success of Kircher, as in his letter to the historian Jacques de Thou—"*I have just received some of the notes of Athanasius Kircher about the hieroglyphs of Egyptian obelisks. He derives his theories from an Arab text, written by an old Rabbi of Babylon, called Rabbi Barachias, a text on which scholars may practise their skills*".[28]

In May 1633, Kircher, urged by Peiresc, cannot help going to Aix. At this point, it is clear that he has not made any progress in the translation. However, he manages to raise enthusiasm in Peiresc, because he brings him the magnetic clock he created with sunflower seeds (see Chap. 2). Of course, Peiresc is still mainly interested in deciphering the Egyptian writing, but he must be satisfied with the promise of a sample translation. It is also true that Peiresc seems impressed by the variety of interests of Kircher—as he reports in his letters to his Paris friends, when he describes "*wonderful news and secrets of Nature*" which Kircher brought, and in particular "*a really marvellous clock, made with sunflower seeds floating on the water*".[29]

Notwithstanding this excitement about magnetic clocks, Peiresc does not know what to do in order to speed up the translation: he gives Kircher lots of useful books, and he buys him a newly published four-volume Arab dictionary. Finally, he promises to convince Kircher's superiors to move him from Avignon to Aix, where he could work without distractions. However, just when he believes he has almost reached his goal, out of the blue Kircher is given the order to move to Vienna because the Emperor, after Kepler's death, needs a new Math teacher. Peiresc realizes that this new appointment, though prestigious, will probably divert Kircher's attention away from the work of translation, thus wrecking the project of which he has been dreaming for months. Therefore, without hesitation, he asks his friend, Cardinal Francesco Barberini, to postpone this order for a year, so as not to offend—he says—the nobleness of Provence, which is hoping "*with great*

[27] A. Kircher, 1650, *Obeliscus Pamphilius…, op. cit.* pp. 35–44.

[28] N. C. Fabri de Peiresc a J. De Thou, 4 April 1633, in Daniel Stolzenberg, 2013, *op. cit.*, p. 74.

[29] N. C. Fabri de Peiresc to J. Dupuy, 21 May 1633, in D. Stolzenberg, 2013, *op. cit.,* p. 75.

devotion" that Kircher may stay in Avignon to devote his time to the study of the "*Egyptian Hieroglyphs*".

Peiresc is a practical man: while using all possible means to obtain the cancellation of the order, he also urges Kircher to show him at least an excerpt of the translation, because he fears that, notwithstanding his intervention, Kircher may be moved to Vienna.

Once again, Kircher seems to have troubles because, though he does assure Peiresc that he is making progress, he also complains that he could work more quickly if he were not distracted by so many commitments, both teaching and public relations, which his superiors entrust him with.[30] Probably, this is not a mere excuse, but Kircher certainly cannot bear distractions from his work. However, notwithstanding these obstacles, in the month of September 1633, Kircher announces that, since he is leaving for Vienna, he will go to Aix first, to report on his work to Peiresc and show him that he can finally read Egyptian hieroglyphs. Kicher himself emphatically describes Peiresc's reaction in the *Obeliscus Pamphilius*, "*…he was overflowing with joy, and from then on he did everything he could to make me continue my interpretation of hieroglyphs*".[31]

For a correct interpretation of these words, we should bear in mind the fact that the *Obeliscus Pamphilius* was published in 1650. Therefore, Kircher writes this account about 15 years later, when memories have probably faded in his mind, and his experience in the translation of hieroglyphs—though fantastic—is by now consolidated. Precise information is necessary, because Peiresc's personal notes, which were written just after the meeting, give us the picture of a disappointed scholar.

Peiresc's disappointment is increased by Kircher's incredible mishap. Indeed, Kircher, trying somehow to meet Peiresc's wishes, sends him an excerpt of the translation of *Barachias,* as well as the interpretation of the inscription on the obelisk of S. Giovanni in Laterano. The text of the inscription available to Kircher, who has never been in Rome by that time, is taken from a drawing appearing in the *Thesaurus Hieroglyphicorum*, a work by Johann Georg Herwart von Hoenburg, a Bavarian scholar who corresponded with Kepler.

The real mess, which Peiresc realizes at first sight, consists of the fact that the "hieroglyphs", which Kircher has just translated, have no bearing whatsoever on the writing of ancient Egypt; rather, they are mere drawings invented by an artist, who had probably thought that, since nobody can read that writing, he might as well save time and invent drawings which seem to him better than the original ones. As a consequence, Kircher has interpreted meaningless drawings, mistaking them for Egyptian hieroglyphs!

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[30] For an exhaustive story of the relationship between Peiresc and Kircher, see D. Stolzenberg, 2013, *op. cit*.

[31] A. Kircher, 1650, *Obeliscus Pamphilius, hoc est, interpretatio Nova…,* Roma, Typis Ludovici Grignani, p. c1 Par. 1 *"Occasio huius Operis"*.

Such an accident might have put an end to the career of any beginner of Egyptian studies, since the picture which Kircher has interpreted looks improbable even to the eyes of a layperson (Fig. 8.2). However, judging from the available documents, Kircher does not worry over it and is not so sorry for the blunder, as for the good chance he has missed, inasmuch as he "*had discovered a beautiful, solid interpretation*"[32] of the pictures in the false reproduction of the obelisk.

Kircher may be partially justified, since at the time hieroglyphs are completely unknown, and they are very difficult for anyone to reproduce. It is as if we asked a European scholar to reproduce Chinese ideograms he does not know. Therefore, Kircher, who is on the point of leaving, expects a certain number of inaccuracies in his text and knows he will probably have to proceed by intuition (the Latin inscription below, on the other hand, is perfectly correct). Moreover, we should not forget that, according to Plotinus—and before him Porfirius, Iamblicus and Hero of Alexandria—down to Ficinus, hieroglyphs are not a writing like any other one. Rather, they are endowed with an intrinsic symbolic value. Therefore, hieroglyphs, considered as initiatory symbols hiding divine truths, must not be "translated", but rather "interpreted" (in a sense, this is the charming aspect of Kircher's approach, but also his limit, since he recurs more to the Holy Spirit than to a philological analysis).

It is certainly not easy for Kircher to justify the fact that he has interpreted a few drawings as if they were messages from an ancient culture. However, if the key for the interpretation of the message is a mixture of fantasy and intuition—Kircher is convinced of this—should it be surprising that Kircher finds a hidden meaning even in a series of false grotesquerie?

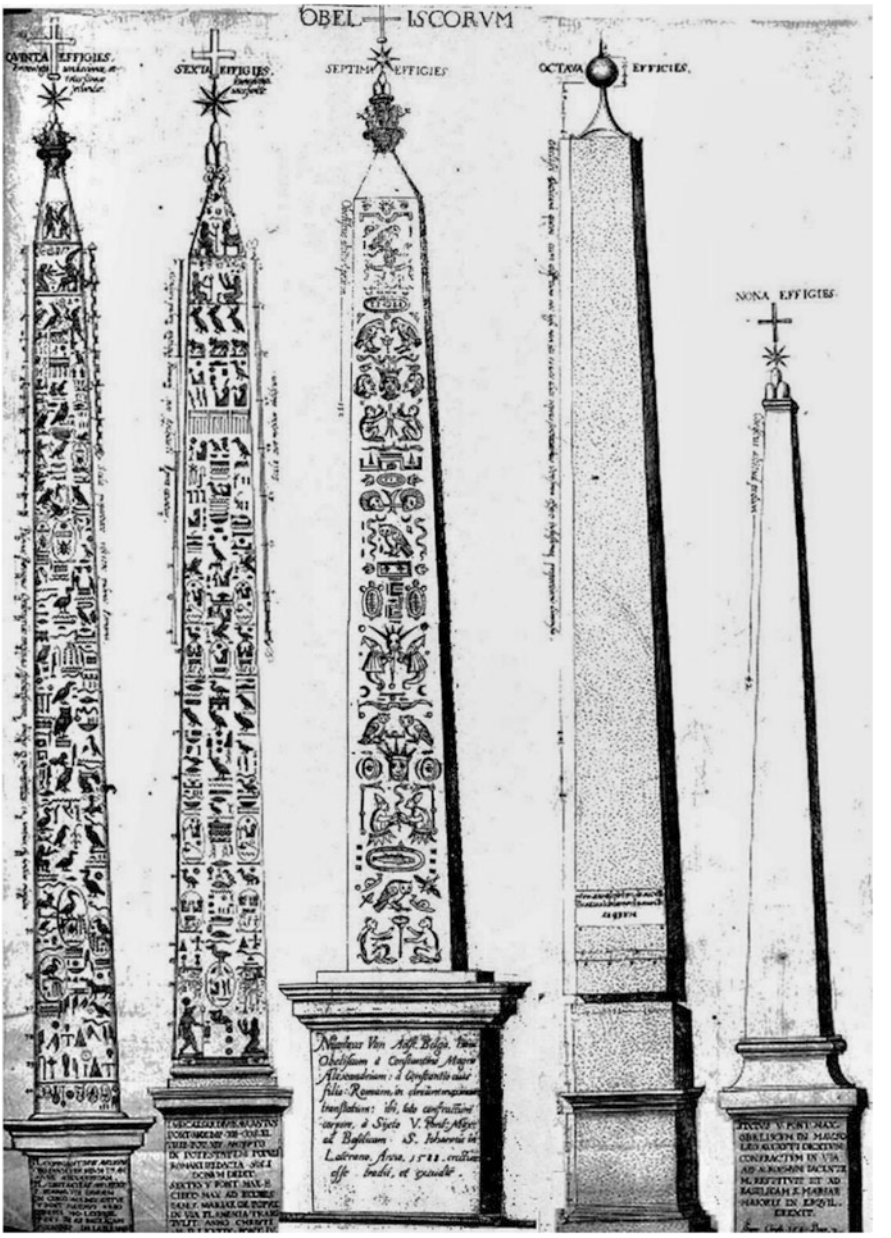
Once overcoming this blunder, Kircher goes on with his studies, thanks to the protection of Peiresc, who is still convinced, against all odds, that Kircher's work represents the most concrete solution to the mystery of Egyptian writing. The problem is that Kircher's superiors, on whom Peiresc can exert only a limited influence, have apparently decided that Kircher should go elsewhere. All Peiresc can do is that, instead of Vienna, Kircher be sent to Rome, a cultured city where he may fruitfully continue his researches on the Egyptian language.

Thus, Peiresc writes to the nephew of Pope Urbanus VIII, the powerful Francesco Barberini, and tries to illustrate the skills of the young Jesuit scholar, his "*ingeniousness, which made him discover many secrets and the main languages of Christendom*", the "*clocks reflecting sun rays through several mirrors*". Peiresc even declares himself "*at his service, and an admirer of his Genius and value, which is by far higher than the average*".[33]

Although Peiresc reaches his goal—namely Kircher is allowed to stay in Rome and is assigned the task of translating *Barachias Nephi*, the relationship between the two scholars remains the same. Namely, Peiresc tries to speed up the

[32] *Note de Peiresc Après la Visite du P. Kircher*, quoted in D. Stolzenberg, 2013, *op. cit.,* p. 77.

[33] N. C. Fabri de Peiresc to F. Barberini, 10 September 1633, in D. Stolzenberg, 2013, *op. cit.* p. 79.


OBELISCORVM
QVINTA EFFIGIES.
SEXTA EFFIGIES.
SEPTIMA EFFIGIES
OCTAVA EFFIGIES.
NONA EFFIGIES.

◀ **Fig. 8.2** Reproduction of some obelisks in Rome: in the middle, the obelisk of S. Giovanni in Laterano ("SEPTIMA EFFIGIES") (from Johann Georg Herwart von Hoenburg, 1608, *Thesaurus Hieroglyphicorum,* Bibliothèque Nationale de France). (The picture is here: http://gallica.bnf.fr/ark:/12148/btv1b2300699s.zoom.r=thesaurus+hieroglyphicorum.f3.langFR.) This is the picture used by Athanasius Kircher as his first attempt at interpreting the hieroglyphs. Unfortunately, the drawings on the obelisk are actually a fantasy. The inscription underneath tells the story of the obelisk, which is reported in detail by Giorgio De Sepi in his work *Musaeum Celeberrimum. "The Lateran obelisk takes his name from the nearby basilica of S. Giovanni in Laterano: this obelisk was ordered by Ramses, son of Sothis, king of Egypt… when they hoisted it on, it risked falling down, because of the weight of such a huge mass. Therefore, the king ordered that his son be tied on top of it, so that the need to save the royal child might make the architects more careful. It was later raised in Tebe, in the temple of the Sun, to which is was devoted until 334 a.C., at the time of the Emperor Costanzo, son of Costantine the Great… who took it away and sent it to Alexandria: however, fate disappointed the Emperor's wishes, Indeed, after the death of Costantine, the obelisk stayed for a long time in Alexandria, ignored by everybody. Later on Costanzo, heir of his father's glory, ordered to take it to Rome and hoist it in the middle of the Circo Massimo, where it stayed for a long time, until the Goths invaded Rome. At that point, it collapsed and lay down on the ground until Pope Sistus V, once he recognized its value, had it unearthed, and raised once again in the Piazza del Laterano* [1588]*, where we can still admire it now"*. (G. de Sepi, 1678, *op. cit.* p. 11, "*Obeliscus Lateranensis à proxima Lateranensi Basilica S. Joannis… nomen accepit, cuius Obelisci author fuit Ramesses Sothis filius, Rex Aegypti…Et quoniam res erat periculosa, ne in sublime elatus degravante tam enormi pondere prolaberetur, summo in apice proprium filium alligare jussit, ut vel sic conservandi Regii pueri causa attentiores redderet Architectos. Erectus porro fuit Thebis in templo Solis, cui consecratus persistit, usque a annum à Christo nato 334, tempore Constantii Imperatoris, Constantini Magni filii…Hunc itaque avulsum loco, Alexandriam devehi mandavit: verùm augustas cogitationes fata succiderunt, nam mortuo Constantino, diu Alexandriae ingloriosus jacuit, quem postea Constantius paternae gloriae haeres inde Romam deferri, & in circo maximo statui jussit, & stetit inconcussus, donec grassante Romae maximè furore Gothico collaptus est, ubi jacuit usque ad Sixti V bene ominata tempora, qui acceptis indiciis funditus subrutum reperit, repertum extrahi, & in campo Lateranensi, ubi hodie visitur, erigi jussit*").

publication of this translation, while Kircher keeps advancing excuses in order to explain his delay. Peiresc does not know what to do in order to convince Kircher. He keeps sending him all the books he considers useful for his task and offers to pay for the publication himself. However, Kircher merely promises Peiresc that he will publish the *Barachias Nephi* as soon as he has finished commenting on the hieroglyphs of four obelisks in Roma, an essay which—he assures—is practically ready.

It seems almost incredible that, just after such disappointing news, Peiresc, in his letters to various friends, keeps defining Kircher "*ce bon Pere*"*(this good Father)*, thus showing a fatherly affection for him. However, Peiresc will be disappointed again. In February 1635, Kircher informs poor Peiresc that, although he will soon finish the translation of *Barachias Nephi,* there is an unexpected obstacle: apparently, the essay contains the description of forbidden magical practices, so that its publication might be censured.

