Christoph Scheiner's Main Work "Rosa Ursina sive Sol"

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In volume I Scheiner tackles the issue of who was first to discover the sunspots, he also proves that Galilei made errors of observation. Volume II shows illustrations of telescopes, projection methods and compares the optics of a telescope with that of the human eye. In volume III, observations on sunspots are illustrated. Volume IV consists two parts. The first part again deals with the phenomena of the sun, the second part is a collection of quotations from the Scriptures, Church Fathers and philosophers, all designed to prove that Scheiner's interpretation of the fluid heavens conformed to Catholic doctrine.

The work contains 784 pages in Latin. The text presents a rather tedious reading task as it is written in the style typical of the time. It contains four books. In the first part, Scheiner discusses the question of priority of discovery in regard to the sunspots. The second part not only describes telescopes, different kinds of projection and the helioscope but also compares the optics of the telescope to the physiological optics of the eye. In the third book, Scheiner presents a comprehensive collection of the data from his observation of the sunspots. Book 4 consists of two parts: The first part deals once again with solar phenomena like sunspots and sun flares, the sun's rotation period of 27 days and the inclination of its axis of rotation. In the second part, Scheiner mentions numerous passages and quotations from the Bible, the writings of the Church Fathers and philosophers to prove that his geocentric view is in accordance with the teachings of the Catholic Church.[1]

Christoph Scheiner, *Rosa Ursina sive Sol*, Bracciano, 1626–630.

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[1]A summarized translation in German is found in: Daxecker, Franz, Ed. (1996), *Das Hauptwerk des Astronomen P. Christoph Scheiner SJ "Rosa Ursina sive Sol" – eine Zusammenfassung*. Innsbruck: Ber. nat.-med. Ver., suppl. 13.

The first 39 pages are not numbered. The title propounds that the sun has a changing surface due to sunspots and sun flares. It rotates in an annual movement around a fixed axis from West to East and in a monthly movement around a mobile axis from East to West. The mobility of the sun will be demonstrated in four books. Scheiner describes himself as a Jesuit and Swabe and dedicates the work to the Duke of Bracciano, Paulus Jordanus.[2] The copper engraving on the title page[3] shows three bears in a cage twined around with roses. The topmost bear holds a sheet of paper in his left paw. A ray of light falls through an opening in the ceiling of the cave, projecting an image of the sun with its sunspots on the paper. In his right paw, the bear holds a pair of astronomical dividers. Instruments telescopes stand near its feet. The second bear breastfeeds the baby bears, the adjacent inscription reads "Continuous hard work will prevail", the third bear is asleep. The inscription says "I am my own nourishment".

Another copper engraving depicts the patron of the work, "Paulus Jordanus II. Orsinus Bracciani Dux", surrounded by twelve suns, with a rose between each two suns.

Scheiner's list of the main chapters of his work is followed by an approbation of Father General Mutio Vitelleschi and the permission to print, given by Father Niccolò Riccardi.[4] The frontispiece follows suit, showing the signs of the zodiac and the name Father Christoph Scheiner SJ at the top left of the page, and underneath it a hand holding an open book which is enlightened by the spirit (Auctoritas sacra). The monogram of Christ "IHS" is placed in the middle of the page, to its right a dedication to Paulus Jordanus II. Beneath it an eye, illuminated by the spirit, is looking at a hand drawing the sunspots (Ratio). Further below a depiction of Holy Bathildis[5], a member of the Orsini family. In the lower third of the frontispiece the coat of arms of the Orsini family is displayed. The lower half juxtaposes secular credibility (Auctoritas profana), symbolized by the closed Bible which is the ultimate confirmation of any statement, and perception (sensus) which is symbolized by dividers, telescope and scales.[6]

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[2]Duke Paolo Giordano Orsini II (1591–1656). His brother was Cardinal Alessandro Orsini (1593–1626). The name of the family and the rose in the coat of arms of the family supplied the name for the work, "Rosa Ursina sive Sol".

[3]Signed "MG", Matthäus Greuter, born 1564 in Straßburg, since 1606 in Rome, died 22 August 1638 in Rome, Noack, Friedrich (1927), *Das Deutschtum in Rom seit dem Ausgang des Mittelalters*, 2 vols., Berlin: Deutsche Verlagsanstalt, vol. 1:133, 743, vol. 2:218.

[4]Master of the Holy Palace.

[5]Queen of the Francs, wife of Chlodwig II.

[6]Goercke, Ernst (1992), *Frontispiz zur Rosa Ursina.* In Die Jesuiten in Ingolstadt, Ingolstadt 1549–1773: Ingolstadt, 155–157; Daxecker, Franz (2000), *Frontispize in den Werken P. Christoph Scheiners SJ*, In Emblematik und Kunst der Jesuiten in Bayern: Einfluß und Wirkung, Peter M. Daly, Richard G. Dimler SJ, Rita Haub (eds.), Imago Figurata Studies. Turnhout: Brepols Publishers, vol. 3:133–144.

