

GALILEO'S ACCOUNT OF ASTRONOMICAL MIRACLES
IN THE BIBLE:
A CONFUSION OF SOURCES

BERNARD R. GOLDSTEIN
University of Pittsburgh

RIASSUNTO

Nella sua *Lettera alla Granduchessa Cristina* Galileo considerava due miracoli astronomici della Bibbia (il sole immobile davanti a Giosuè, e l'ombra solare che si muove a ritroso sui passi [cioè la meridiana] d'Achaz), citando alcune discussioni di questi passi nella letteratura precedente. Dopo aver esaminato le relazioni tra questi testi e altri commenti antichi della Bibbia da cui essi dipendono, l'Autore dimostra che Galileo non ha probabilmente esaminato tutti e sette i testi in prima persona, ma che la sua fonte era in realtà il commento di Magalhaens al libro di Giosuè, pubblicato nel 1612 (il più recente dei sette in cui gli altri sei sono citati); e che, oltre alla confusione già esistente nei testi citati, Galileo ha ulteriormente confuso i riferimenti testuali.

In the *Letter to the Grand Duchess Christina*, written in 1615,¹ Galileo discussed the two miracles found in the Hebrew Bible that concern astronomy, interpreting them in support of Copernicus's heliocentric system. While he pays more attention to the miracle of Joshua, he also cites the miracle of Hezekiah; these two miracles are treated together following the antecedent tradition of Biblical scholarship on which Galileo depended. Briefly, Galileo's argument is that at Joshua's

¹ GALILEO GALILEI, *Opere*, Florence 1968, vol. 5: 309-348. I have also consulted the English translation by S. Drake in *Discoveries and Opinions of Galileo*, New York 1957, pp. 175-216.

request God willed the Sun to stand still, and at the same time all other celestial motions ceased with the result that the celestial bodies remained in the same relative positions, and so the day was miraculously prolonged. It was only necessary for the Sun to be so commanded, in agreement with the literal sense of the text, reason, and even the Church Fathers and later commentators. Further, the Biblical text says that the Sun stood still in the midst of the heavens, surely more easily understood according to the Copernican system than the Ptolemaic one. The same reasoning also applies to the miracle of Hezekiah.

My concern here is not to assess the validity of Galileo's argument, but only to consider the sources he invoked in the course of his interpretation of the two relevant Biblical passages: Dionysius the Aeropagite (actually, Pseudo-Dionysius dated by various authorities between the fourth and the sixth centuries);² St. Augustine (actually, an anonymous Irish priest of the seventh century who wrote *De mirabilibus sacrae scripturae*);³ the Jewish authors endorsed by Josephus;⁴ Paul of Sancta Maria (Bishop of Burgos: d. 1435);⁵ Alonso Tostado (Bishop of Avila: d. 1455);⁶ Thomas de Vio (Cajetan: d. 1534);⁷ and Cosme Magalhaens (d. 1624), a Portuguese Jesuit at Coimbra.⁸ As far as I can tell from an investigation of the Galileo literature, there has not been any extended study of these sources, their relationship to one another or to Galileo, even though this work of Galileo is near the heart of the

² R. HATHAWAY, *Hierarchy and the Definition of Order in the Letters of Pseudo-Dionysius*, The Hague 1969, where these letters are said to date from the early sixth century (p. 30); cf. R. ROQUES, *Denis l'Aréopagite*, in *Dictionnaire de Spiritualité*, Paris 1957, vol. 3: 244-286; and M. DE GANDILLAC, *Oeuvres complètes du Pseudo-Denys l'Aréopagite*, Paris 1943.

³ See M. ESPOSITO, *On the Pseudo-Augustinian Treatise 'De mirabilibus sanctae scripturae', Written in Ireland in the Year 655*, « Proceedings of the Royal Irish Academy », 35, C (1918-1920), pp. 189-207.

⁴ Josephus, a general in the Jewish revolt against Rome in the first century A. D., is best known for his account of that war, and for his treatise, *The Antiquities of the Jews*.

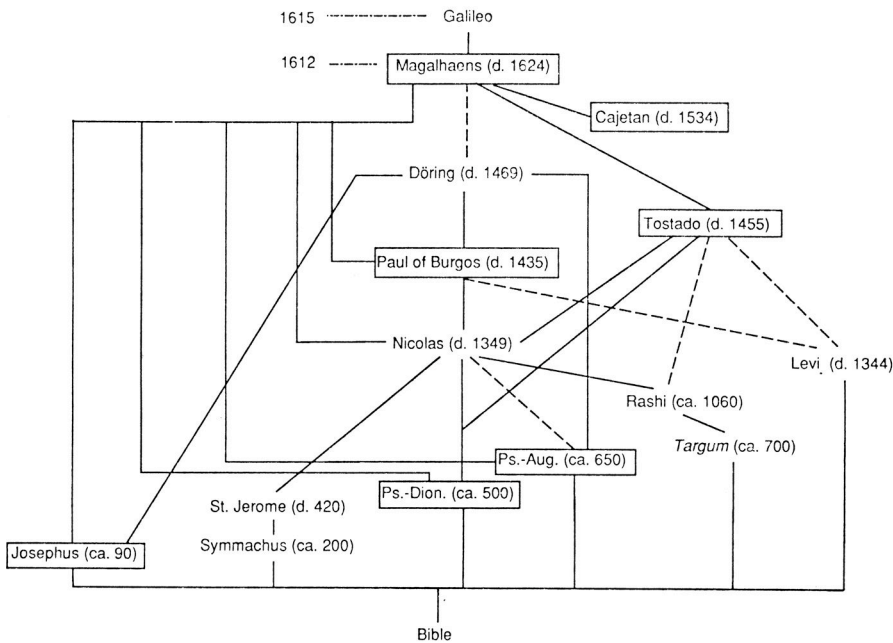
⁵ On Paul of Burgos, see Y. BAER, *A History of the Jews in Christian Spain*, Philadelphia 1966, vol. 2: 139-155.