Peiresc is probably near to desperation and suggests publishing an expurgated version of the essay, were it only to warn good Christians about this danger. However, Kircher is inflexible and states that the safest way to avoid arousing the

suspicion of the Church censorship consists in inserting parts of the translation into an extensive book. This solution obviously postpones the publication of *Barachias Nephi* indefinitely.

Kircher, though not meeting Peiresc's request, does not miss this chance to ask him for a further recommendation to Cardinal Barberini, in order to get a privileged access to the Vatican Library. Needless to say that Peiresc immediately sends a letter to the Cardinal, dwelling upon Kircher's skills, and asking that he may be allowed to take a few manuscripts home, so as to be able to study them at leisure.

This infinite tug of war between Peiresc, who does everything he can to see this essay published, and Kircher, who clearly is in no hurry to complete this task, is concluded in a natural way on 24 June 1637, because Peiresc dies without the satisfaction of seeing one page of *Barachias Nephi*, apart from the index, which Kircher had shown him a few years earlier—one of his attempts at gaining yet more time.

Kircher never published the translation of this essay; several critics have wondered whether this work has ever actually existed. It is certainly strange that this essay has never been found, and it is puzzling that its contents sometimes are merely a support for Kircher's interpretation of some hieroglyphs. Following Daniel Stolzenberg,[34] however, we may consider that Peiresc, who had seen the essay, believed it possessed a certain value. It is therefore reasonable to suppose that the manuscript, though of an uncertain origin, really existed, even though it was probably a mere Arab translation of works written by several authors.

In any case, Kircher's passion for ancient Egypt is certainly authentic. He cultivated this passion for years on end, until he became a recognized authority in the field of the interpretation of hieroglyphs. In 1647, just after his election, Pope Innocent X decides to decorate Piazza Navona with an obelisk which—at the time—lay in pieces along the via Appia. In order to do this, the Pope consults the well-known Jesuit scholar.

Pope Innocent belongs to the Pamphili family. Their *palazzo* overlooks Piazza Navona; therefore, the Pope wants a work worthy of the place. Finally, he decides that, together with the obelisk, a fountain should be built, as the "mostra" (exhibition), i.e. the ending of the aqueduct of Acqua Vergine. They say that Bernini manages to obtain the order because he presents his project of the fountain to the powerful sister-in-law of Pope Innocent, Donna Olimpia. This woman, probably convinced by a model, made of solid silver, persuades the Pope to assign this task to Gian Lorenzo Bernini, who thus defeats his competitor, Borromini.

This may be mere gossip (even though Donna Olimpia was notoriously insatiable). Probably, Pope Innocent was simply struck by the magnificent project. However, the fountain is a real jewel of baroque architecture and brings out the

[34] D. Stolzenberg, 2004, PhD Dissertation, Stanford University, *op. cit.*, pp. 57–58. Most of the letters which illustrate the relationship between Peiresc and Kircher can be found in that exhaustive Dissertation.

obelisk, which the Pope had previously seen lying on the ground as he had visited the church S. Sebastian on the via Appia.

The Emperor Domitian had that obelisk built to celebrate his own ascent to the throne, just as the Egyptian religion, which he himself professed, was spreading in Rome. He had decided to place the obelisk in the Iseum, the area of Egyptian temples which lay between the Collegio Romano and the church of S. Stefano del Cacco.

At the beginning of the fourth century, Maxentius had the obelisk moved into the circus, which he had built along the via Appia, in honour of his son Romulus, who had died young. It was there that Pope Innocent saw it, broken in pieces; in giving new life to the obelisk, the Pope wanted to state the central position of Rome within the Christian world. If you say that the Catholic culture is a direct inheritance of ancient wisdom, this represents a courageous contraposition with the historiography of the Reform which, on the contrary, is by itself a break-off from the past. Kircher, who loved ancient Science, is given the task of assisting Bernini in retrieving the fragments of the obelisk, which is in poor conditions, and in rebuilding its missing sections.

This assignment is so important that Kircher writes about it years later in his autobiography, exaggerating the Pope's trust in him and defining the Pope himself a supporter of the mystery interpretation of hieroglyphs. Here is Kircher's account: "*Father*"—the Pope informs him—"*we have decided to raise an obelisk of remarkable dimensions: you will be in charge of giving life to those stones by interpreting what is engraved upon them. Therefore we want that, thanks to the skills which the Lord has given you, you bring to light the secrets and the innermost mysteries concealed in those pictures*".[35] These words push Kircher to complete his book on the interpretation of hieroglyphs, on which he had been working for more than 20 years; at this point, he is convinced that the mystery has finally been solved —"*…just like Ariadne's thread, availing ourselves of the help of analytical or combinatory science, through yearlong efforts and researches, in the end, accompanied by Our Lord, we have discovered the secrets of the hieroglyphs*".[36]

According to his congenial approach, Kircher faces the challenge by defining the historical context, starting from the moment in which the Pharaohs' religion pervades the Roman culture. He also tries to spot the area where Egyptian temples had been built in Rome. Relying upon the testimony of historians, such as Sextus Rufus, Vitruvius and Varro, Kircher correctly places the Iseum near Saepta Iulia, the wall which is still visible along the left side of the Pantheon.

Once identified the place, Kircher even undertakes the theoretical reconstruction of the Iseum (Fig. 8.3), which he realizes on the basis of Juvenal's tale,

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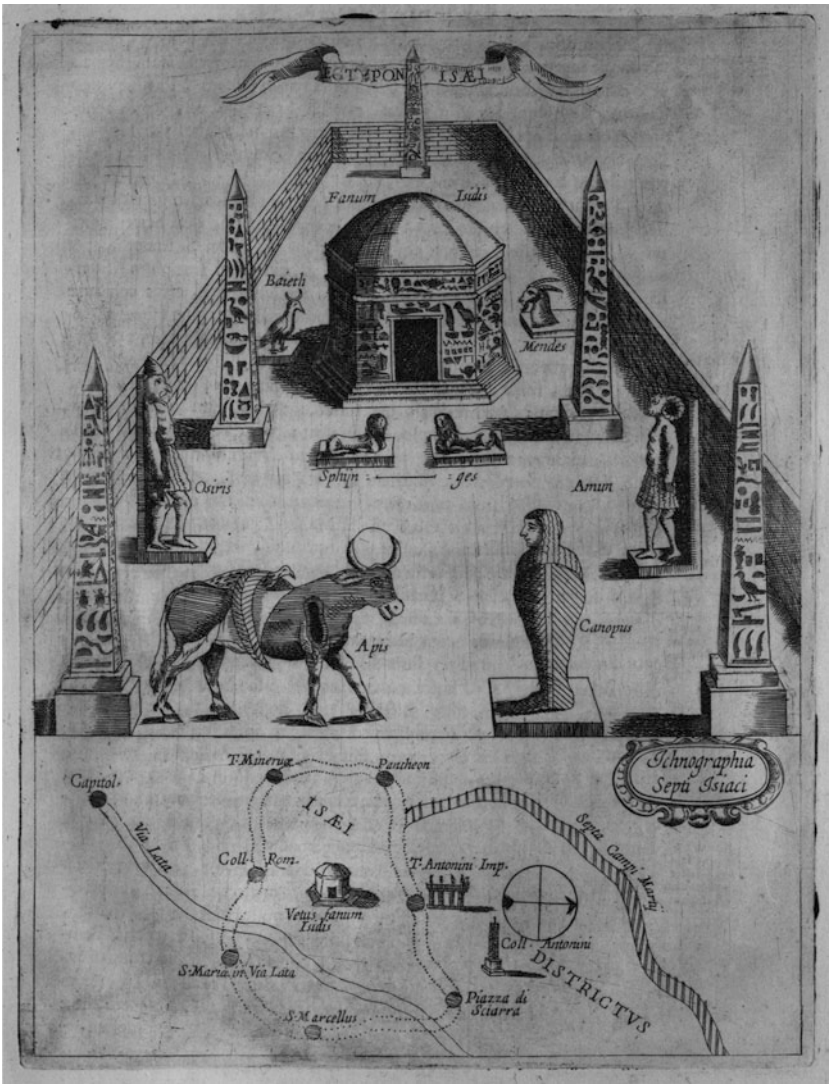
[35] A. Kircher, 1684, "*Vita Reverendi Patris Athanasii Kircheri Societatis Jesu", op. cit.* p. 57.

[36] A. Kircher, 1650, *Obeliscus Pamphilius.., op. cit. (Epistola, last page) "tamquam ad filum Ariadnae secutos, analytice seu combinatoriae artis subsidio, multorum annorum labore, & speculatione, tandem Deo duce, & doctore, in arcana & hieroglyphica sacramenta penetrasse"*.


ÆGYPTIORUM ISÆI
Fanum Isidis
Baieth
Mendes
Osiris
Sphyn ges
Amun
Apis
Canopus
Ichnographia Septi Isiaci
T. Minervæ
Pantheon
Capitol.
ISÆI
Via Lata
Coll. Rom.
T. Antonini Imp.
Septa Campi Martij
Vetus fanum Isidis
Coll. Antonini
S. Maria in Via Lata
DISTRICTVS
Piazza di Sciarra
S. Marcellus

◀ **Fig. 8.3** Imaginary Reconstruction of the Iseum: below, its possible location (from A. Kircher, 1666, *Obelisci Aegyptiaci nuper inter Isaei Romani rudera effossi interpretatio hieroglyphica Athanasii Kircheri e Soc. Iesv*, Romae, Ex Typographia Varesij, p. 7). The Egyptian faith had been spread in Rome starting from the I century BC. Isis was particularly worshipped, as the goddess who influenced human destiny. A large temple devoted to Isis was built in the area of Campo Marzio and was called "Iseo Campense" (Isaeum in the Field). Because of this temple, a few obelisks were found in Rome, together with the so-called Mensa Isiaca (Isis' table, also defined "tavola Bembina", from the name of Cardinale Pietro Bembo, who had bought it after its discovery, during the Sack of Rome in 1527), a table made of bronze, copper and other metals. Nowadays, we know that this table, made by the Romans, only contains Egyptian pictures. However, several authors, including Kircher, tried to interpret what they thought were hieroglyphs. The Iseum had ups and downs and was destroyed and rebuilt more than once. Its traces remained visible until the Middle Ages, as the last 28 granite columns left were used to build the central nave of the church of S. Maria in Trastevere. Kircher, on the basis of various witnesses, showing his deep knowledge of ancient authors, reconstructs both the structure and the location of the Iseum (the *Via Lata* on the map coincides with the current *Via del Corso*)

according to which the temple had been built on the model of the Serapeus of Memphis. Therefore, by following the Egyptian model, Kircher places a statue of the ox Apis at the entrance of the holy area and two sphinxes as guards of the shrine.

Although the task which Kircher receives from the Pope—giving advice to Bernini for the Egyptology of the work—it is clear that he also plays a fundamental role in the realization of the big allegorical machine constituted by the fountain: namely, the animals emerging from the cave—the basis of the fountain itself—the lion drinking under a palm, the rampant horse, the dolphin, the snake on the rocks and the armadillo—shaped as a drake. All these animals are listed in the Jesuit's report and remind us of Noah's Ark, whose plan is probably already in his mind at the time.

The work, which Innocent X commissions to Bernini, is included in the wider plan of the embellishment of Rome, which is being realized, notwithstanding the precarious economic reality of the State. In any case, the Popes appointed after the short period of strictness imposed by Sixtus V consider it their legitimate right to recover the money they have spent for their own election by privileging the enrichment of their own families. Less serious reasons had provoked revolutions, which were breaking out all over Europe: after the English Revolution of 1640 and the rebellion in Naples in 1647, there were more in Palermo, Granada and France, as well as in Cordoba, Seville, and Switzerland in 1648. However, in Rome, where the authority of the prince coincides with the religious authority, the economic crisis is actually transformed into a sort of financial miracle, based on the debts of an institution, namely the Church, which is essentially itself a guarantee for creditors, thanks to its millenary existence.[37]

It seems that the Rivers Fountain is not appreciated by the inhabitants of Rome, since, in order to pay for it, new hateful taxes are imposed—for instance, on bread

[37] E. Lo Sardo, 1999, *Iconismi e Mirabilia,* Roma, Edizioni dell'Elefante, p. 32.

Fig. 8.4 Frontispiece of *Obeliscus Pamphilius, hoc est, interpretatio Nova et hucusque intentata Obelisci Hieroglyphici ecc. (1650)*. This is the first book in which Kircher systematically handles the interpretation of Egyptian hieroglyphs, two years before the publication of Oedipus Aegyptiacous. The obelisk, knocked down by time personified, with a large sickle in his hands, and fame, represented by an angel in chains, standing for the oblivion in which the hieroglyphs engraved on the obelisk have fallen. Mercury, flying, shows a papyrus with a picture of the obelisk and indicates the hieroglyphs to a winged woman who, in the page "*Athanasius Kircher*" of the book of knowledge, notes down the god's explanations. The writing woman leans on four large volumes on Egyptian wisdom, Pythagoras' Mathematic, Greek Philosophy and Chaldean Astrology, which show the subject matters necessary to learn in order to study the hieroglyphs. To crown it all, there is a winged putto imposing silence: it represents Arpocrates and lays his foot upon a crocodile, a reference to the East and to the difficulties of this sort of studies

and wine. The popular protest is expressed through the "talking statue" of Pasquino who, as in all critical moments, starts talking through written messages, either adapting to the current situation one of our Lord's temptations: "*That these stones may become loaves of bread!*", or with satirical sentences—the so-called *pasquinate:* "*Neither steeples nor fountains, we only want bread, bread, bread!*".[38] When the Jesuits want to celebrate the unveiling of the Four Rivers' statues with an extraordinary distribution of bread at the Collegio Romano, the general opinion does not change since, because of the huge crowd of people, there were victims and casualties. In the month of June 1651 on the occasion of the final unveiling of the fountain, they protect it with a line of gendarmes to avoid that people may fill it with rubbish, out of rage.

The role played by Kircher in the realization of the fountain is certainly invisible for common people. Notwithstanding the protests, Kircher, as a "*master of a hundred arts*",[39] can peacefully complete the task which Pope Innocent has entrusted him, by publishing two essays on the interpretation of hieroglyphs, *Obeliscus Pamphilius* of 1650, and the much larger *Oedipus Aegyptiacous* of 1652. As usual, the frontispieces of these two books constitute almost a summary of the contents, in a somewhat repetitive manner. In Fig. 8.4, we can see the frontispiece of the first book.

In the frontispiece of *Oedipus Aegyptiacous,* Kircher is portrayed like Oedipus questioning a sphinx which wears a provocative, but reassuring smile. In the upper section of the picture, we can see two angels bearing ribbons, on which we can read words appearing in other works by Kircher: "*Reason, sense and experience*", to indicate the necessary attitude of the scholar as he faces the challenges of Nature. The two angels hold a book indicating the 16 languages used by Kircher in his studies. Underneath the book, we can see bookmarks belonging to the cultural tradition he refers to, namely Egyptian wisdom, Phoenician Theology, Chaldean Astrology, Jewish Kabbalah, Persian magic, Pythagoras' Maths, Mythology, Latin Philology, Greek Theosophy. These branches of learning show the necessary background of studies for the interpretation of ancient knowledge.