The following pages are dedicated to Paulus Jordanus II. The term "Rosa Ursina sive Sol" is explained: in ancient India, roses were a present for the noble. The rose oil, which was dedicated to the sun, had the power to win their hearts. Scheiner claims having worked on the volume for 18 years, Rome, profess house, 2 July 1629.

To the reader: In 1611, Scheiner observed the sun in moderate fog from the Holy Cross Church in Ingolstadt. He used a telioscope and had no prior notice or rumor of the sunspots. Johann Baptist Cysat suggested the use of tinted glass to facilitate observation at all times. Father Gretser[7] was informed and passed the news on to Marcus Welser. Father Theodor Busaeus, Father Provincial of the Upper German Province, had suggested the use of the pseudonym Apelles to protect Scheiner's reputation.

First Book

The opportunity to write in the City [Rome]

Chapter 1 (p. 1): "In the year of 1624, dear reader, I had travelled to Italy with his Highness Archduke Karl of Austria, whose soul God may bless ... to look after certain matters ... so I had shared my knowledge of the sun which I had gained over a period of successive observations in 1611 ... they insisted unswervingly that I not delay such consequential work which is of utmost importance to philosophy ... so I should present the solar phenomenon, which I had begun and never dropped ... in correct order ... to free myself from false accusations ... I had also been shown a certain work, printed in the Italian language in Rome in 1623, whose title was "Il saggiatore", ... I perceived that Apelles was slandered and accused of ignominious theft while his work on the elliptical sun was made subject to derision."[8] Scheiner continues to zealously defend himself against Galile's accusations.[9]

Chapter 2: Scheiner relates his first observation in Ingolstadt in 1611 and the print of his new observations under the pseudonym, "Apelles latens post tabulam".[10]

Chapter 3: Apelles did not use Galilei's ideas, which is proved by the date on Galilei's letter, which is 28 September 1612. Scheiner did not receive the letter until 5 October 1612 (p. 9/II/34–35). He was the first to use the pinhole projec-

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[7]Father Jakob Gretser SJ (1562-1635), theologian and humanist.

[8]In "Il saggiatore", Galilei accuses Scheiner of plagiarizing, albeit without giving his name, Braunmühl, Anton v. (1891), *Christoph Scheiner als Mathematiker, Physiker und Astronom*, Bayerische Bibliothek 24, Bamberg: Buchnersche Verlagsbuchhandlung, 21–23.

[9]Gorman, Michael John (1998), *The Scientific Counter-revolution. Mathematics, natural philosophy and experimentalism in Jesuit culture 1580–1670*, Florenz: European University Institute, 137–158.

[10]Casanovas, Juan (1997), *Early Observations of Sunspots: Scheiner and Galileo*. In 1st Advances in Solar Physics Euroconference, Advances in the Physics of Sunspots, ASP Conference Series 118; B. Schmieder, J. C. del Toro Iniesta, M. Vásquez (Eds.), 3–20.

tion method and the reflection method. Likewise the use of tinted glass and the drawing method go back to Scheiner. Galilei explains the movement of the sunspots in a straight parallel with the ecliptic.[11]

Chapters 4–7: Scheiner gives more reasons for the time of discovery of the sunspots.

Chapter 8: Scheiner has never claimed priority of discovery, Galilei falsely claims to have invented the telescope.

Chapter 9: Scheiner accuses Galilei of ignoring the essential properties of the sunspot phenomenon: the annual movement, the irregular monthly movement, the direction of the movement, the location of the spots, the obliqueness of the movement in relation to the ecliptic. Galilei is also unaware of the aberration of the telescope and the curved path of the sunspots. The Apelles letters contain the basis for all the teachings found in the "Rosa Ursina sive Sol."

Chapter 10: Galilei's faulty observations and Scheiner's true observations are juxtaposed in 24 antitheses; for example, Galilei's observation that the axis of the sun is perpendicular to the ecliptic. Scheiner counterargues that the sun's axis is never perpendicular in reality while appearing so at two times.

Chapter 11: Once again Scheiner gives proof that he wrote his letters himself and that he has not changed his opinion by giving data from his correspondence with Galilei. He admits to having mistaken the spots for spherical bodies but pleads that he corrected his mistake 22 days later (p. 59/11/17, 25).

Second Book
Instruments and Methods

Chapter 1: Astronomy needs data from telescopic observation; the telescope is of excellent use: "Celestial bodies have been the subjects of many teachings, based on assumptions and beliefs. Due to the enormous distances, little could be proved by empirical fact and the senses. Now that the telescope, the all-pervading eye, has been bestowed on us from Germany by the grace of God, ... we have been vouchsafed the opportunity to closely study the celestial bodies or almost touch them" (pp. 68/II/6-23).