⁶ See D. GONZALO MAESO, *Alonso de Madrigal (Tostado) y su labor escrituraria*, « Miscelanea de estudios arabes y hebreos », 4, 1955, pp. 143-185.

⁷ J. A. WEISHEIPL, *Thomas de Vio (Cajetan)*, in *The New Catholic Encyclopedia*, New York 1967, vol. 2: 1053-1055. Cajetan, a Dominican, wrote commentaries on the Bible using both the Hebrew and the Greek versions, as well as a commentary on Aquinas's *Summa theologiae*; see also C. H. LOHR, *Renaissance Latin Aristotelian Commentaries*, « Renaissance Quarterly », 28, 1975, p. 692.

⁸ Magalhaens is also known for his participation in editing the Aristotelian commentaries of Coimbra: cf. LOHR, *op. cit.* (n. 7), p. 717, and ID., « Renaissance Quarterly », 31, 1978, p. 555. The work cited by Galileo is his *In sacram Josue historiam commentarium tomii duo* (Tournon 1612): I consulted the copy in the Bibliothèque Nationale, Paris (shelfmark: A.792).

controversy between Galileo and the Church, surely one of the best known episodes in the history of science. The relevant sources are all available in early printings, but not in modern critical editions. They are generally quite lengthy and the absence of precise references by Galileo is a severe handicap for one who seeks to retrace his steps. Our goal then will be to examine these sources and their relationship to one another as well as to some other early commentaries on which they depend.



Galileo's Sources.

The names enclosed in rectangles were cited by Galileo in his work of 1615; solid lines between authors indicate direct citations, whereas dashed lines indicate possible influences. Note that in his work of 1612 Magalhaens mentioned all sources cited subsequently by Galileo.

Let us begin by reviewing the two Biblical passages:

1. « Then Joshua spoke to the Lord in the day when the Lord delivered up the Amorites before the Israelites, and he said in the sight of Israel: Sun, stand thou still upon Gibeon; and thou, Moon, in the valley of Ayalon. And the Sun stood still and the Moon stayed, until the people avenged themselves upon their enemies. Is this not written in the book of Yashar? So the Sun stood still in the midst of heaven,

and hastened not to go down about a whole day. And there was no day like that before it or after it, that the Lord hearkened to the voice of a man, for the Lord fought for Israel » (*Joshua* 10:11-14).

2. « And Hezekiah said to Isaiah, What shall be the sign that the Lord will heal me, and that I shall go up into the house of the Lord the third day? And Isaiah said, This sign shall you have of the Lord, that the Lord will do the thing he has spoken: shall the shadow go forward 10 steps or go back 10 steps? And Hezekiah answered, It is a light thing for the shadow to go down 10 steps: nay, but let the shadow return backwards 10 steps. And Isaiah the prophet cried to the Lord: and he brought the shadow back 10 steps by which it had gone down on the steps (*or*: dial) of Achaz » (2K 20:8-11; cf. *Isaiah* 38:7-8, where there is a slightly different account of the same miracle). The word here rendered « steps » is sometimes translated « degrees » which originally meant steps. The use of the term « dial of Achaz » in some translations depends on an interpretation of the text, for the Hebrew word *ma'alot* is elsewhere translated « steps ».

In Galileo's *Letter* we read: « According to Dionysius the Aeropagite, it was the *primum mobile* which stood still; not the Sun [for Joshua]. St. Augustine is of the same opinion; that is, that all celestial bodies would be stopped, and the Bishop of Avila concurs. What is more, among the Jewish authors endorsed by Josephus, some held that the Sun did not really stand still, but that it merely appeared to do so by reason of the shortness of the time during which the Israelites administered defeat to their enemies. Similarly, with respect to the miracle in the time of Hezekiah, Paul of Burgos was of the opinion that it took place not in the Sun but on the sundial ».⁹ Later, Galileo adds a section about the miracle of Joshua: « For if the Sun had been near the meridian, either it would have been needless to request a miracle, or it would have been sufficient to have prayed for some retardation. Cajetan is of this opinion to which Magalhaens subscribes ... ».¹⁰

Galileo's study of the commentary literature would thus appear to be quite extensive and, indeed, both contemporaries and near contemporaries cite roughly the same set of sources. However, in the course of my own investigation of these texts, I became convinced that Galileo did not examine all of them at first hand, but that he depended on his memory (faulty at times) of Magalhaens's *Commentary on Joshua* in

⁹ GALILEO, *Opere*, vol. 5: 337-338; DRAKE, *op. cit.* (n. 1), pp. 204-205.