The reference to so many different cultures, the words "*sense*" and "*experience*", makes us understand that, when we talk about hieroglyphs, according to Kircher, we should not aim at a word-for-word translation but at the *interpretation* hidden beneath the symbols.

On the other hand, there is not yet a Rosetta stone, which could make us hope for an objective translation of the message. The only key available to Kircher for an interpretation of hieroglyphs is what he knows (or, better, what he thinks he knows) about Egyptian culture. The technique, which Kircher creates, is made up

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[38] G. Gigli, 1608–1679, *Diario Romano,* G. Ricciotti ed., Rome; Facsimile reproduction,1994, by M. Barberito, Colombo ed.; the Diary is quoted by *Francesco Cancellieri,*1811, *Il mercato, il lago dell'Acqua Vergine ed il Palazzo Panfiliano nel Circo Agonale detto volgarmente Piazza Navona,* Francesco Bourlieed ed., p. 58.

[39] Conor Reilly, 1974, *Athanasius Kircher: a master of a hundred arts, 1602–1680*, Studia Kircheriana, Wiesbaden: Edizioni del Mondo.

of four steps. The first step consists in organizing pictures of various kinds: animals (lions, doves, vultures, crocodiles, dogs, snakes and beetles) and plants (leaves, reeds, lotus and so on). There are also "mixed" pictures, such as men with animal heads, and geometric shapes (crosses, spheres, triangles and squares). The second step consists in organizing elementary pictures into a list, in which Kircher associates a parallel list of immediate meanings. The third step is the link between one picture and other meanings, either according to philological considerations or, more often, out of a mere logical deduction. For example, the picture of a lion is associated with the concept of a god, because when the Sun enters the sign of Leo, the river Nile overflows, bringing benefits to the land of Egypt.[40] The fourth crucial step, largely based on intuition, consists of attributing a meaning to compound hieroglyphs: a sphere, for example, may indicate "the world"; however, if the sphere is underneath a snake, the meaning is "animated world".

The fact that the same sign may assume different meanings is not a shortcoming of this method, but rather a positive feature, if the goal is conveying a concept coming from the Lord—which, as such, must contain the manifold resources of the world. The crucial point is the intervention of the interpreter who, in the case of Kircher, is full of knowledge, beliefs, certainties, experiences, which—all together—acquire an independent role in decoding the text.

At this point, we may wonder whether we may obtain an interpretation effectively related to the message the authors wanted to convey. In fact, Kircher must have had the same doubt, since he often feels the need to thank the Lord, the Virgin Mary and even his Guardian Angel, who have inspired him, until he has found a solution to the challenge he is facing. Kircher, according to his own reading technique, is convinced there are at least four ways—or better still, four levels of interpretation of an Egyptian hieroglyph: the first level is available to simple souls (who are indeed called idiots) who, while giving a literal interpretation to the stories told by the hieroglyph, only set up superstition and idolatry. The second level belongs to those who aspire at discovering mystic mysteries, even without suitable intellectual means. The third level of interpretation pertains to those who identify in the stories the rules of Ethics and Moral Theology. Finally, there are men who, starting from study and knowledge, manage to reach that mysterious Egyptian wisdom, which has been handed down to us in fragments.

Kircher is convinced he has finally managed to put together the fragments of Egyptian knowledge. This conviction (over and above the request of Pope Innocent) gives Kircher the necessary boost to venture for the first time in the interpretation of the long sequence of hieroglyphs engraved on the four sides of the Obelisk in Piazza Navona.

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[40] A. Kircher, 1650, *Obeliscus Pamphilius.., op. cit.*, p. 283.

[41] Translation of the side which Kircher identifies as "Lateris II australis" (*Obeliscus Pamphilius,* p. 444) can be found in D. Stolzenberg, 2013, *op. cit*., p. 200.

Starting from the side which Kircher identifies as the eastern face (which is actually the southern face), he ignores the fact that the commemorative text means no more than "*To the Emperor Domitian, loved by the gods*".[41] However, even if he knew this, he would probably still insist on giving his own solutions, convinced that the text of a hieroglyph, particularly at its deepest level, cannot possibly be so banal.

Kircher's translation is therefore much longer than that. The interpretation of the so-called eastern side, for example, goes: "*To the Threefold god Hemfta, prime Mover of everything, friend of the world, multiform spirit; eternal trinity, without start and ending; origin of inferior gods. This deity, from his solitary Monad, spread from the centre and from the top in the width of the mundane pyramid, thanks to his goodness, offered itself to the intelligible world of the gods ruling the East; these gods, being given the features of the threefold deity, are appointed lords of the threefold World. The highest in order, Genius of its Choir, hands down to the nether world, with a continued influence, the truth of Hemfta, through the Asecli Geniuses, who obey its orders. Thence comes the variety of all things, which are born and die, in order to be born again, the origin in the nether world; thus is fulfilled human happiness, a model for the priests to propose in their rites. Hemfta, from the centre of its monad, inside the dyad, and thence through the triad, namely the Angelical Minds in the tryad of the world—the sensible world immersed in the sidereal world:* (Hemfta) *entered in communion with the supreme god Osiris, who rules the solar world. Osiris, soul of the sidereal world, thanks to the virtue transmitted* (by Hemfta)*, prime mover of the skies, with the support of visible gods (planets) enlivens, fecundates and enriches the Universe, imprinted by the character of the Threefold God.*

The monad diffused through the dyad in the triad and thence in the tetrad, which would be the elementary world, propagates in it, through the powerful Agathodemone its threefold diffusion and strength in the threefold aspect of the elementary world, namely the Ilei Worlds; thence descending in the Sphere of generation, as distinct in the quintuple order of the Entities, thus stimulates anything to generation, fecundity and full bloom. Finally, after satisfying its circular impulse of goodness, from the baser mixture of material worlds, it goes back to its solitary monad, as a Deity which everyone should adore with divine worship and honour".[42]

On the other hand, the "western" side, according to Kircher, is devoted "*To the threefold god Hemfta, Mover of all things, Mind full of ideas, spirit with a thousand shapes; to the trine, the eternal, which knows both start and end; to the origin of second gods. This god spreads from its solitary Monad, from the centre and from the top towards the width of the mundane pyramid, thanks to its own goodness, offers itself to the intelligible world of second Geniuses, ruling on the West, with supreme ministers under a higher guide; the latter decorated with the intrinsic features of the Archetype's essence, spreads virtue, communicates with the second Geniuses—the Sun and the Moon, which deviate the acquired influence*

[42] A. Kircher, 1650, *Obeliscus Pamphilius.., op. cit,* p. 435.

towards the inferior order of the nether world in the West, in different ways give instructions on the symbols, the attitude to adopt in the propitiatory sacrifices, how to disperse adversities and propitiate benignant forces, as it should be. From these, virtue moves to the sidereal world, where Osiris , the Sun-God, who can be perceived by the world, fecundates everything with its virtue; (Osiris), true sensible soul of the world, guides, rules, and indicates the way, sets everything in motion, gives life, enriches and fertilizes everything through the character imprinted by the threefold god; transfers virtue to the elementary world, in which it spreads towards the West. In this part of the elementary world, Anubis and Isis are affected by the sky, and take care of the remaining tasks, so that they follow the fertility of the river Nile, the beneficence and benignity of the gods. As a consequence, the abundance of all necessary goods, necessary for human happiness, is spread all over Egypt".[43]

The other two sides of the obelisk express similar concepts, which go back—with clearly neoplatonic and magical hints—to a Universe created by a triune god, who uses minor deities to convey his positive influence to the material world.

Following Shakespeare, we may say "*Though this be madness, yet there is method in 't*'" *(Lord Polonius, Hamlet, act 2, scene II).* Doubtless, Kircher's feat of producing a few pages of translation from a short dedication raises some doubts about the author's soundness of mind. Kircher, conscious of the possible scepticism provoked by his work, indicates—for more than 400 pages—all the techniques he uses in the interpretation of hieroglyphs. Moreover, at the bottom of a couple of his "translations", he explicitly recommends the readers that they "*examine the preceding pages and the individual hieroglyphs*"—in order to understand how he reached that result.

Naturally, these invitations would not suffice to make his interpretation credible. However, a few years later, in 1665, an event took place, which still intrigues scholars and, by increasing Kircher's credibility, fills him with pride.

A small obelisk was found in the vegetable garden of the Dominican fathers of S. Maria sopra Minerva, and this was yet one more proof that the Iseo Campese was once here. Kircher, who works at the Collegio Romano, about 200 meters away, is obviously intrigued by this find, but since he is going to leave for his annual religious retreat, he asks one of his disciples to keep him informed. The rest of the story is told by this assistant, Giuseppe Petrucci who, in his tale (in Italian in the original text), conveys all the enthusiasm and the admiration he feels for his master: "*While they were excavating in the vegetable garden of the Reverend Fathers of the Minerva, they found by chance an obelisk, which appeared smaller than all the others, but whole, and almost perfect. They asked Father Kircher, an expert in these matters, whether he could tell them something about it; however, since he was leaving for his annual mission to the Madonna della Mentorella, he asked me, as soon as the obelisk was entirely exposed, to send a drawing of it to Tivoli, where he would stop during his journey. However, I could only draw three*

[43] A. Kircher, 1650, *Obeliscus Pamphilius.., op. cit,* p. 447.

sides of the obelisk, since I did not want to delay my task. In the end, I only sent him a copy of them. Kircher answered with a drawing of the missing side, and anyone—even scholars—who saw this drawing were greatly astonished. As I saw this unexpected drawing, amazed and curious, I went immediately there to see whether the drawing corresponded to the original, and I did find out they were identical. Moreover, in those spots where pictures were missing, Kircher had provided the original ones…".[44]

In sum, Kircher manages to guess the missing hieroglyphs on the fourth side of the obelisk, starting from the three known sides: if anyone had doubted Kircher's skill in understanding the meaning of the hieroglyphs, there could not be a better proof!

That is why we are surprised by the rest of Petrucci's story. Indeed, he recalls that, about this episode—"*there were a few incredulous people. However, hatred slows down the mind…if they had heard the praises received by Father Kircher, and had seen his reconstruction of the fragments of the 'Obelisco Panfilio', they would not even open their mouths…*".[45]

This is not the first time that Kircher must defend himself against scepticism and slander, which, notwithstanding a certain number of indisputable acknowledgements, have accompanied him throughout his life. However, Father Athanasius does not seem to pay much attention to criticism. On the other hand, his assistants defend his public image by relating a number of episodes and circumstances, which show he is surrounded by respect and esteem. For instance, Kaspar Schott recalls Kircher's good knowledge of Eastern languages, which enabled him to speak—in their own languages—with Greeks, Hebrews, Arabs and foreigners from both Asia and Africa. In particular, Schott wants to dismantle the charge of lacking the capacity for criticism, by recalling the meticulousness with which

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[44] A. Kircher, 1666, *Obelisci Aegyptiaci nuper inter Isaei Romani rudera effossi interpretatio hieroglyphica Athanasii Kircheri e Soc. Iesv*, Romae, Ex Typographia Varesij, p. 4, *"Scavandosi nell'orto dei Reverendi Padri della Minerva, portò il caso che fosse ritrovato un obelisco, il quale quanto appariva inferiore nella grandezza a tutti gli altri, altrettanto appariva più perfetto e più intero. Al Padre Atanasio Kircher, competente su queste faccende, fu richiesto che ne desse piena contezza; ma capitava che dovendo compiere la sua annuale missione alla Madonna della Mentorella, lasciò a me l'incarico che, appena fosse stato completamente scoperto, ne inviassi un disegno a Tivoli, dove egli si sarebbe fermato. Accadde che solamente tre lati si potessero disegnare, per cui essendo io impaziente di non ritardare la missione che mi era stata affidata, inviai copia soltanto di quelli. Nella risposta fattami dal Padre, con grande meraviglia di chi vide, e di molte persone di dottrina non ordinaria, mi mandò il quarto lato, disegnato di proprio pugno. A vista cotanto inaspettata, stupefatto e curioso corsi di subito a vedere se corrispondeva con l'originale, e rinvenni essere il medesimo contenuto, senza segno di variazione alcuna, anzi in quei luoghi dove non v'erano scolpite figure, Egli supplì, con espormi ciò che mancava…".*

[45] *Ibidem, "…vi fu più di uno che mostrò incredulità. Ma l'odio rende caliginoso l'intelletto…e se costoro avessero visto gli elogi che Padre Kircher ha ricevuto e le testimonianze sulla sua capacità di ricostruire i frammenti dell'Obelisco Panfilio, non avrebbero il coraggio di aprire bocca…".*

[46] K. Schott, in A. Kircher, 1652, *Oedipus Aegyptiacus. Hoc est Universalis…* Romae, Typographia Vitalis Mascardi, p. II, section "*Benevolo lectori*".

Kircher checks his sources and frequently asks his students to go and verify the accuracy with which they copied a hieroglyph, so that his interpretations of ancient texts are rigorously based on the originals.[46]

Following this critical rigour—his affectionate student continues—many antiquarians, princes and curious people have consulted with Kircher and submitted both holy and profane inscriptions, engravings on stone, as well as manuscripts on parchments, amulets, etched blades, coins, ancient books nibbled by insects or gnawed by rats, and they always obtained a solution. Doubtless—Schott continues—Kircher has translated such a high number of documents that, if they were all put together, they would occupy much more than a single volume. Moreover, when someone happened to try and cheat his master, submitting to his attention a fake manuscript, they had to go off shamefaced, because Kircher immediately realized the fraud and unmasked its author.

Of course, such a list of passionate, though sincere, praises sounds like a defence against scepticism which, often with poisonous irony, circulates in the contemporary cultural ambience. On the other hand, Kircher is doubtless a resourceful scholar, who keeps revealing surprising skills. For instance, once a "*cultured nobleman arrived at the Collegio Romano from a far-away land, bearing a gem, which he had found in Assisi during the construction of a church, on which a few Greek characters had been engraved. The man had already shown the gem to scholars of ancient Greek all over Italy, and no one had been able to understand the meaning of that inscription. The gem was therefore brought to Kircher, who, at the presence of Schott, immediately explained that it was a Gnostic Amulet. The characters had to be read in association with the numbers, and Kircher took his pen, and transcribed at once the interpretation of the contents*".[47]

Kircher is constantly pushed by the wish to show off his own remarkable culture and is willing to face the most difficult challenges, but he is also convinced that the Lord has endowed him with an intellect capable of understanding the mystery of creation and feels he must share this deep satisfaction with other people. The satisfaction is even greater if he manages to make a *coup de theatre,* such as guessing the contents of the hidden face of the obelisk of the Minerva, which, because of a series of circumstances, is becoming the most popular of the city.