Chapters 2 and 3: These chapters describe the difficulties encountered in the observation of the sun: excessive brightness, a small visual angle and constant changes in the sun's position. Observation is possible by naked eye, by telescope and by projection. The naked eye yields no useful results.

Chapter 4: The helioscope is a telescope using colored glass whereas the telioscope (telescope) uses colorless glass. The helioscope has a convex lens and a concave lens [the ocular as a concave lens]. Scheiner built his first telescope

[11]Shea, William R. (1970), *Galileo, Scheiner, and the Interpretation of Sunspots.* In: Isis 61:498–519.

using blue glass planes. He gave a telescope to Archduke Maximilian III the Grandmaster[12] in the Tyrol and explained sunspots and sunflares to him.

Chapter 5: This chapter illustrates several methods of projection. Through a pinhole, light falls into a dark chamber onto a screen, allowing excellent observation.

Chapters 6–9: Further explanations regarding the advantages of the pinhole projection method. It produces clear images and does not strain the eyes. The projection is sizeable yet structured, the process saves time. Chapter 8 (p. 77) gives an illustration of the telioscope based on pinhole projection. Observation is restrained by the three different movements of the sun, i.e. the daily movement, the annual journey and the movement of the sunspots.

Chapter 10: Scheiner introduces a procedure to record the daily movement of the sun and the sunspots on a sheet of paper, which serves as a projection screen.

Chapters 11–14: The instrument needs to be moved in accordance with the solar movement. Scheiner also mentions the importance of the right moment for observation and how to apply a plumbline. The sunspots do not follow a regular movement.

Chapters 15–20: The ecliptic runs parallel to the horizon in one point, at noontime at the beginning of June and December, in the morning between December and June, and in the afternoon between June and December. Due to the movement of the sunspots, the observation has to be concluded within a quarter of an hour. In unfavorable time and conditions, the projection screen has to be moved in accordance with the sunspots. The purity of the lens and its shape is of crucial importance: "A clear, transparent, pure, homogeneous and even lens is considered equal to a gemstone" (p. 97/II/40–44). The seat of vision is not the lens but the retina (p. 101/II/31–34). The right smoothness of the lens can be judged by looking at the reflection of a bright object.

Chapters 21, 22: The lenses have to be fitted correctly into the telescope. Scheiner includes a precise description. The telescope rests on a slanted mount [for an illustration see p. 105].

Chapter 23: Several illustrations draw a comparison between an eye and a camera obscura. The eye is a system of lenses similar to the telescope [for identical illustrations see p. 107, 109, 111, 113, 123]. Each depiction shows the artificial telescope on the left side and the eye as natural telescope on the right side, preceded either by a divergent lens, a convergent lens, a Dutch telescope and an inverse Dutch telescope. Scheiner mentions an experiment conducted in Innsbruck in which he demonstrated a large *camera obscura* for Archduke Maximilian III (p. 110/II/20–30). He also describes the intersection of the light rays inside the eye: "I have proved, I may add, that the rays intersect before the image of the object is

[12]Daxecker, Franz (1995), *Briefe des Naturwissenschaftlers Christoph Scheiner an Erzherzog Leopold V. von Österreich-Tirol 1620–1632*, Innsbruck: Publikationsstelle der Universität Innsbruck, vol. 207:11–5.

projected on the retina. Not only have I showed this in my work Oculus with many plausible experiments and thoughts, I also saw clearly, when looking at the human eye in Rome in the year of the Lord, 1625, that the rays of candlelight entering through the pupil crossed before touching the retina when the sclera had been removed. I had conducted this experiment with numerous animal eyes. The eye was dissected by an anatomist, a doctor of the Roman Sapientia,[13] however, in the presence of Reverend Father Niccolò Zucchi[14] to please me" (p. 110/II/39–53).

Chapter 24: The eye and a concave lens resemble a telescope used the wrong way round. A concave lens improves the sight of the myopic patient.

Chapter 25: The convex lens serves the presbyopic patient. The eye is a system consisting of two convex lenses.

Chapters 26–28: Scheiner explains several different combinations of lenses, comparing the retina of the eye to a projection screen. A concave lens in combination with a convex lens will produce a clear, distinct image on the screen. Chapter 28 shows the path of the light ray through a flattened concave lens, a double concave lens and a telescope.[15]

Chapter 29: One type of telescope is called the "common" [also named "Dutch" or "Galilean" telescope] telescope with a concave and a convex lens. Scheiner found that myopic patients shortened the telescope during observation.[16] "If the eye could move the layer underneath the retina in likewise manner or if the crystal lens were moveable to the necessary extent,[17] an extension or contraction of the telescope would not be necessary."

Chapter 30: This chapter contains an illustration of an operated cataractic eye with and without additional lens. It also contains a method for the determining the apparent diameter of the sun through a small opening. Two convex lenses [a Kepler telescope] in a tube produce an inverted image.[18] This was Scheiner's method of observation for the secondary sunspots and sun flares. As early as 1614 he showed such a telescope at the court of Archduke Maximilian III (p. 130/I/6–9). With the help of two convex lenses, a fly can be turned into an elephant (p. 130/1/32–38).

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[13]Half a line is missing in the original text of the "Rosa Ursina sive Sol" (p. 110/II/50). Scheiner supplements in the "Erratorium Correctio": quoda Sapientiae Romanae Doctore.

[14]Father Niccolò Zucchi SJ (1586–1670), Astronomer.

[15]Daxecker, Franz (1994), *Further studies by Christoph Scheiner concerning the optics of the eye*. In Documenta Ophthalmologica 86:153–161.

[16]He alludes to the principle of the optometer, an instrument formerly used for determing the appropriate glasses by measuring the degree of extension of the telescope.

[17]Scheiner repeats his erroneous opinion that the accommodation (viewing objects at close range) is achieved by a movement of the retina or the lens. In Scheiner, Christoph (1619), *Oculus hoc est: Fundamentum opticum*, Innsbruck: Daniel Agricola, p. 23 he attributes it correctly to the increased flattening of curving of the lens; Daxecker, Franz (1992), *Christoph Scheiner's eye studies*. In Documenta Ophthalmologica 81:27–35.

[18]Scheiner used the telescope designed by Kepler.

Chapter 31: This chapter explains how to use the telescope for the observation of the sun and the planets. The concave lens is placed behind the convex lens. More than 2000 observations using such telescopes were made in Rome.

Chapter 32: The phenomenon of the sunspots can be observed in different ways: with a telioscope through the fog [as in Ingolstadt], with a helioscope, through a small opening [camera obscura], as the reflection of a plane mirror on a screen, as the projection of a convex lens in a dark room, as the projection through a telescope on a screen. It is the eye lens which projects the image onto the retina, the seat of vision.

Chapter 33: Scheiner gives instructions on how to build a telescope. A plane-concave and a plane-convex lens are the most suitable in this case. The telescope he used in Rome was approximately 3 feet long.

Chapter 34: The course of the sun, its observation and the difficulties involved are treated in this chapter. A long telescope is best suited for the sun. While drawings made with the help of a single lens show no aberration, the necessary distance [from the screen] makes them hard to come by. The image of the sun must be round, a circle must be drawn through 4 limiting points.

Chapter 35: 8 points must be determined on the circumference of the projecting screen. Plumbline, time and solar altitude need to be determined.

Chapter 36: The sunspots are named by letters of the alphabet. The points of orientation are located outside the circle. Scheiner claims to have continued observations of the sun for over 16 years (p. 142/11/45–47), with sometimes more than 30 observations per day.[19]

Chapter 37: This chapter contains the interpretation of the results and explains the measurement of the distance between the sunspots and the fringes of the center of the sun. Any changes in the instruments must be recorded carefully.

Chapter 38–42: Scheiner introduces the ecliptic into the illustrations of the sun. There are ideal times of day for solar observations. Between December and June, they should be undertaken in the afternoon, from June until December the sun is best observed in the morning.[20]

Third Book

P. 150 shows a copper engraving covering a whole page. It displays all the methods of observation: a helioscope (D) for observing the sun, a telescope (C) and an obelisk with a lens (R) which reflects the sun rays on a screen. The second obe-

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[19]Most of the copper engravings in "Rosa Ursina sive Sol" were manufactured by Daniel Widmann who signed on p. 150 in the bottom left corner. Widmann, born 1598 in Strassburg, who worked as a copper engraver in Rome and died in Rome on July 25, 1658, Thieme-Becker (1907–1950), *Allgemeines Lexikon der bildenden Künstler von der Antike bis zur Gegenwart*, 37 vols., Leipzig: Seemann, reprinted Leipzig: Seemann, 1999, vol. 35/36, 516 (falso David, recte Daniel).

[20]P. 149 occurs several times, followed by p. 150 in the third book.

lisk has a bored sphere (G) projecting the sun rays through the hole on a screen, a plane mirror (K) reflects sun rays on a screen whereas the lower half shows the helioscope and two observers. A Jesuit can be seen in the background, taking notes on a sheet of paper with a circle divided into four sections. In the foreground, an assistant is holding a plumbline into the path of the rays, splitting the projection of the sun in two halves. Using a pair of dividers, he determines the position of the sunspots. The two men may well be Father Scheiner (in the background) and Father Cysat. The different methods of observation are as follows: 1. Pinhole projection through an opening onto a screen at a distance of 15 to 20 feet. 2. Directly through a lens. 3. With the naked eye in foggy conditions. 4. With a helioscope. 5. With a common telescope in foggy conditions. 6. with a plane mirror. 7. Projection through a telescope as used in Ingolstadt in 1612. General remarks: The following illustrations of the sunspots were chosen from more than 2000 observations made in Rome. Some other observations were also included. The text differentiates between sunspots, sun flares and sun shadows. The sunspots have a core, the sun flares display different degrees of brightness and the sun shadows are described as delicate, indeterminate, cloudy and changing forms. They might be early stages or traces of sunspots. Scheiner made his observations with the assistance of Father Johann Baptist Cysat SJ, Father Georg Schönberger SJ and Father Carolus Malapertius SJ. The text is followed by 70 copper engravings depicting the sunspots.[21]