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[47] *ibidem,* p. VI section "*Benevolo lectori"*, "*Vir nobilis & eruditus è regione longinqua venit ad Collegium nostrum Romanum, & evocato uno ex Patribus eiusdem regionis ostendit ipsi gemmam arcanis notis, & Graecis characteribus insignitam, atque Assisij è terra erutam, dum pro templo quodam novo fundamenta collocabantur; rogavitque ut Domino Athanasio Kirchero interpretandam offeret…Addidit, illam se gemmam in omnibus Italiae Urbibus ostendisse Viris doctissimis… omnesque respondisse, characteres quidem esse Graecos, at voce esse peregrinas, ac sibi ignotas… ad Kircherum esse recurrendum… Adfertur Kirchero gemma me praesente; qui statim respondit, gemmam Amuletum esse Gnosticorum… & arrepto calamo resolvit literas in numeros, sensum patefecit, interpretationem authoritatibus stabilivit…".*

The interest in the small pink granite obelisk, in fact, would probably have been confined to the circle of scholars specialized in ancient civilizations, until Pope Alexander VII, a lover of Egyptian history, decided to raise it in a square in Rome and asked Gian Lorenzo Bernini, the most famous architect at the time, to plan its base. For Bernini, this is a unique chance, because the plan had already been prepared for Francesco Barberini, nephew of Pope Urban VIII, who had commissioned from him in 1632, when he had decided to erect an obelisk in the garden of his *palazzo* in Via delle Quattro Fontane.

As, 30 years later, they found the obelisk of the Minerva, only three parts of the original expensive plan of Francesco Barberini had remained: the obelisk (which lay down in the garden of the palazzo until it was raised on the Pincio in 1822), the presence of Athanasius Kircher (who had been called to Rome to decipher the inscription upon that obelisk) and Bernini's plan, namely a small elephant on which the stele should be erected. An ideal situation, after all, so that Pope Alexander immediately accepts what the Dominican fathers are asking: namely, that the obelisk may be raised in the square in front of their monastery. The pope commissions to Bernini the realization of an elegant monument, which consists of a small elephant bearing the obelisk on its back. Father Kircher, who has already demonstrated his knowledge of Egyptian hieroglyphs, takes care of interpreting the inscriptions and reconstructing its missing parts, thus renewing his collaboration with Bernini, which had been well tested during their common work on the obelisk of Piazza Navona.

The Dominicans, however, think they have the right to express their opinion on the architecture of the monument. Since they have no other arguments, they express their doubts on its stability: the obelisk—they claim—weighing upon the elephant might make the whole fall down. Naturally, Bernini reacts against such a gross criticism, which ignores the fact that he himself placed the "Obelisco Pamphilio", which was much heavier than this, upon the empty grotto of the Rivers Fountain in Piazza Navona. However, this has become a matter of principle, and the Dominican Order is so powerful that Bernini, together with Pope Alexander VII, must give up and place a horrible stone support underneath the elephant, though badly masking it with a saddle cloth on the back of the animal.

They say the architect got his revenge for the stupidity of the Fathers by placing the elephant with its back to the monastery, and moving the tail, so as to signify its irreverence. However, this argument makes the monument very popular, and as a consequence, Kircher also becomes well known as the supervisor of the realization of the monument, as anticipated in the *Obelisco Alessandrino (Obeliscus Alexandrinus).*[48]

The popularity acquired by the obelisk emphasizes the *coup de théâtre* which Kircher had realized, probably with a bit of luck—certainly with good insight, by

[48] With this name, they normally refer to A. Kircher, 1666, *Obelisci Aegyptiaci nuper inter Isaei Romani rudera effossi interpretatio hieroglyphica Athanasii Kircheri e Soc. Iesv*, Romae, Ex Typographia Varesij.

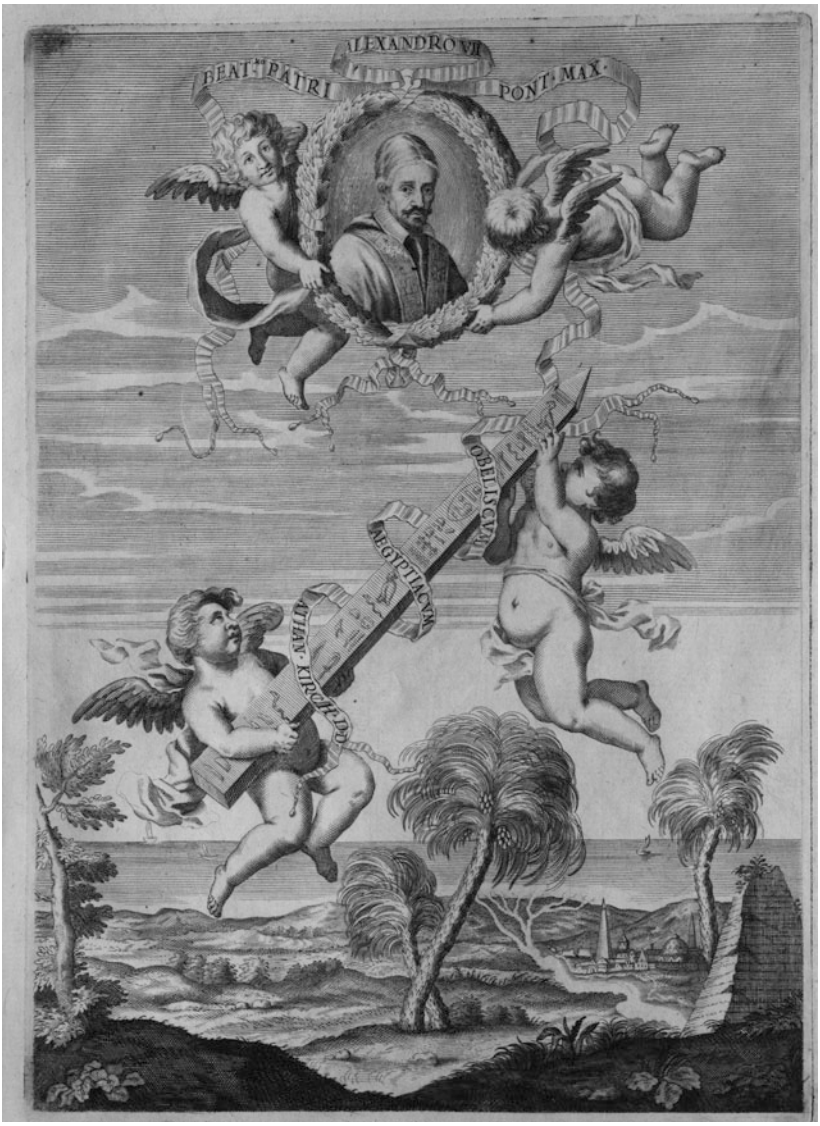

Fig. 8.5 Frontispiece of *Obelisci Aegyptiaci nuper inter Isaei Romani rudera effossi interpretatio hieroglyphica Athanasii Kircheri e Soc. Iesv* (1666). We can make a comparison between this frontispiece and the "*Pulcino della Minerva*", as Bernini's elephant was called, in order to show the contribution of Kircher in planning the monument for the obelisk of the Minerva, which was realized the year after the publication of the *Obelisco Alessandrino*. The portrait of Pope Alexander VII, who dominates the engraving, has the same celebratory role of the coat of arms of the Chigi family, namely six mountains and a star, placed on top of the obelisk. The exotic city, with pyramids and domes, in the lower right side of the page, recalls Egyptian wisdom, whereas the ruin in the foreground suggests antiquity. In the monument of the Minerva, this reference to ancient wisdom is entrusted directly to two inscriptions on the base, which have been dictated by

◀ Pope Alexander himself. Here is the first sentence, tracing the continuity between Egyptian and Christian wisdom: "*This ancient Obelisk, monument of the Egyptian Pallas, excavated from the ground and erected in the square of Minerva, now devoted to the Mother of God, Alexander VII dedicated to the divine Wisdom in the year of Christian salvation 1667*". The second sentence recalls the force of the elephant as a symbol of the power of papacy: "*Whoever you are, you will see in the obelisk the sculpted figures supported in Egypt by the elephant, the strongest animal; you should know that a strong mind feeds a solid wisdom*" (First inscription (capital letters in the original)"*VETEREM OBELISCUM PALLADIS AEGYPTIAE MONUMENTUM E TELLURE ERUTUM ET IN MINERVA OLIM NUNC DEIPARAE GENITRICIS FORO ERECTUM DIVINAE SAPIENTIAE ALEXANDER VII DEDICAVIT ANNO SAL. MDCLXVII*"; second inscription "*SAPIENTIS AEGYPTI INSCULTAS OBELISCO FIGURAS AB ELEPHANTO BELLUARUM FORTISSIMA GESTARI QUISQUIS HIC VIDES DOCUMENTUM INTELLIGE ROBUSTAE MENTIS ESSE SOLIDAM SAPIENTIAM SUSTINERE*".). The eastern landscape of the frontispiece introduces us to the philosophical background of the interpretation of hieroglyphs, just as the obelisk represents the action of God upon the Universe

drawing the content of the fourth side of the obelisk. With hindsight, we are not so surprised, because we know that an obelisk played essentially a celebratory role; therefore, one might expect conventional and repetitive inscriptions on its four sides, as Kircher himself had ascertained when he had studied the four sides of the *Obeliscus Pamphilius,* and drawn the similar texts we saw above. The astonishment Kircher wants to rouse, however, makes him an archetype of the baroque scientist, who considers wonder as the first step of curiosity and therefore encourages us to pursue knowledge. Revealing the contents of the fourth side of the obelisk, in any case, is the proof—according to Kircher—that he has reached the highest level of mastery of the mysteries hidden by the hieroglyphs, which he wants to hand down in the *Obeliscus Alexandrinus.* In Fig. 8.5, we can see the frontispiece of the book.

This is one among the most elegant of Kircher's books. It is finely illustrated, rich in references which he has used for the symbolic interpretation of the hieroglyphs, as well as of the obelisks, which assume themselves a learned meaning. If their pointed shape recalls the origin of the world and God Himself, the four sides represent the Nature diversified in various manifestations. This means that God's influence passes from archetypes through the mind to the stars, up to the elements. The human history which Kircher outlines in the Obeliscus Alexandrinus begins from the Pharaohs and, passing through the Roman Emperors, gets to the Popes, so as to underline the continuity between the Imperial and the religious power, and, in a sense, between the authors of the hieroglyphs and Kircher himself, their interpreter.

Kircher was convinced he held the key for the interpretation of hieroglyphs: this absolute trust actually brought him to ignore the elements which did not agree with his theoretical framework, as well as to exaggerate the role of other elements which supported his hypothesis, thus provoking, in the end, a victory of prejudice over data.

For example, Kircher considers the presence of god absolutely necessary in the cusp, since the cusp recalls the origin of the world. This god, according to Kircher,

is represented by the golden scarab with open wings, defined by him in *Pamphilius* the "*Threefold God Hemfta, Mover of all things*". However, the scarab does not appear in the *Obeliscus Alexandrinus*: Kircher, rather than accepting this fact, concludes that, though that hieroglyph is not there, the author wanted to sculpt it, as it is clear from the sentence in the lower left side of Kircher's picture reproduced in Fig. 8.6 (left), "*Obeliscus imperfectus est*", and it would have been there, if only the obelisk had been finished.[49]

As a further example of the prejudice prevailing on the data, Fig. 8.6 shows the difference between the picture of the obelisk as it has been found, and the picture Kircher uses for his interpretation.

With such certainties, there is always the risk of altering the meaning, as it does happen. However, it would be wrong to think that Kircher does not make the utmost effort to support his interpretation upon objective elements. Rather, Kircher tries to apply to the inscriptions on the new obelisk the same rules he has already explained in his preface to *Obeliscus Pamphilius* and starts his work with renewed energy and a somewhat unusual modesty.

These rules push Kircher to interpret the sentence "*Shining gold, you who make two countries flourish, son of the Sun—Uahabra from Neit, the country of the bee in southern Egypt, beloved eternal giver of life, like the Sun*",[50] which celebrates pharaoh Uahabra in the northern side of the Alexandrine Obelisk, in the following way: "*Hemphta, supreme archetype spirit, infuses its virtue and presents into the soul of the sidereal world, namely the solar spirit subject to it, from which the life motion comes for the material or elementary world, together with the abundance of all things and the variety of species. It flows unceasingly from the fructification of Osiris basin, attracted by some marvellous sympathy. It is strong because of its twofold domain. Chenosiris who sees everything, is also the guardian of the holy canals, which constitute the dampness in which all life develops. The good demon Ophion, to whom this table is devoted in order to obtain his favours and the propagation of life, for his benevolence, with the assistance of the humid demon of divine Osiris Agatho, the seven towers of the sky and the fortress of planets are protected from all adversities. Therefore, to this goal his picture must be shown during rites and sacrifices. The left hand of Nature or Hecate's spring, or circulation, i.e. Nature's breath, evoked through sacrifices. Attracted by these, the demon Polymorphus spreads the generous variety of things into the world of four natures. The deceptive tricks of Typhon are defeated when the happy life is maintained; that is why he bears these pentacles or amulets, since they are made upon his mystic basis. Therefore, they are powerful, so as to obtain all the good things of a pleasant life*".[51]

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[49] A. Kircher, 1666, *Obelisci Aegyptiaci…, op. cit.* p. 23.

[50] O. Marucchi, 1898, *Gli Obelischi egizi di Roma,* Roma, Loescher&C, pp. 115–125, in C. Marrone, *op. cit.*

[51] A. Kircher, 1666, *Obelisci Aegyptiaci…, op. cit. p. 78, Specimen lectionis idealis*.

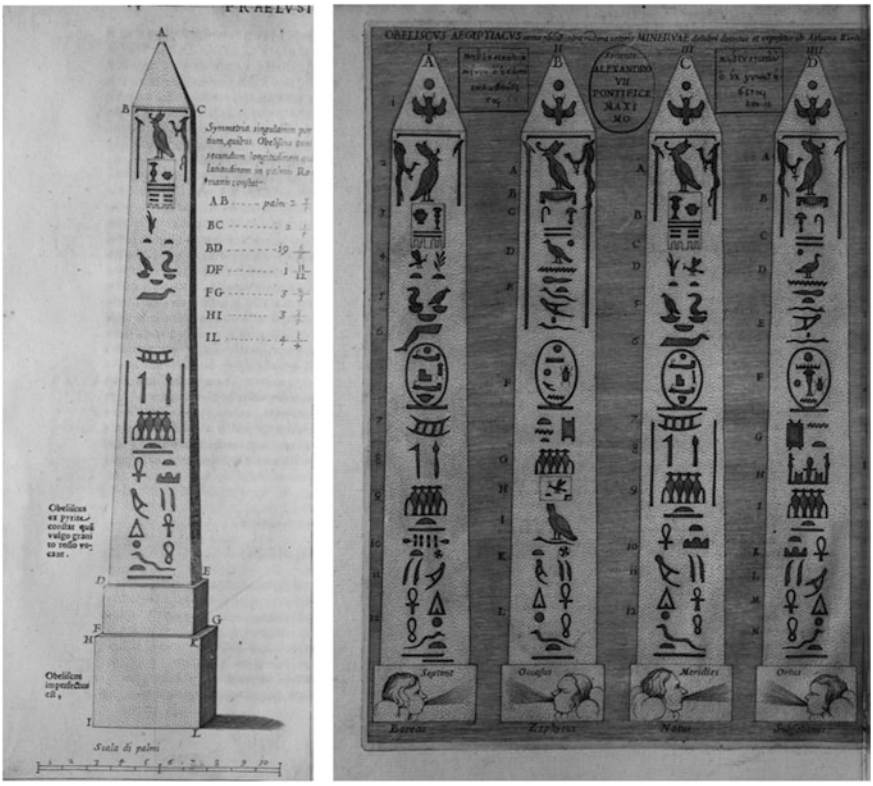

Fig. 8.6 *Left* Eastern side of the Alexandrine Obelisk. *Right* Reconstruction of the hieroglyphs on the four sides, according to Kircher (A. Kircher, 1666, *ibidem, p. 14 (left), p. 22 (right)*). Note that in the reconstructed eastern side, there is an ellipse in the middle, which does not appear in the picture on the left, but can be inferred from the sign in the southern side. The "reconstruction" takes place through a logical deduction, since Kircher ignores that the oval represents the pharaoh's name, which was cancelled later. This cancellation is a rough job, since the pharaoh's name is still partially visible in the western side. The figures representing the winds, in the base of the obelisk, are mere decorations, which do no longer exist in the monument

What strikes us most here is not so much Kircher's unfaithfulness to the real text, as his will to go on with the interpretation of hieroglyphs, even when their theological contents do not seem so deep.