Essential information in the "Rosa Ursina sive Sol": It identifies shadows or secondary spots, spots of light, the "royal path" of the sunspots (approximately 30° North and South of the solar equator) and the spots themselves. A description of Father Christoph Grienbergets heliotropic telescope and his methods (pp. 347–400) with an illustration is found on p. 349.[22]

Fourth Book

Fourth Book, part one

This part deals with two fields: the peculiarities of the solar phenomena, the theory of the solar phenomena and other conclusions.

Chapter 1. The sunspots rise and set with the sun. They never leave the sun despite lacking a parallax.

Chapter 2. All sunspots move from the East to the West of the sun.

[21]See also Copper engraving of sunspots in Athanasius Kircher's *"Mundus subterraneus"*. 1678. Vol. 1, Amsterdam: Joannes Janssonius à Waesberge & Filios, p. 64.

[22]For indirect observation of the sun with a telescope flexibly mounted on two axes. A plumbline in front of the projection screen, a sector and a dial determine the position. The sun's projection in the middle of the screen could be followed with a single movement of the telescope, so it was possible for the observer to work on his own (equatorial mounting, machina aequatoria).

Chapters 3 – 6: The sun's diameter's average value is 31'. Scheiner adds that Venus has phases like Mercury, from which fact he concludes that both planets orbit the sun. The names of Copernicus and Tycho Brahe are mentioned here (p. 412/II/8 – 17).

Chapters 7 – 15: Sunspots and sun torches never appear outside the solar disc. Apelles' seemingly contradictory statement was an assumption based on the irregular movement, not on the result of observation. The sunspots were then considered small solar moons. The sunspots never halt or move backwards, they follow a regular path at all times, repeating their motions every half year. The sunspots move in a straight line twice a year, once between the end of November and the beginning of December, then between the end of May and the beginning of June. They have the same rotation period as the sun and are inclined at an angle of 6° – 8° with the ecliptic, ascending in winter, descending in summer. The curvature and the inclination of the chords are dependent on the season.[23]

Chapters 16 – 20. The curvature of the sunspots' path is discussed once more.

Chapters 21 – 27. Several possible counterarguments are refuted. Scheiner emphasizes again that the spots are not outside the sun.

Chapters 28 – 33. Scheiner observes the effects of a small aperture and the aberration caused by lenses. "A single true observation", he writes (Chapter 33, p. 472/II/21 – 23), "ridicules a thousand hair-splitting arguments."

Chapters 34 – 40. Scheiner points out the regular movement of the sunspots. The spots, when near the axis of the telescope, are by a third smaller than at the sides. Each sunspot has its cycle of waxing and waning, even their initial sizes differ strongly. They take their matter from the intestines of the sun, always changing their brightness. Sunspots dissolve into spots with and without a core. Their shapes can be regular or irregular.

Chapters 40 – 47. The sunspots are neither shadows nor holes in the shining layer of a dark solar body. The sun appears brighter in the middle.

Chapters 48 – 52. Some of the spots are brighter when near the horizon. The sunspots consist of a solid, dark and non-transparent body, with part of the matter protruding beyond the bright surface of the sun.[24] Like an ocean, the sun is constantly covered with ruffled waves. The observation of this phenomenon, however, requires a powerful telescope.[25] There are times when no spots appear on the solar

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[23]In spring, the sun's south pole can be seen. The path of the sunspots has the shape of a hollow are pointing upward. In fall, the north pole of the sun can be seen while the are faces downward. In June and December, the sunspots follow an almost circular movement. Galilei had not paid attention to this annual pattern. Due to the tilted Earth's journey around the tilted sun, the sunspots only seemed to turn upward or downward.

[24]The pages are correctly numbered as far aspage 510, then follows p. 459 (= 511) until p. 479 (= 522). From p. 523 onward correct pagination is followed.

[25]He probably means the granulated surface.

disc. According to observation, the sunspots are located on the same surface as the sun flares which seem to be in the center of the sunspots.

Chapters 53–66. "Some spots shrink in size and appear to become thinner. In the end only a delicate shadow is left, ..." (p. 535/I/10–14).[26]

Chapters 55 to 66 present 12 confirmations of the true position of the sunspots.

Fourth book, part two

This part reveals the theory of the movement of the spots and flares, the apparent and true diameter of the sun, fiery nature, transitoriness, the liquid consistency of the sky and the stars and the opinion of the Church Fathers and the scholars.

Chapter 1. In regard to the ecliptic, Scheiner wrote, that, "I sometimes ... measured 6°, never less, sometimes up to 8° but never beyond that. Most of the time the value was between 7° and 7.5 °, on which assumption I have based my experiments."[27] The sunspots have different rotation periods, varying between 25 and 28 days.[28]

Chapter 2. In this chapter, Scheiner describes the different zones on the sun. There is a hot zone as far as 30° in latitude on either side, from 30° up to 83° the temperature is moderate, between 83° and 90° the temperature is stable and low.

Chapter 3–6. In June, the sun's diameter is at least 46'. Scheiner assumes a diameter of 32' like Tycho Brahe, to be on the safe side.[29] Scheiner constructed an instrument (p. 575) to measure the sun's diameter, but his method yielded exaggerated results.

Chapters 8–17. Scheiner tries to understand the duration of the solar phenomenon, the effect of the sunrays and the protective properties of the atmosphere. All solar phenomena are located on the sun's bright surface. He considers astrology a useless science. Scheiner is also concerned with questions of quality and movement of the sunspots and the nature of the sun. The sun answers all these questions, even explaining several Bible passages, especially from Genesis. The death of Charlemagne was preceded by lunar and solar eclipses (p. 608). Cedrenus writes that the seventh year of the reign of Constantine VI saw an eclipse which lasted for 17 days. In the year of Caesar's death and during the Antonian war, the sun was pale for a whole year, according to Pliny. The eclipse at the time of Christs death, which reportedly could be seen all around the world, is explained as the

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[26]Schreiber, Johann SJ (1902), P. *Christoph Scheiner, S. J. und seine Sonnenbeobachtungen.* In Natur und Offenbarung, Münster: Aschendorffsche Verlagsbuchhandlung, 48:1–20, 78–93, 145–158, 209–221, 150.

[27]Schreiber, 210. According to modern measurements, the plane of the solar equator against the ecliptic is determined 7°15'.

[28]Today, the Siderean (sidus = a fixed star as mark of comparison) rotation time of the sun is assumed at 25.38 days.

[29]The sun's diameter at the end of June is 31' 31".

consequence of a sunspot. Even comets seem to originate from the sunspots, as matter that can break away from the sun. When the sun is projected through a small opening, the topmost third of the sun is shown with regular brightness. The brightness decreases toward the sides, the image is blurred. A small opening will produce a large image and vice versa. Johann Kepler made a similar experiment. The sun, the stars and the sky are described as "fiery, transitory or liquid" (p. 624). This description is backed by passages from the Church Fathers, the Holy Bible and its interpretations.

On the fiery nature ofthe sky and the stars:
Scheiner uses a quotation from Flavus Magnus Aurelius Cassiodorus: "I recommend not the personal opinion ... but the sayings of the old ...".

Chapter 18. This chapter lists quotations from authors who believe that the sun was created on the Fourth Day, from a cloud of fire and light. Among the authors are Juvencus, Alcuin, Saint Venerable Bede, Saint Anselm of Canterbury with a quotation on the fiery nature of the skies, Saint Junilius and Dionysios the Areopagite.

Chapter 19. Augustinus Steuchus and Hermes Trismegistos are among the more recent authorities who have studied the fiery nature of the sun, the sky and the stars.

Chapters 20–23. Authorities from the Holy Bible and Hebrew sources refer to the fiery nature of the sun, among them are Psalm 19, Ecclesiastes 1:5, Jesus Sirach 17:31, 43:2. All the ancient philosophers were in favor of the fiery nature. Some mathematicians either follow the system of Tycho Brahe or the Copernican hypothesis. The Copernicans believe in the fiery nature of the sun which they call the center of the world, like the followers of Tycho Brahe.

On the transitory nature of the sky and the stars:
Chapters 24 and 25. This chapter presents quotations from numerous Bible passages, among them Genesis 1:6–7; Psalm 104:2, 148:4; Jesus Sirach 17:31; The Apocalypse 6:13, 20:11, 21,1; Second letter to Peter 3,3–13 (p. 659), Saint John Chrysostom and Saint Basil. Saint Ambrose says that, "All things composite perish." Scripture is the foremost source of knowledge, not the ancient philosophers. Even Plato borrowed his arguments for the transitoriness of the world from Moses and the Prophets. Peter believed that the sky was created so the unworthy should not see the throne of God. The mathematicians give many arguments to support this view, the seas are down below, the mountains were taken from the bottom of the sea. The chapter also mentions Father Marin Mersenne SJ, Father Alfonso Salmerón SJ, Saint Ignatius, Johann Baptist Laurus, Father Johannes Maldonatus SJ and Aristotle, who says that, "nothing can come of nothing, thus the world has eternal existence". Matthew (24,29) prophesies that, "stars will begin to fall." Other quotations are from Nicolaus Serarius, Father Johann Baptist Folenghius OSB, Génébrardus and Father Martin Becanus SJ.