Probably, Kircher, in a world where modern science inexorably prevails despite the resistance of courts, stakes and inquisition, is forced to cling to the authority of the ancient world, even when it is a mere ghost. Doubtless Kircher represents the old world which is going to fade away, but still brings its own contribution to the new world which is coming up. The question of the interpretation of hieroglyphs is significant: Kircher's ideological and fanciful solutions contain a wealth of insight, just like the reference to Coptic, and to the languages deriving from archaic Egyptian, which will allow the real translation once the Rosetta stone is available.

Kircher therefore overcomes the idea of Ficinus and Pico della Mirandola—namely transcendent truth can be found through esoteric practices—rather, he puts himself in the place of a curious antiquarian, who makes good use of his own knowledge to decipher astonishing ancient writings.

Chapter 9
Crystal Skies and Circles of Hell

I think that in disputes about natural problems, we Should not start from the authority of passages from The Holy Writ, but rather from the experience of the Senses and from the necessary demonstrations

G. Galilei

Letter to Madama Cristina di Lorena Mi par che nelle dispute di problemi naturali non si dovrebbe cominciare dalle autorità di luoghi delle Scritture, ma dalle sensate esperienze e dalle dimostrazioni necessarie

At 70, Galileo is worn out, though he is working on his last essay, *Discourses and Mathematical Demonstrations relating to two New Sciences,* which is nowadays considered his scientific masterpiece.

There are valid reasons to think that, in that period, Galileo must have been reminded of his youth, just after the publication of *The Little Scales*, when he had studied the shape and dimensions of Dante's Hell, on the request of the Accademia Fiorentina (Florentine Academy); this study was very important for his academic career.

The Accademia Fiorentina, together with the Accademia del Disegno (Academy of Drawing), was the institution which, in the middle of the sixteenth century, gathered the most famous scholars of Florence. Both Academies had been established by Duke Cosimo I, with the specific task of glorifying the history of the city, while linking it with the Medicis. We can therefore imagine the emotion the young Galileo must have felt when the Accademia Fiorentina had invited him to hold "*Two lessons on the figure, location and dimensions of Dante's Inferno*", in December 1588.

The question, which had dragged on for more than a century, concerned the dimensions of *Inferno* as they can be deduced from the analysis of the Dante's *Divine Comedy (Divina Commedia),* but had also enlarged to the defence of Dante as a native of Florence, and had therefore entered the sphere of competence of the Accademia Fiorentina. Probably not by chance, the first person who had wondered about the realism of Dante's poetic construction had been an architect, the young Filippo Brunelleschi, who, as Giorgio Vasari writes, "*in this period devoted a long time to Dante's descriptions, and he understood very well both places and measures*".[1]

[1] G. Vasari, 1550, *Vite de' più eccellenti pittori, scultori e architetti*, G. Antonelli ed. 1848, Tomo IV, p. 440.

R. Buonanno, *The Stars of Galileo Galilei and the Universal Knowledge of Athanasius Kircher*, Astrophysics and Space Science Library 399,
DOI: 10.1007/978-3-319-00300-9_9, © Springer International Publishing Switzerland 2014

The problem assumed a particular relevance because of the changed perception and representation of space, which was spreading in Florence in the fifteenth century, and allowed to read Dante's *Inferno* through a different key, which was no longer only religious and ethical, but also realistic. That is why the first florentine edition of the *Divina Commedia*, celebrated by the Medicis as a repossession of Dante on the part of the city, includes inside the *Proemio,* a commentary by Cristoforo Landino,[2] and a paragraph devoted to the "*site, shape and measure of Hell, as well as to the height of the giants and of Lucifer*", in which he alludes to the essays of Antonio di Tucci Manetti, friend and biographer of Brunelleschi.

An edition of the *Commedia* had been published in 1544 with a commentary by Alessandro Vellutello, born in Lucca, who in the book *Descrittione de lo inferno* overturned the conclusions of Landino, charging him with unfaithfulness to Dante's text.[3] Not by chance, this edition had been printed in Venice and therefore represented an explicit disowning of Manetti's authority, as well as of the authority of the whole Accademia Fiorentina, to which he belonged, in the interpretation of Dante's texts.

In this context, Galileo is entrusted the task of protecting the prestige of the Accademia by defending Manetti's reasons, which at this point had become Florence's reasons. Galileo, though not yet 25 years old, faces the challenge with a remarkable skill, starting his first lesson with an impartial analysis of Manetti's thesis (as exposed by Landino), in comparison with Vellutello's one, "*two scholars have written more extensively about this topic: Antonio Manetti and Alessandro Vellutello: their commentaries are different and obscure: this is not their fault, since their subject matter is difficult*".[4] However, as Galileo goes on with his analysis, his tone becomes more and more sarcastic towards the arguments of Vellutello "*…this is the invention which Vellutello liked, and made him laugh of both Manetti and the whole Accademia Fiorentina. Namely, Vellutello says that the Inferno of Manetti is a fantasy, common to the whole Accademia, and different from Dante's idea…*". Finally, Galileo ridicules Velutello completely by the end of the second day "*this does not really matter for our main goal, which consists in explaining the place and figure of Dante's Inferno, as well as defending*

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[2] C. Landino, 1481, *Comento sopra la Comedia*, Firenze, Nicolò di Lorenzo della Magna.

[3] A. Vellutello, 1544, *La Comedia di Dante Aligieri con la nove espositione di Alessandro Vellutello*, Venezia, Francesco Marcolini da Forlì.

[4] G. Galilei, 1588, "*Due lezioni all'Accademia fiorentina circa la figura, sito e grandezza dell'inferno di Dante*", http://www.liberliber.it/biblioteca/licenze/, p. 1, "*due sono che più diffusamente ne hanno scritto: l'uno è Antonio Manetti, l'altro Alessandro Vellutello, ma però questo da quello assai diversamente, e l'uno e l'altro molto oscuramente, non già per loro mancamento, ma per la difficoltà del suggetto*".

[5] *ibidem*, pp. 10–13 "*…e questa è l'invenzione che tanto è piaciuta ad esso Vellutello, che l'ha fatto ridersi del Manetti ed insieme di tutta l'Accademia Fiorentina, affermando, l'Inferno di esso Manetti esser più tosto una fantasia ed un trovato suo e degli altri Accademici, che cosa che punto sia conforme all'intendimento di Dante…*", "*non molto importa al principale intendimento nostro, che è stato di dichiarare il sito e figura dell'Inferno di Dante, ed insieme difendere l'ingegnoso Manetti dalle false calunnie ingiustamente sopra tal materia ricevute, e massime perché non lui solo ma tutta la dottissima Academia Fiorentina pungevano, alla quale per molte cagioni obligatissimo mi sento*".

the ingenious Manetti against false calumnies, which he unjustly received about this matter, mainly because they attacked Manetti, together with the cultured Academia Fiorentina, towards which I feel obliged for several reasons".[5] These words probably caused a great satisfaction to the florentine audience.

Unfortunately, in this lecture, Galileo is probably betrayed by his wish to please the audience and falls into a —literally— infernal trap. In short, the *inferno* of Manetti has precise dimensions, which one may easily calculate, by bearing three elements in mind: (1) after his rebellion, Lucifer was hurled down to the centre of the Earth and created a cone with his fall, (2) the city of Jerusalem is placed at the centre of the base of the cone and (3) the entrance to hell is placed, as in Virgil's imagination, around Cuma (Fig. 9.1).

Then, Galileo locates hell "…*let us imagine a line coming from the centre of the Earth and getting to Jerusalem, and an arch extended from Jerusalem for the twelfth part of its largest circumference… if we imagine a cone-shaped hole … this is Hell. From this reasoning we get first of all the picture; secondly, the site, given its position, its lowest extremity at the centre of the world, and the base towards an area of the Earth, which contains Jerusalem in its middle…*". At this point, Galileo evaluates its dimensions "… *calculating according to what Archimedes demonstrated in his books about the sphere and the cylinder, we shall discover that Hell occupies a space which corresponds to less than one of the 14 parts of the whole aggregate…*", and, in particular, he guesses the size of the base of the upturned cone "*and in its embrasure, which is the circle around Jerusalem, is equal to its diameter, because a rope—whose length corresponds to half-diameter, is subtended to the arch of a sixth of the circle*".[6]

The young Galileo now thought he had all the necessary instruments in order to calculate the thickness of the Earth crust above this huge pit; assuming that the eight sections of Dante' hell all have the same dimensions, he gets to the conclusion that the shell of *Inferno* has a radium of 3,245 miles, equal to the Earth's radium, with a layer of 405 miles. So far, so good.

The problem is that this Hell is almost 10 times deeper than what Vellutello draws from his analysis of Dante's text, so that Galileo is forced to defend the structure of Manetti, even though, as someone suspects, the thickness of the vault might not be sufficient to hold without falling down "…*Someone might say that Hell should not be as large as Manetti thinks; since, as someone has inferred, it*

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[6] G. Galilei, 1588, "*Due lezioni all'Accademia…*", *op. cit.,* p. 10 "…*immaginiamoci una linea retta che venga dal centro della grandezza della terra sino a Ierusalem, ed un arco che da Ierusalem si distenda per la duodecima parte della sua maggior circonferenza… se ci immagineremo una buca in forma di conica superficie… questa è l'Inferno. E da questo discorso ne aviamo, prima, la figura; secondo, il sito, essendo talmente posto, che il suo bassissimo punto è il centro del mondo, e la base o sboccatura viene verso tal parte della terra, che nel suo mezzo racchiude Ierusalem…*", "… *facendone il conto secondo le cose dimostrate da Archimede ne i libri Della sfera e del cilindro, troveremo che il vano dell'Inferno occupa qualcosa meno di una delle 14 parti di tutto l'aggregato…*", "*e nella sua sboccatura, che è il cerchio attorno a Ierusalem, è altrettanto per diametro, per ciò che all'arco della sesta parte del cerchio gli è sottesa una corda uguale al semidiametro*".

Fig. 9.1 Scheme of Dante's Inferno according to the interpretation of Antonio Manetti, as reported by Girolamo Benivieni in the so-called Giuntina (D. Alighieri, 1506, *Comedia,* Commento di Girolamo Benivieni, Filippo Giunti, Firenze). Hell's cone reaches the centre of the Earth, whose radius, indicated in the picture, is expressed in Arab miles. The *selva oscura (dark forest)*, following Virgil and the Aeneid, is placed near Cuma. Since the city of Jerusalem is situated at the centre of the base of the cone, it is possible to calculate all the dimensions of Dante's *Inferno*

does not seem possible that the vault covered by Hell, being so thin since Hell is so high, may hold, rather than falling down together with Hell itself…"

Galileo meets this objection "*… this width is more than sufficient: since, if we take a small vault, made for that reason, we shall get an arch 30 ells wide, there will be about 4 ells left for that width, which is more than enough, since, if we add 1 ell to a 30-ells arch, perhaps even 1/2, instead of 4, it should already hold; therefore… this vault will be huge, much more than necessary to stand up.*"[7]

This is actually Galileo's mistake[8]: indeed, with this logical procedure, he assumes that in the science of building, one may proceed by proportions; unfortunately, this is wrong.

Following Galileo's argument, the terms of the problem appear as such: Hell is a pit which goes down to the centre of the Earth, with a large flare, which is about 3,200 miles wide. The thickness of the vault, taking into consideration the fact that the depth of seas is nothing compared to it, is about 400 miles, which corresponds to 12 % of its depth. By analogy, we may consider that a dome, such as the Cathedral of Florence, which is about 90 ells wide, has a thickness of about 4 ells, which corresponds to about 4 % of its width. Since Brunelleschi's dome holds beautifully, Hell's dome should hold even better, since—in proportion—it is 3 times as thick as the Cathedral dome. Thus, the critique of Vellutello from Lucca to Manetti from Florence is ridiculed. This argument may sound convincing, provided we assume that we may scale down dimensions a thousand times. Unfortunately, such an *Inferno* would immediately collapse under the weight of the vault, as any student of architecture might confirm!

Galileo's lessons on Dante's Inferno were in fact a sort of interview before the Academy could accept that Galileo be entrusted with a job as Maths "reader" at the University of Pisa. Fortunately, nobody had realized the ingenuousness of the lecturer; perhaps, the self-respect of the Academy members had been so cleverly encouraged that nobody thought it suitable to spoil the atmosphere.

How can we guess that, in 1634, Galileo, confined in his house in Arcetri, so tried by recent events, might still think of a fact which had taken place 50 years earlier? A convincing answer has been suggested by Peterson (2002).[9] According to his opinion, the main reason is given by Galileo's last book, *Discourses and*

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[7] *Ibidem*, pp. 11–12 "*…Qui ci potrebbe essere opposto che né l'Inferno si deve credere esser così grande come il Manetti lo pone; essendo che, sì come alcuni hanno sospettato, non par possibile che la volta che l'Inferno ricuopre, rimanendo sì sottile quant'è di necessità se l'Inferno tanto si alza, si possa reggere, e non precipiti e profondi in esso Inferno…*", "*…che tal grossezza è suffizientissima: perciò che, presa una volta piccola, fabricata con quella ragione, se arà di arco 30 braccia, gli rimarranno per la grossezza braccia 4 in circa, la quale non solo è bastante, ma quando a 30 braccia di arco se gli desse un sol braccio, e forse ½, non che 4, basteria a sostenersi; onde… nulla di meno rimarrà detta volta grossissima, e più assai che non è necessario per sostenersi*".

[8] Mark A. Peterson, 2002, *Galileo's discovery of scaling laws, Am. J. Phys.,* 70, 575.

[9] *ibidem.*

[10] G. Galilei, 1638, *Discorsi e dimostrazioni attorno a due nuove scienze*, Elsevirii, Leida.