On the liquid nature of the sky:[30]
Chapter 26 lists various authorities from the Scripture. Isaiah compares the sky to nothingness in 40:23–24 and to smoke in 51:6. The sources listed here comprise also Joshua 10:12–13 (p. 699/II/2),[31] Jesus Sirach 1, Psalm 19:7 and 104, Job 38, Isaiah 13:10 and Habakkuk 3.

Authoritative passages from the Church Fathers on the liquid nature of the sky:
Saint Augustine: "We must not assume fantastic or miraculous circumstances but have to obey Holy Scripture." This quotation is followed by others from the work of Saint Basil, Saint Ambrose, Saint Epiphanius and Saint Cyril of Jerusalem. Saint Eucherius writes, "If water can be airborne, so can man be" and Saint Venerable Bede that "The water does not fall, for it is like ice." These sources confirm Scheiner's opinion that the sky is not composed of solid matter. He proceeds to list other authorities such as Ptolemy, Saint John Chrysostom, Saint Eusebius, Saint Philastrius, and Firmianus Lactantius. Saint Isidore calls the sky "pure air" and Saint Bonaventure says that, "The stars move in the sky like birds in the air ...". Aristotle's notion that the sky is different from nature has not yet been proven.

On the liquid,[32] *fiery or mixed nature of the sky:*
Chapter 27. More recent theologians favor the liquid sky, among them Cardinal Robert Bellarmine, Duke Federico Cesi[33] of Sant'Angelo and Father Johann Baptist Folenghius OSB. Marin Mersenne affirms that the stars are moved by angels or directly by the hand of God and that the sky is like ether. Raphael Aversa believes that the stars revolve around their center, which is his explanation for the twinkling of the stars. He believes in the liquid sun. Father Hurtadus de Mendoza SJ speaks of 3 heavens. Paul's delight took him to the third heaven. Chapter 28. All the ancient philosophers assume a liquid sky. Aristotle, Cicero, Seneca and Artemidorus are mentioned as examples. For Albertus Magnus, there is an airlike substance between the heavenly spheres, even Egyptian hieroglyphs confirm the idea of a liquid sky. Chapter 29. Expert astronomers favoring a liquid sky include Ptolemy, Homer, Anacreon, Vergil, Lucretius and Pliny. Vitruvius claims that Mercury and Venus orbit the sun, consequently neither Tycho Brahe nor Galilei have discovered this as a fact. Even Hyginus, Manilius and Marcianus Capella repeat

[30]"Liquid" is used here in the sense of celestial bodies, moving in a liquid sky like fish in the sea.

[31]Scheiner does not give the full quotation. "So Joshua prayed to the Lord, on the day the Lord delivered up the Amorites to the Israelites. He said in the presence of Israel: Stand still, O sun, at Gibeon, O moon, in the valley of Aijalon! And the sun stood still and the moon stayed, while the nation took vengeance on its foes. Is this not recorded in the Book of Jashar? The sun halted in the middle of the sky; not for a whole day did it resume its swift course."

[32]The liquid sky is contrasted to the crystal spheres.

[33]Duke of Sant'Angelo (1585–1630), friend of Galilei's.

the ancient teaching of the Egyptians that Mercury and Venus orbit the sun. Copernicus and his followers, who believe in the movement of the planets, postulate a liquid sky and a fiery sun. Their opinion is shared by Johannes Kepler, Galilei, Tycho Brahe, Cornelius Gemma, Vitichius, Christoph Rothmann and others. Never in the course of 2000 years has the solid nature of the sky been taught in the academies, not even in China. Scheiner quotes more expert opinions, including those of Father Joseph Blancanus SJ, Father Johann Baptist Cysat SJ and Father Oratius Grassi SJ. While Father Christoph Clavius SJ observed the phases of Venus, he was still unaware of the sunspots. Also Antonio Magini has taken to asserting a liquid sky. The idea of a solid sky was never an astronomets opinion, it was spread by Eudoxus and Callipus.[34]

Chapter 30. This chapter gives additional answers to arguments against the liquid nature of the sky. The term "firmament" does not signify the firm nature of the sky, but its extension in three dimensions.

Final conclusion: Only God is unchanging.

Rome, written at the Collegium Romanum of the Society of Jesus and at the profess house between 1624 and 20 March 1629.

Letter from Duke Federico Cesi to Cardinal Robert Bellarmine. Cesi writes about the nature of the sky according to the Holy Scriptures, the discoveries of Galilei and Hebrew etymology; the letter is dated 14 August 1618.