Mathematical Demonstration relating to two new Sciences, which he is writing at the time.[10]

In this essay, notwithstanding the damages provoked by the *Dialogue upon the two chief World Systems*, Galileo uses once again the dialogue structure, comparing the opinions of the same three characters—namely Salviati, Sagredo and Simplicio. The book starts with the three friends meeting at the Arsenal of Venice: they remark that the largest boats—on dry land—are supported by special slings, whereas the smaller boats are placed on the sand, without particular precautions. Thus, the friends start arguing—not by chance—about proportions, and Salviati, i.e. Galileo, wonders "*…why were they using all those supports, protections and devices for the galliass which was going to be launched, while nothing of the kind was done for smaller vessels…was it perhaps so as to avoid the danger of straining, oppressed by the excessive weight of its bulk, a problem which smaller ships do not have?*" Further on, he finds himself the answer: "*…The larger machine, made of the same material and the same proportions of the smaller one, in all other conditions will react with the right symmetry to the smaller one, except for its strength and its resistance against violent invasions; the bigger the ship, the weaker it will be…*".[11] Thus, Galileo seems to be resuming the same argument he had treated years earlier, as he had esteemed the vault of Hell strong enough to hold, simply scaling down the proportions of a smaller vault. This time, however, Galileo handles the question very well, and when Sagredo says he is surprised by the fact that the geometrical argument of proportions cannot be applied to Physics "*My mind is already upset…*", Salviati—Galileo simply answers "*That is so, Mr. Sagredo…*"[12] and does not hesitate in admitting that "*some time ago*" he had made the same mistake himself, namely he had evaluated the strength of materials simply by scaling down the linear dimensions of the examined objects. This is the only hint at his mishap at the Accademia Fiorentina.

Galileo had studied for a long time the problem of materials' resistance as related to their dimensions, and he explicitly refers to this matter in a letter he sends to Antonio de' Medici in the month of February 1609, "*I recently found all the conclusions… relating to the force and resistance of woods of different length, width and shape…*".[13]

Summing up, Galileo's unfortunate lessons at the Accademia Fiorentina date back to 1588, his letter to Antonio de' Medici is written in 1609 and the

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[11] *ibidem*, pp. 2–3 "*… per qual ragione facevano tanto maggior apparecchio di sostegni, armamenti ed altri ripari e fortificazioni, intorno a quella gran galeazza che si doveva varare, che non si fa intorno a vasselli minori… ciò farsi per evitare il pericolo di direnarsi, oppressa dal gravissimo peso della sua vasta mole, inconveniente al quale non son soggetti i legni minori?*" "*… il solo esser materiale fa che la machina maggiore, fabbricata dell'istessa materia e con l'istesse proporzioni che la minore, in tutte l'altre condizioni risponderà con giusta simmetria alla minore, fuor che nella robustezza e resistenza contro alle violente invasioni; ma quanto più sarà grande, tanto a proporzione sarà più debole…*".

[12] *Ibidem*, p. 4.

[13] G. Galilei, 1609, *Letter to Antonio de' Medici,* 11 February 1609.

Discourses and Mathematical Demonstrations relating to two New Sciences are published in 1638. Therefore, if we want to establish a connection among these three circumstances, we should conclude that Galileo has kept a sort of secret for almost 50 years, namely his defence of Dante's florentine identity through a wrong argument, which might have been turned on him.

There are three further elements we should take into consideration in this hypothetical series of circumstances. First of all, Galileo had clearly been thinking for decades about the problem of the linearity of physical laws, namely whether it is possible to apply the technique of proportions in solving problems. Secondly, in so many years, he never found the right chance to mention his two lessons about the *Inferno,* even though they concern topics which are similar to the ones handled in *Discourses and Demonstrations relating to two New Sciences*, and had represented—after all—the first step of his academic career. Thirdly, Galileo's lessons at the Accademia Fiorentina are forgotten for a very long time and are only rediscovered in the nineteenth century.

Why does Galileo come out with this story 50 years later, since probably his former audience have disappeared? Perhaps—this is Peterson's hypothesis[14]—this is what happened: Galileo soon realized his mistake, perhaps even the day after his lessons, but what could he have done in such a situation? He should have written a denial of his own words, and, at the same time, he should have invented another solution in favour of Manetti and against Vellutello: this was impossible! The only viable alternative which Galileo chooses was to prepare an answer, in case someone, even years later, found out the misunderstanding he had run up against. That is why he had continued thinking about this matter. Finally, many years later, Galileo realizes that this topic has never really been handled and decides to introduce it in the first 2 days of his last essay, *Discourses and Mathematical Demonstrations relating to two New Sciences,* but of course nobody remembers his old mistake, and he thinks it would be useless to mention it. Right enough. However, if we look at the matter more closely, we find a clue, as Salviati admits to his two friends: "*What is happening to Mr. Simplicio, also happened to me for some time, when I believed that the resistance of similar solids were alike …*"[15]: this is the acknowledgement of a scientist who, in his old age, does not fear admitting the mistakes he made during his long career.

If Galileo studies the structure of Hell at the start of his professional life and once again towards the end of his earthly life, this is probably because in the central part of his life, he studied the structure of the sky.

Kircher too, in his maturity, studies Cosmology, but in a way, you would not expect it from a philosopher of Nature. When, in 1656, he decides to write *Itinerarium exstaticum coeleste*,[16] he realizes a book which is closer to a poem than to a

[14] M. A. Peterson, 2002, *op. cit.*

[15] G. Galilei, 1638, *Discorsi e dimostrazioni*, *op. cit*., p. 123.

[16] A. Kircher, 1656, *Itinerarium exstaticum qvo mvndi opificivm id est Coelestis expansi…* Romae, Typis Vitalis Mascardi.

scientific essay. He seems to convey the message that the study of the sky structure requires an approach which is nearer to a dream than to the analysis of observations. Indeed, a few years earlier, Kircher had written *Musurgia Universalis,* which is commonly considered his most successful work. In this book, as if in a dream, he identifies in the deep structure of the world a musical harmony. Accordingly, the Lord must have realized the creation of the world through an organ (Fig. 9.2), which has been beating time with its different registers, during the 6 days of Creation.

Doubtlessly, Galileo's social position is different from Kircher's, who, as a priest, does not feel authorized to express scientific opinions, unless they have been approved by his superiors, so that he tends to move his view onto the level of poetry, which he perceives as a free domain. However, the attitude of the two scholars towards Astronomy is markedly different: Galileo, sure of his own reasons, is often prone to neglect caution. On the other hand, Kircher accurately avoids any discussion, and since he is constantly looking for an invisible scheme holding together the whole Universe, considers any obstacle to his research as an insufferable waste of time. Kircher certainly does not commit himself to original books of Cosmology. Nevertheless, he is constantly updated on the cultural upheavals, which have been taking place while he was moving from Germany to France and Italy. His fame as an encyclopaedist is such that Marcaurelio Severini, a lecturer of the University of Naples, comparing him to Pythagoras, does not hesitate to write that his learning is so bright that it can be compared to "*a newly discovered moon*".[17] This renown puts him in contact with a number of political and scientific authorities of the age, such as Leibniz and Huyghens, who allow Kircher to keep up with astronomical discoveries, which are sometimes hinted at in his books.

The structure of the *Itinerarium exstaticum* closely recalls the *Divina Commedia,* since the protagonist is accompanied by an angel on a visit to the afterlife.

The book starts with Kircher who, in the first person, tells us that "*Not so long ago, I watched by chance at our College the performance of an academic trio of incomparable musicians, whom I would define as contemporary brothers of Orpheus…*".[18] At least twice at the start of the book, Kircher repeats that the event really took place. At the end of the concert, Kircher falls asleep into a sort of spiritual ecstasy, during which he is carried to a meadow and transformed into Theodidactus, a character who, from now on, becomes the narrator and represents the playful side of Kircher's soul, who uses this device in order to express his fantasies without scientific worries. "*…I suddenly saw a strange man: his head and his face were shining beautifully, his eyes were as bright as rubies, he was wearing a strange robe, such as I had never seen before, his wings were*

[17] In J. Fletcher, 1970, *Isis*, Vol. 61.

[18] A. Kircher, 1656, *op. cit.,* p. 33, "*Accedit non ita pridem, ut ad academicum trium incomparabilium Musicorum (quos si aevi nostri orpheos dicam…)*".

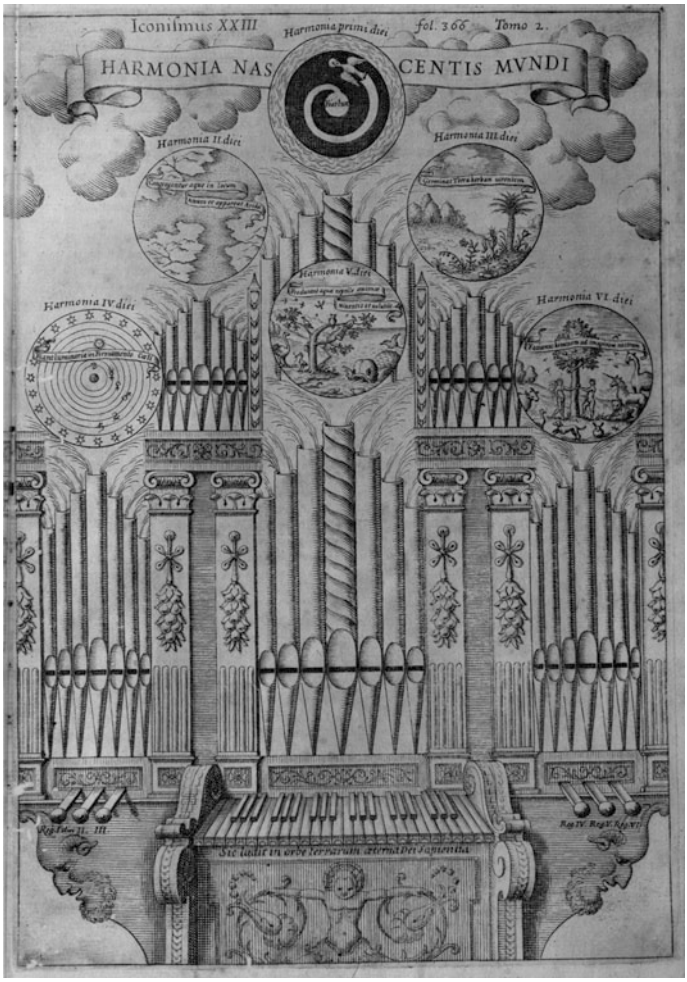

Fig. 9.2 The organ of universal harmony (1650, *Musurgia Universalis*, Tomus II, Romae, Ex Typographia Haeredum Francisci Corbelleti, iconismus XXIII, fol. 366). Music dominates the world and represents its different intrinsic harmonies. The first voice of the organ has been used by the Lord on the first day of Creation in order to generate light. There follows the "*preludes*" of the separation of waters from Earth, the birth of plants and the creation of the Sun and the stars (please note that the representation of the Cosmos comes from Ptolemy rather than from Tycho, probably only for the sake of symmetry in the drawing). Later on, the Lord played the register of the fifth day, when He created reptiles, snakes and birds, and of the sixth day, in which all the animals of Heaven were born. In the end, the Lord sounded at the same time all the six registers of the organ and gave life to the first man

resplendent with a gorgeous drawing…". This man cries: "*Stand up, Theodidactus, do not be afraid, because your wishes have been fulfilled, and I have been sent to show you the greatness of Lord in the world*" "*Who are you?*" "*My name is Cosmiel, I am an angel of God, and genius of the world*".[19] The angel offers to accompany him on a visit, to reveal to him the most secret shape of the sky and Theodidactus, useless to say, accepts at once.

It would be ungenerous to underline that in these lines there is not much, over and above the narrative structure, which may recall the poetry of the *Commedia.* However, Kircher's goal is not poetry, but rather a fantasy book which may allow him eccentricities and speculations on miscellaneous topics, in order to make an updated synthesis of his own view of the world.

In any case, the Jesuit college education includes the effort, recommended by Ignatius from Loyola, to identify oneself with the Holy Writ and try to feel the sensations one might feel in Heaven or in Hell. Therefore, Kircher is probably repeating an exercise which is usual for him and does not even dream of comparing his own story to Dante's *Commedia.* Moreover, the clueless Theodidactus does not even remotely look like severe Dante, nor does Kircher make any effort to liken his guide, the chatty and somewhat superficial Cosmiel, to the celestial, diaphanous Beatrice. In fact, from this comparison, it is clear that there is a huge difference between the rock-like Medioeval Cosmology and its fluid seventeenth century version, now open to doubts. Aristotle's concepts, which constitute the basis of the *Commedia*, are transformed, in the *Itinerarium,* into flexible ideas which are accepted as facts (since they are taught as such in the Jesuit colleges), but can be interpreted, and sometimes denied, in order to explain the ever-growing amount of observational data.

Kircher therefore faces a difficult challenge, which we should not underestimate: namely, the description of the new Cosmology of Tycho Brahe, which has been accepted by most Jesuits as the natural evolution of the classic Catholic Cosmology, though it is still seen with a certain suspicion by the Orthodox, who considers it a Copernicus-like theory in disguise, and still largely refers to Aristotle and Ptolemy, who date back to almost fifteen centuries before.

Thus Kircher, with his usual dramatic skill, takes advantage of Theodidactus' nonsense and Cosmiel's chatting to realize an entertaining work, which may teach everybody the structure of a world, where observations agree with the Holy Writ.

At the start of the journey, while they are moving towards the Moon, which has by now been recognized as the Earth's satellite, Theodidactus starts complaining because he is cold, and short of breath, whereas Cosmiel seems to be perfectly at

[19] *Ibidem*, pp. 35–36, "*& protinus mihi insolitae constitutionis vis adstitit, caput eius faciesque miro quodam fulgebat jubare, oculi carbunculorum instar coruscabant, habitus totius corporis exotico & inviso hucusque vestimento constituebatur; siquidem admiranda quadam in formam alarum complicatarum textura ita adornabatur…*" "*Surge, ne timeas Theodidacte, ecce exaudita sunt desideria tua, & ego ad te missus sum, ut tibi summam Dei Optimi Maximi Majestatem… in operibus suis mundanis elucescentem monstrarem… quis es tu Domine mi?… Ego sum Cosmiel minister Dei altissimi; & Mundi genius*".

ease. The angel then carries and places him upon a high mountain of the Moon, and Theodidactus keeps complaining about the growing cold, but cannot help expressing his wonder in seeing both the bright and the dark faces of the Moon. This view, however, frightens him, because of the rises and clefts, which produce an abundance of grey and black shadows reminding him of the aculei of a horrible, prickly porcupine (a comparison made by Theodidactus).

Kircher's tale certainly appears so simple, at times so childish, that the reader is dumbfounded. It is difficult to imagine that a man, who was well known for his learning, does not realize the naivety of some of the fictional solutions he offers, for instance when Theodidactus complains of the hot surface of the Sun, and is relieved by a few dewdrops on his head. It seems therefore probable that Kircher is telling his story in a deliberately simple style, by using the clueless Theodidactus, so as to make accessible to the general public a few basic concepts, which were being stated at the time (even though, as his book is in Latin, its diffusion may have been imagined at least at the level of the younger students of the Jesuit colleges).

For example, the shortness of breath felt by Theodidactus once he gets to the Moon is a way to popularize the observations of Giovanni Battista Cysat, Scheiner's collaborator, who stated that he had observed with his telescope that even the Moon is endowed with an atmosphere, though it is much thinner than the earthly atmosphere.

In the same way, when Cosmiel carries Theodidactus to a mountain on the Moon and the latter does not recognize a lunar ocean and naively asks: "*What's that large dark spot which you can see from the Earth too?*", Kircher is merely confirming the concept that the Moon is a sort of miniature Earth, with mountains, valleys and seas.