Letter from Cardinal Robert Bellarmine to Duke Federico Cesi

The Cardinal affirms that the sky is round as this is the perfect shape. Rome, 25 August 1628.

Index and Table of misprints:

The book includes an index of 34 pages and a table ofmisprints *(Erratorum Correctio)* of two pages.

On the context of the book:

In "Il saggiatore", Galilei accused Scheiner of plagiarism.[35] Scheiner defends himself against these accusations by asserting, "Galilei may have observed the sunspots earlier, albeit he did not describe them earlier"; "The example of Christ and the practice of clemency taught him never to claim priority of discovery" (p. 26/II/16–26) and "Scheiner's knowledge cannot possibly have been taken from Galilei."[36]

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[36]Braunmühl, 24.

[34]Scheiner quotes approximately 160 Saints, Church Fathers, Scriptors, Astronomers.

[35]"...some tried to steal my honor by pretending ignorance of my writings, while claiming for themselves miraculous discoveries which I had already made...", *Le Opere di Galileo Galili* (1890–1909), Edizione Nazionale, direttore: Antonio Favaro. Firenze: G. Barbèra (Ed.); XX vols., vol. VI: 149–150, 214; Ziggelaar, August SJ (1986), *Scheiner und Grassi Widersacher Galileis*, In physica didactica 13:35–43, 37; Braunmühl, 22.

The print of the work was begun in 1626 and not finished until 1630, due to Scheinets difficulties in raising funds. Father General Vitelleschi had to pay an advance to Duke Orsini. In his letters to Archduke Leopold V, Scheiner writes about progress with his work: "I implore you that Galilei must not hear of my writings on the sunspots."[37] In 8 May 1627, Scheiner writes that, "My work on the sunspots is now at the printer's. The first book is now finished, on Monday the third book should be begun." Scheiner was afraid his work would not be completed: "I am afraid our Honorable Father will send me to your Highness before my work has been printed, empty-handed and filled with shame as I do feel ashamed to appear thus in Germany. I have finished writing and the work has been printed with the exception of a small passage at the end which is still held by the censorship authorities. Once the last passage has been approved of, the work shall be printed in two month's time." He is eager to return to Germany and asserts that "I have waited but for the completion of my book...,"[38] "my book will be for sale no later than a fortnight after Easter ... ."[39] Alessandro Orsini has volunteered to sponsor the book and that Duke Paolo Orsini demands 300 copies.[40] On 8 May 1632, he complains that Duke Orsini is still in possession of the original frontispiece for the work.[41] On 1 January 1632, Pierre Gassendi inquires about the work on the sunspots, adding that he is a follower of Galilei's teachings. In two letters dated 2 November 1634 and 7 May 1633, Gassendi expresses his delight in the book.[42] On 15 March 1634, Scheiner writes a letter to Athanasius Kircher in Rome, asking him to "... climb up into the attic and take a look at the stacks of the 'Rosa Ursina' lest they should suffer from humidity, rain or mice."[43] Between 1634 and 1639, Vitelleschi repeatedly urges Scheiner to pay his debts.[44]

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[37]Daxecker(1995), 85.

[38]Daxecker (1995), 127, 139, 142: Letters to Archeduke Leopold from 8 May 1627, 7 September 1628, 9 Februar 1630.

[39]Daxecker (1995), 144: Scheiner's letter from 30 March 1630 to Archduke Leopold.

[40]Daxecker (1995), 152: The letter was dated 29 November 1630 to Archeduke Leopold. Scheiner mentions the names of several receivers of copies.

[41]Daxecker (1995), 159: 8 May 1632 to Archeduke Leopold.

[42]Daxecker, Franz, Florian Schaffenrath, Lav Subaric (2001), *Briefe Christoph Scheiners von 1600 bis 1634.* In Sammelblatt des Historischen Vereins Ingolstadt 110:117–141, 129, 136, 140.

[43]Daxecker (1995), 175; Daxecker, Schaffenrath, Subaric, 141.

[44]Archivum Romanum Societatis lesu, Epistulae Generalis (Epist. Gener.): e.g. Epist. Gener. 1628–1635, Austr. 4-II, fol. 950, 16 November 1634 to Vienna; Epist. Gener. 1623–1637, Boh. l-II, fol. 794, 25 October 1636 to Neisse; Epist. Gener. 1637–1557, Boh. 2-1, fol. 16, 6 February 1638 to Neisse; Daxecker, Franz, Lav Subaric (2002), *Briefe der Generaloberen P. Claudio Aquaviva SJ, P. Mutio Vitelleschi SJ und P. Vincenzo Carafa SJ an den Astronomen P. Christoph Scheiner SJ.* In Sammelblatt des Historischen Vereins Ingolstadt lll:101–148; Daxecker, Franz (2004), *The Physicist and Astronomer Christopher Scheiner: Biography, Letters, Works,* Innsbruck: Publications at Innsbruck University, vol. 246:124–145.