The comical register starts once again with Cosmiel who, in order to make sure that Theodidactus learns his lesson and never forgets it, forces him to drink a cup of that water. The poor guy immediately feels his whole body swell and stretch like a drum and cries: "Cosmiel, please help me, I'm dying!"[20]

Kircher is not necessarily successful in his intention of making his reader laugh. However, we are not talking about his sense of humour, but rather of the atmosphere and the oceans on the Moon, which are considered as acquired facts: indeed, the poor Theodidactus, who does not recognize them, appears as a simpleton.

Kircher, in his alter ego as a space explorer, in this role play, does not feel hurt by the brisk manner of his angel; rather, he keeps calling Cosmiel a "*sweet guide*" and "*my Lord*", because he teaches him so much, and finds the courage to confess that "*As a boy, at the peripatetic school, I often heard about the sphere of fire [which should be around the Earth], but I never saw it, neither above nor around*

[20] *ibidem*, p. 53 "*quem cum sumpsissem, ecce derepente totum corpus instar tympani inflari, omnia membra dilatari, & in ingentem molem excrescere, incredibilem deniq; me violentia sustinere sentio. O Cosmiel adiuva me, morior*".

the Moon…". Cosmiel (and Kircher) cannot give a clearer answer: "*If you think that Aristotle said only the right things about the nature of celestial bodies, you are making a big mistake…. Those who formulate hypotheses without caring for experiments, get to the wrong conclusions,… which are so far from the truth as the Earth is far from the Moon*".[21] So much for Aristotle's followers!

It is therefore true that the story is elementary, but the rehabilitation of the experimental method (which is, unfortunately, almost 30 years late, after Galileo's sentence) cannot be more definite than this.

The fact of recognizing that the Moon does have mountains and seas, just like the Earth, requires nerve, more than we would imagine, because Kircher indirectly touches on a moot point, namely the plurality of worlds, a concept sanctioned by the Holy Office in 1650. On the other hand, Kircher has studied those realistic maps of the Moon, which Claude Mellan realized under the guidance of Gassendi and Peiresc, his old friend. In these maps, one can clearly see mountains, plains and oceans of the Moon, and it is necessary to proceed with caution, without denying the facts or evoking the ghost of Giordano Bruno, who had imagined a Universe populated by many worlds similar to our own.

Kircher, clever as usual, avoids this problem: when Theodidactus asks Cosmiel the reason why on the Moon "*you cannot see either animals, or plants or men*", the angel answers that, though there are several worlds like our own in the Universe, they are inhabited only by angels like himself, and the Earth, even though it is only in one of the centres of the cosmological system, is, in this sense, different from all the other celestial bodies. The solution is certainly not elegant from the philosophic viewpoint, but it does avoid embarrassing questions, which emerge on the topic of the plurality of worlds, i.e.: "if there are other inhabited planets, are those creatures also born with the original sin?"—or "In case, was there also a Redemption through the sacrifice of Christ?" And so on.

Clearly, *Itinerarium exstaticum* is neither a Cosmology nor a Philosophy essay, but rather a didactic work, which is not aimed at answering subtle philosophical questions. However, this is an important text, since it shows that a certain number of new ideas are no longer considered a moot point: on the contrary, they are so largely accepted among the Jesuits that they constitute the topic of a non-specialist book like this one. The clumsy character of Theodidactus, who is near to dying after drinking Moon-ocean water and incredibly manages to get through the spheres of water and fire, which should surround the Earth, redeems himself with a vision well ahead of its time. In their journey towards the Moon, Cosmiel stops and shows him the Earth from far away, a view which has been observed by astronauts only 400 years later.

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[21] *Ibidem*, pp. 54–56 "*… me a puero multa in peripatetica schola de sphaera ignis inaudivisse, quam tamen nec supra nec infra Lunam vidi…*" "*Erras sane summo opere, si Aristotelem de ijs rebus quae ad supremorum corporum naturam pertinent, omnia vera locutum esse tibi persuadeas…fieri enim non potest, ut Philosophi solis suis cogitatis insistentes, repudiatisque experientijs quidquam solidi circa naturalem Mundi constitutionem concludere possint… a vero aberrant longius, quanto hunc globum Lunarem a terreno longius distare videmus…*".

It must not have been easy for Kircher to expound all these concepts, although acquired by the scholars, because *Itinerarium exstaticum* remains the only book by Kircher which comes up against the obstacle of censorship. Even after Kircher's correction of several sections of his manuscript, he keeps receiving requests from various people to analyse the text closely. Probably, his book was excessively optimistic about the possible existence of other Earth-like worlds.

It is getting late on the Moon, and Cosmiel urges his guest "*…It is time to show you more important and more entertaining things…*". Theodidactus, after "*sitting down between the large plumose wings*"[22] of his angel, lets himself be carried towards the skies of Venus and Mercury.

Theodidactus is attracted by Venus, which in Tycho's system is the planet nearest to the Earth. In fact, the first thing Theodidactus asks Cosmiel is whether the water on Venus might be used to baptise a heathen or a Jew. Once Theodactus is reassured of the effectiveness of this improbable purification, Theodidactus remarks that the influences of that planet on the Earth, namely beauty and love, are ruled by crowds of angels singing and carrying baskets of perfumed flowers. Theodidactus, however, admits he still wonders why Venus affects some people in a domineering way, whereas other people are scarcely touched by it.

Mercury too is peopled by angels, but they are cold and detached, because the task assigned to this planet consists in spreading wisdom. Theodidactus, as he had already done on Venus, wonders once again why intelligence and other influences from the planets exercise a different effect upon different people. Cosmiel says that people's features depend on two different actions: on the one side, the *natural influence* issued by the planets, to the advantage of everybody. On the other side, a supernatural gift is given by the Lord according to His unfathomable will.

In this stage of *Itinerarium exstaticum*, perhaps in order to underline the role of Mercury, the tone of the story is higher, and Cosmiel makes cultured references: he quotes Aristotle, and starts a long, learned disassertion on free will, while recalling Dante's *Purgatorio*, as well as Cato, who owned cardinal virtues, which are a human feature, but, as a heathen, was deprived of the divine gift of theological virtues.

Indeed, the poetic flight is rather short, because Theodidactus sees something on the horizon and asks: "*Cosmiel, what's that globe of fire rising from Mercury's horizon?…*"—Cosmiel explains: "*It is the Sun!*" Theodidactus, as if he did not expect this, expresses his admiration with a series of exclamations, thus marking a comeback to an elementary fictional register—"*What a wonderful body, it's admirable, what a divine work!…*".[23]

Cosmiel, probably in order not to listen any longer to the litanies of his guest, decides to carry him at once to the Sun, where Theodidactus starts a new litany which risks being endless: "*We arrive on the Sun, the eye of the world, grace and*

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[22] *Ibidem*, p. 88 "*me intra pennigerum amictum complicatum…*".

[23] *Ibidem*, p. 120.

[24] *ibidem*, p. 122.

decoration of the sky, source of daylight, heart of Nature, father of gold and gems, moderator of time, prince of stars, king of celestial bodies, source of light, miracle of the Universe…".[24]

Fortunately, Cosmiel remembers that the Jesuit has been allowed the privilege to see the structure of the cosmos and tries to remind Theodidactus of this "*… look closely at the Sun, which you have never seen nor understood!*". However, Theodidactus complains of the blinding light, as well as of the excessive heat (!), so that Cosmiel pulls out a jar of celestial dew and sprinkles a few drops on the head of his guest, while assuring him that this will protect him from any nuisance.

The Sun is a large ocean of fire, so that both pupil and teacher must board a small ship, which Cosmiel himself drives. He shows Theodidactus the mountains of fire and the volcanoes, giving out pure vapour which, observed from the Earth, appear as sunspots.

When Cosmiel explains that the Sun's virtue consists in fecundating plants and animals with its heat, Theodidactus poses an important question: "*where does the Sun's heat come from?*" "*You should not focus on the Sun's heat*"—Cosmiel explains—"*because this is a secondary virtue, whereas Light is the primary virtue*". Cosmiel is probably starting a relevant philosophical consideration, but is interrupted by Theodidactus who, being a muddler, thinks he has understood and exclaims "*is it like wine and pepper which, though not warm, produce heat in our stomach?…*". Poor Cosmiel could have wept: "*How on earth can you imagine that the Sun is a globe of peppered bread? Who do you think would have made it?…*".[25]

This time too, Theodidactus appears fictionally unprepared. Of course, everybody knows that Kircher has kept a long exchange of letters on sunspots with Father Scheiner and is informed about the argument on comets, because he has lived for many years at the Collegio Romano, where Orazio Grassi was teaching. Indeed Cosmiel, urged by Theodidactus, explains that sunspots are provoked by the eruptive activity of the solar surface and starts a dissertation upon comets, which originate from the Sun, and whose orbits depend on the irregular eruptions. Once again, Kircher provides scientific explanations which border on absurdity, but shows anyway that he has definitely overcome Aristotle's concept, namely that the Sun is a perfect, incorruptible sphere.

Shortly after this, Theodidactus sees the Seraphs, the angels who live on the Sun, and expresses once again his admiration with his litanies: "*Eternal creator of all things! My life and my desire! Ancient beauty, end of all beauties, unique virtue, completion of all virtues! Eternal truth! And so on…*" until Cosmiel interrupts him—"*That's enough…*"—because they must move on to another planet, Mars.

As soon as they arrive on the planet of war, Theodidactus feels so angry and resentful that he is worried about it. Cosmiel, as usual, intervenes with a celestial

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[25] *ibidem*, pp. 141–142, Theodidactus: "*Quin imo vinum et piper, atque adeo omnia summo gradu calida formalem in stomacho calorem producere iam ab ineunte aetate in scholis edoctus fui…*", Cosmiel: "*O quantum a scopo aberras fili mi; imaginare tibi piperaceum globum Solem esse…*".

liquor, which is an antidote against the negative influences of the planet's atmosphere, dense with poisonous vapours. Then, the angel explains that Mars' negative influence upon human life is similar to Venus' positive influence, namely the influence is there, but does not decide the actions of human beings, who are endowed with a free will. They watch the fearful angels of Mars, riding fire horses, fully armed and ready to fulfil their task: provoking plagues, wars and horrors, which God orders so as to punish the wicked and sinners who exceed the limits of His patience.

The role played by Mars' influence within God's design, namely causing wars and plagues, though only hinted at, cannot help reminding us that in 1656, the year in which *Itinerarium exstaticum* was published, the Black Death broke out, as the last consequence of the 30 Years' War, which devastated the whole of Europe. Kircher soon writes about this plague in the *Scrutinium Physico-Medicum Contagiosae Luis, Quae Pestis dicitur (1658)* which, though devoid of innovative ideas, constitutes a chance to discuss a relevant concept within the religious view of the world, namely the incomprehensibility of evil.

Doubtless, a plague breaks out only if God allows it, but this is one of the infinite manifestations of the Devil in the world. Even though, on certain occasions, we can identify the material cause of the plague, the point is that the origin of evil has metaphysical causes and, as such, it is inexhaustible in the world. Human science can certainly help out (and Kircher commits his whole life to find improbable remedies to many kinds of sickness as those indicated in the Tabula Cominatoria in Mundus Subterraneous, see reference n. 186), but an unshakeable faith in our Lord is the only defence available to humankind.

The two visitors realize that the atmosphere of Jupiter is completely different. Everywhere, they smell perfumes, and the landscape is exceptionally beautiful, with oceans, islands and continents. The planets' landscape is so marvellous that Theodidactus thinks that, rather than on a planet, he may find himself in Heaven. The angels are suited to the landscape and therefore wear rich robes shining with silver. Their faces, surrounded by golden locks, show majesty and clemency; the swords they carry with the one hand (while the other bears a thurible) have a hilt decorated with precious gems.

Over and above these fantasy descriptions, however, the visit to Jupiter represents a chance to recognize Galileo's discoveries. In fact, this is one of the rare occurrences in which Kircher quotes Galileo. In his introduction, Kircher recalls that, although the number of stars in the Universe had been fixed in ancient times as 1,022, Galileo—with his telescope—found 12 stars in Orion, 36 in the Crib, more than 40 in the Pleiades, at least 80 between Orion's belt and sword, and more than 500 nearby.[26] Kircher then remembers that Jupiter's four satellites "*…have been seen by Galileo with a telescope*"[27] and recognizes Galileo's merit when he,

[26] A. Kircher, 1660, *Iter Extaticum Coeleste,* Joh, Andr. & Wolffg. Jun. Endterorum Haer. Herbipoli, p. 25.

[27] *Ibidem*, p. 262.

in order to demonstrate that Jupiter has an atmosphere, declares: "*Doubtless there is an atmosphere on Jupiter, as Galileo writes in*" "*Nuncius Sidereus*"—and he goes on to explain that—"*Jupiter does not travel alone in that vast region between Mars and Saturn, but, as a lord and king, is followed by four satellites (which some astronomers call "companions"), which were observed for the first time in Italy by Galileo Galilei in 1610 with a telescope…*".[28]

This acknowledgement is not up to much, almost 50 years after the observations of the Medicis' satellites. However, we should bear in mind that only a decade has passed from the death of Galileo—in house arrest—and the mere mention of his name on the part of a Jesuit sounds like a partial attempt at recognizing his work. On the other hand, with this reference to Galileo, Kircher is probably paving the ground to more radical statements on the structure of the Universe as, once they have left Saturn, his travellers finally get to the sky of fixed stars.

Theodidactus, clueless as usual, fears that, during their flight towards the sky, they may not sight the crystal sphere in which fixed stars are set, thus risking a collision. However, Cosmiel, with consumed patience, explains to him: "*My dear Theodidactus, I do realize that you are a real simpleton, and believe everything people tell you. That crystal sphere you are looking for does not exist in Nature, and you cannot believe that stars are set in this sphere. Do have a look around, and you'll see that the Universe is filled with a clear, ethereal and boundless Ocean*".[29]

That is official: Aristotle's Cosmology, at least in its "physical" version, namely the version which states the real existence of spheres carrying planets, is no longer acceptable to a Catholic scholar.

This is the end of crystal spheres. However, humankind still wonders why celestial bodies rotate one around the other. Cosmiel, while merely recalling God's will, asks "Don't tell me that you still believe that stars are lit up by the Sun!", and the poor Theodidactus—abashed—answers: "Indeed, I do!"[30]

Therefore, even a simpleton like Theodidactus realizes that the Universe is huge, a concept which has been accepted with a certain difficulty, since they could not understand why the Lord had created such a uselessly vast space. Indeed, a small Universe is what one would expect, if the aim of creation consists in hosting

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[28] *Ibidem*, pp. 267–268 "*De Jovis igitur atmosphaera nullum mihi dubium est, eamque admittit etiam Galilaeus in fine Nuntii Siderei*"… "*Jovem non solitarium degere in vastissima illa Saturnum inter et Martem interiecta regione, sed veluti dominum ac regem quatuor stellis aliis tanquam satellitibus… (quas comites appellant Astronomi recentiores) primus ope telescopii deprehendit in Italia Anno 1610 Galilaeus Galilaei…*".

[29] A. Kircher, 1656, *op. cit.,* p. 259, "*Mi Theodidacte; iam vere video, te nimis simplicis ingenij esse, & ad quorumuis sententias amplexandas plus aequo creduli: sphaera illa chrystallina, quam quaeris, in rerum natura non reperitur; stella autem huiusmodi sphaerae infixas esse, nullo prorsus fundamento nititur [my emphasis]; gyra oculos … limpidissimam aetherei Oceani nullis finibus conclusi, volubilem, subtilissimamque auram reperies*".

[30] *Ibidem*, p. 260, "*Anne omnes huiusmodi stellas à Sole illuminari putabas?*", Theodid. "*Ita putabam*".

humankind and the Earth at its centre. If we accept the fact that the dimensions of the Universe are so large, this means admitting that neither the Earth nor humankind is the goal of creation. Moreover, a huge Universe removes one of the main obstacles to the acceptance of Copernicus' hypothesis, namely that the stars do not show the parallax effect, i.e. they do not seem to be moving during the year, because of the reflected motion of the Earth around the Sun.

A huge Universe has an inconceivable number of consequences, which Cosmiel illustrates, apparently without embarrassment. If the stars are so far away one from the other, this means that each star is, so to speak, a system in itself, so that "*the supreme Archetypical mind wanted the Universe to host all possible forms of life, with numberless celestial globes…*".[31] Therefore, Cosmiel is talking about the infinite worlds, evoked by Giordano Bruno in his book *De l'infinito universo et mondi* (*About the Infinite Universe and Worlds*), where he writes "*Indeed there is not only one world, one Earth, one Sun; there are so many worlds as many lamps we see, which are neither more nor less in one sky, one place and one mind; this world, in which we live, is in one mind, one place and one sky*".[32] Doubtless Kircher here shows a remarkable courage, in consideration of the condemnation of Bruno to the stake in Campo de' Fiori.

We can finally see the courage of Kircher, who in any case remains a quiet scholar, who only wants to spend the rest of his life studying the topics he is interested in. Kircher has mentioned the unquestionable results of the new Astronomy, namely sunspots, comets, the mountains of the Moon, the irregularities of Saturn, Jupiter's satellites and the Sun's changeability, in most of his books. He has even paid homage to a scientist such as Galilei, while weighing his own position and reaffirming backward orthodox positions. However, when he talks about the cosmic view of Giordano Bruno, a name which the censorship of his superiors would have never allowed him to publish, Kircher cannot help writing that he does share that view.

However, the only cultural affinity between Kircher and Bruno is that both are against Copernicus' system and have both studied the Renaissance Neoplatonic philosophers. Kircher starts from here his interpretation of Egyptian hieroglyphs, whereas Bruno follows the path of fifteenth century magic, a Christian magic which combined amulets and the Bible's mysticism with a sacred vision of the Cosmos as a living body.[33]

As for the dislike of Copernicus, Kircher makes it clear in the *Scholium VII* in the chapter on the Sun, whereas Bruno, though invited by prestigious Universities in order to hold lectures on Copernicus' theory, shows that he has not really

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[31] A. Kircher, 1660, *op. cit.,* p. 361, "*Supremus ille Archetypus intellectus infinitis omnium possibilium rerum ideis foetus est, ita mundum hunc… innumera globorum…*".

[32] G. Bruno, 1584, *De l'infinito universo et mondi,* E-book, http://www.liberliber.it/, p. 444.

[33] E. Buonanno, 2008, "*Giordano Bruno, il copernicano esoterico e panteista*", *Il Riformista,* 1 March 2008.

understood it. Indeed, when he has difficulties in answering some objections, instead of finding the right answer, he simply abuses those who have made the questions. A lecturer recorded his visit to Oxford: "*When that small Italian man, who called himself "magis elaborata Theologia Doctor etc ."… visited our university, he clearly wanted to be famous. When he managed to occupy the highest rank of our best school, rolling up his sleeves like a juggler… he tried to defend Copernicus' theory, according to which the Earth rotates, while the skies stand still; but in fact I think his head was turning around*". However, the story goes on with Bruno's mishap: "*A serious man, who holds a prominent position in that university, had the impression of having read somewhere the same thing that lecturer was explaining. Back to his study, he found out that both the first and the second lecture had been practically copied from the books of Marsilius Ficinus*".[34] This is probably why, in his *Cena de le ceneri*, *(Ash Wednedsday Supper)*, Bruno attacks those "pedantic" people in Oxford.

There is a vein of poetry in the empathy which, about 70 years later, is developing between Bruno and Kircher; it is baroque poetry. Bruno perceives an infinite Universe, the motion of planets, the nature of the worlds through hermetic rites. The heliocentric theories are supported by an Italian magician in a non-scientific way, on the basis of an Egyptian solar worship. There is no scientific triumph: "*when reality is still experienced on the basis of a text, or a faith (any text, and any faith), you can still come up against the truth in a poetic fashion. Bruno, by theorizing magical "theatres of the memory", studying cabala and star influences, provoking his own arrest in Venice for trafficking esoteric essays, was condemned shortly after in Rome as a magician (not as a supporter of Copernicus). By pure chance, he had actually attained reality*".[35]

Kircher too is attracted by esoterism, though he shuns it, he always mentions it, and spends most of his life following the *prisca teologia (ancient theology),* whose base is hidden in the hieroglyphs left by the Ancient Egyptian priests. Naturally, the 70 year intervening between the Dominican heretic and the Jesuit scholar, who always respected his hierarchy, has changed the background of astronomical knowledge. However, they both retain a dreamer's approach to knowledge. Kircher adapts to the traditional view of the world—the angels ruling the planets, Noah's Ark—so much that he even sounds disarming. However, when he writes about the Universe, Kircher spreads his wings and sees an infinite Universe, dreams of other worlds, whose existence might be confirmed, if we only managed to retrieve what the Lord taught Adam. In the meantime, the sky of fixed stars looks at us, still and harmonious forever.

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[34] F. Yates, 2006, *Giordano Bruno e la tradizione ermetica,* Laterza ed., p. 231, original edition *Giordano Bruno and the Hermetic Tradition* (The University of Chicago Press: Chicago and London. 1964, repr. 1991 pp. 208–209).

[35] E. Buonanno, 2008, "*Giordano Bruno, il copernicano esoterico e panteista*", *Il Riformista,* 1 March 2008.

Conclusion

Believe there are no limits, but the sky

Miguel de Cervantes,1606

The ways of the Lord are infinite. Those of science are infinite too. At least, this is true of seventeenth century science. Athanasius Kircher tries in every way to demonstrate that Physics can be found in the Holy Writ, and that Science is a large Noah's Ark, a collection of fossiles, a Museum, a system of fine watches. Kircher is devout to our Lord who gave him a whole Universe to be observed and catalogued, and provided him with the keywords to understand it. If we read his books, we may suspect that, though worshipping the Creator, Kircher is actually in love with the Creation, which—from the very first moment—had been paving the way to the Christian revelation. Kircher offers a view of Creation, which may overcome the fragmentary view of the new Mechanic philosophy, which is spreading in the whole of Europe.

Doubtless, Kircher's researches attract us for his capacity of wonder, a capacity which modern science seems to have lost. However, a true scientist should follow a different method. He does not fall in love with phenomena—rather, he observes them. He does not look for explanations in the Holy Writ—rather, he searches them through the inner logic of phenomena.

Nowadays, even scientists endowed with faith follow a shared research method, which is made of logical rigour, experimentation, and public check of their results.

Between Kircher's method and the modern scientific method we can place Galileo, a Christian scientist who was convinced that, in order to interpret the world, you do not need to trouble Our Lord. If Galileo and Kircher had ever imagined to survive to themselves, avoiding condemnation, criticism and abjuration, they would have continued to look around, observe and reflect on the Universe, with science and conscience, but also with faith, doubt, irony, as well as with marvel and creativity.

Galileo has deliberately ignored Kircher, and Kircher himself has hardly quoted Galileo, as if, conscious of not being able to agree, they did not want to admit that they were perhaps complementary.

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Was Galileo right? Of course he was, in the sense that the method he proposed can forecast events, and therefore can help increase our knowledge of the world.

However, there were no proofs of the Earth's rotation. The Jesuits were not obscurantist. Clavius, Grassi and Scheiner did not play a role as enemies of modern science, but rather as scholars proposing different explanations of the phenomena you observe, a role foreseen by modern science. This role was actually indispensable along the complicated path of knowledge. The Jesuits' Collegio Romano was a place where the cultural heritage was preserved, where Galileo had found attentive colleagues and harsh critics who, sometimes restrained by their faith, reached more advanced conclusions than Galileo himself.

Was Kircher right? Obviously not, in the sense that the method he suggests consists in convincing his audience of things he or someone else already knows. This method does not contribute to an effective advancement of knowledge. However, it is not a fruitless method, since it produces, in collaboration with Gian Lorenzo Bernini, at least two masterpieces of the Baroque style in Rome.

We are impressed by Kircher's tireless activity as a collectionist, researcher and writer, aiming at organizing into a system all the ideas circulating at the time. In order to succeed in this effort, it is inevitable to get to know all these ideas. However, Kircher happens to live in a period when there are more and more things to discover and study. In a sense, Kircher becomes "The last man who knew everything", as Paula Findlen defined him.

Kircher is encouraged by the spirit of Ignatius of Loyola, who obsessively suggests to him to show—with shapes and pictures—what the Fathers of the Church wrote. Therefore Kircher is always anxious to demonstrate everything, and considers any object as a holder of hidden truths.

This attitude, so clearly faithful to the letter of the Holy Writ, since it is an expression of Counter-Reform, paves the path to knowledge, to a research which is so free, that it looks like eccentricity. However, it sometimes happens that scientists looking for one thing actually find something else, since the Universe is complicated—just like the human mind.

It is therefore not surprising that, though starting from wrong premises, and following fanciful paths, Kircher sometimes gets to an astonishing truth. In fact, "truth" is not the right definition: however, his conclusions can be true enough to make his name admired, and even worshipped, by students like Petrucci and Kestler, who dedicate to him the frontispieces of their books.

If only he had discovered the manuscript of the Anonymous by Manzoni, he would have certainly wondered whether the character of Don Ferrante might also be his own portrait, drawn with a touch of irony: *"…he knew how to entertain a conversation by reasoning of admirable virtues and peculiar curiosities; by describing exactly the shapes and habits of the mermaid and the phoenix; by explaining how the salamander stays in the fire without burning: how the remora, a small fish, has the strength and the skill to stop any large ship at sea; how dewdrops may become pearls inside a shell; how the chameleon eats air; how crystal derives from ice which has slowly hardened with the passing of centuries; and about other marvellous secrets of Nature."*

Athanasius Kircher dies in 1680. In his will, he asks that his heart be buried inside the Sanctuary of Mentorella, in a casket at the foot of the statue of the Virgin. On the casket, we can read the following sentence: *"Athanasius Kircher, Jesuit, who restored this temple and established the holy pilgrimage which is celebrated here each year. He wanted his heart to be buried at the foot of the altar of Our Lady"*. He does not see the publication of Newton's book, in which he exposes the solid theory supporting Copernicus' Cosmology, but those crystal skies, which have made the cosmos rotate for almost two thousand years, have been definitely shattered, and the sky in which, according to Kircher, "*terrestrial things are placed in a celestial way, while celestial things are placed on the Earth in a terrestrial way*" has become an object of study, and is no longer considered as a sort of receptacle for all the petty vicissitudes of human life.

Appendix
Galileo Galilei and Athanasius Kircher: A Parallel Chronology

1517 Scism of Luther.
1543 Copernicus publishes *De revolutionibus*.
1545 The Council of Trent starts. Catholic Reformation.
1564 Galileo Galilei is born (Pisa, 15 February).
1587 Galileo goes to Rome to meet Christoph Clavius.
1589 Galileo is appointed lecturer at the University of Pisa.
1592 Galileo is appointed professor at the University of Padova.
1596 Kepler publishes *Mysterium Cosmographycum*.
1600 Giordano Bruno is burnt on the stake in Rome. Virginia is born to Galileo.
1600 William Gilbert publishes *De Magnete, Magneticisque Corporibus....*
1602 Athanasius Kircher is born (Geisa, 2 May).
1603 Federico Cesi establishes the *Accademia dei Lincei* in Rome.
1609 Galileo improves the spyglass of Hans Lippershey, and starts observing the sky.
1610 Galileo discovers Jupiter's satellites and publishes *Sidereus Nuncius*.
1611 The Jesuits at the *Collegio Romano* confirm many observations by Galileo
1611 Contemporary discovery of sunspots on the part of Galileo, Scheiner Harriot, and Fabricius.
1612 Galileo writes *Discourse on Bodies on or in Water*. Niccolò Lorini preaches against Copernicus' theory.
1614 Tommaso Caccini attacks Galileo from the pulpit of S. Maria Novella.
1615 Galileo is denounced to the Holy Office by Lorini.
1616 Galileo publishes *Discourse on the Flux and Reflux of the Sea*.
1616 The Holy Office condemns Copernicus' theories.
1617 Kircher is saved miraculously by the Virgin, who heals the gangrene in his feet and an abdominal hernia (this episode is quoted in his autobiography).
1618 Kircher enters as a novice The Jesuit College of Paderbon.
1618 Three comets appear and provoke an argument between Galileo and Orazio Grassi.
1622 Kircher flies to Köln, followed by Lutheran soldiers. He falls into the frozen Rhine, but is saved miracolously (this episode is quoted in his autobiography).

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1623 Maffeo Barberini is appointed Pope with the name Urban VIII. Galileo dedicates *Il Saggiatore* to him.
1623 Kircher is prisoner of the Lutherans, and is saved by divine intercession (this episode is quoted in his autobiography).
1628 Kircher teaches Phlosophy, Mathematics, Hebrew and Syrian in Wurzburg.
1629 Bubonic plague in Florence.
1631 Kircher flies to Avignon because of the Thirty Years' War. He helps Nicolas Claude Fabri de Peiresc decipher the ancient Egyptian papyri.
1632 Galileo publishes *Dialogue concerning the two chief World Systems*.
1633 Galileo is brought to trial for heresy. He is sentenced to life imprisonment, later commuted to house arrest. The *Dialogue concerning the two chief World Systems* is put on the Index.
1633 Kircher is in Rome, where he teaches Mathematics, Physics and Eastern languages at the Collegio Romano.
1634 Death of Galileo's daughter, Sister Maria Celeste.
1636 Kircher publishes *Prodromus Coptus*.
1638 Galileo publishes Discourses and Mathematical Demonstrations relating to two New Sciences.
1641 Kircher publishes *Magnes, sive de Arte Magnetica libri tres*.
1642 Galileo dies (Arcetri, 8 January).
1646 Kircher publishes *Ars Magna Luci et Umbrae*.
1650 Kircher publishes *Musurgia Universalis*.
1651 Kircher creates the Museum of the Collegio Romano.
1652 Kircher publishes *Oedipus Aegyptiacus*.
1665 Kircher publishes Mundus Subterraneus.
1668 Queen Christina of Sweden converts to Catholicisim and moves to Rome.
1669 Kircher publishes *Ars Magna Sciendi*.
1675 Kircher publishes *Arca Noë in tres libros digesta*.
1680 Kircher dies (Rome, 27 November). His heart is entombed in the chapel of the Virgin Mary in the Sanctuary of Mentorella.