¹⁰ GALILEO, *Opere*, vol. 5: 347; DRAKE, *op. cit.* (n. 1), p. 214.

2 folio volumes published in 1612 in which all the sources cited by Galileo can be found.

For me the first difficulty concerned the reference to Josephus, for the views ascribed to him are not to be found in the relevant sections of his *Antiquities of the Jews*.¹¹ In fact, the view that the Sun did not really stand still is to be found in Levi ben Gerson's commentary on the Bible written in the fourteenth century.¹² The other difficulty for me concerned Paul of Burgos, whose view, cited by Galileo, that the miracle of Hezekiah did not take place in the Sun, is also the view of Levi ben Gerson. Let us consider then the discussions of these two miracles by Levi ben Gerson which appear both in his commentary on the Bible and in his major philosophical work, *The Wars of the Lord*. Concerning Joshua he wrote that the Sun continued its normal motions without interruption; the miracle was that the Israelites defeated their enemies while the Sun seemed to maintain the same altitude, i.e., for about a half hour on either side of noon. Levi interpreted the passage in *Joshua* to mean that the Sun stood still at mid-heaven, i.e., at noon, because this is the technical term in medieval Hebrew for the point where the ecliptic crosses the meridian. Levi adds that miracles do not involve the abrogation of natural law.¹³ His discussion of the miracle of Hezekiah appears in several places including his commentary on *Joshua* 10:12, but the passage concerning 2K 20:10 will suffice to represent his views:

« Hezekiah said: it is easy for the shadow to decline (*linʔot*) 10 steps (*maʔalot*) ». This verse is very difficult to explain because it is known that the declining of the shadow is due to the motion of the Sun. As the Sun moves slowly, the shadow declines slowly, and this is self-evident. Since this is so, how can Hezekiah say, « It is easy for the shadow to decline 10 steps »? How did Hezekiah think easy such a wondrous miracle (*moʔet*), the like

¹¹ Josephus discussed the miracle of Joshua in *Antiquities*, V.59-61 (Loeb edition, trans. H. St. J. Thackeray and R. Marcus [Cambridge MA 1966], vol. 2: 29); and the miracle of Hezekiah in *Antiquities*, X.24-29 (Loeb edition, trans. R. Marcus [Cambridge MA 1951], vol. 6: 171-175).

¹² Levi ben Gerson (1288-1344) lived in Orange (France) and wrote extensively on philosophical and scientific subjects in Hebrew: see C. TOUATI, *La pensée philosophique et théologique de Gersonide* (Paris 1973); and B. R. GOLDSTEIN, *The Astronomy of Levi ben Gerson* [1288-1344], New York, Berlin 1985. His commentary on the Bible has not been edited critically and is only available in the standard Rabbinic Bible as well as in manuscripts: I have used the standard Rabbinic Bible, cited *ad loc.* The original Hebrew version of his *Wars of the Lord* appears in print as *Milchamot Ha-schem*, Leipzig 1866.

¹³ B. R. GOLDSTEIN, *Astronomical and Astrological Themes in the Philosophical Works of Levi ben Gerson*, « Archives Internationales d'Histoire des Sciences », 26, 1976, pp. 221-224. On Levi ben Gerson's naturalistic theory of miracles and the role of prophets in predicting them, see M. M. KELLNER, *Gersonides on Miracles, the Messiah and Resurrection*, « Daat », 4, 1980, pp. 5-34; and TOUATI, *op. cit.* (n. 12), pp. 458-459, 469-477.

of which we have not seen [performed by any other prophet], not even by Moses who has no equal, despite all the signs and miracles that he performed, for those miracles only changed the order of lower [i.e., sublunary] things, and it would be immeasurably more wondrous to change the order of the higher [i.e., superlunary] bodies. Since this is so, the speech of Hezekiah would have been the greatest folly; how can we think this about him in light of the apparent perfection of his words (*devarim*)? Indeed, if we say that this miracle did not take place in the motion of [the shadow, but in the motion of] ¹⁴ the Sun itself, there would be much difficulty with the passage in *Chronicles* [2 Chr 32:24,31] concerning the ambassadors of the Babylonian princes who came to inquire about a miracle happened in the land [of Judah]. From that passage it seems that the miracle concerned his illness, for there it says that he [i.e., the king of Babylon] heard that Hezekiah was ill. From all this it seems to me that this miracle took place in the shadow and not in the Sun. You already know that clouds that move under the Sun sometimes cause the ray (*nişos*) of the Sun to be displaced, and this is clearly perceptible. Hezekiah saw that the motion of the wind at that time, and some vapors (*edim*) under the Sun which move easily, caused the shadow to return 10 steps, for their motion was in the same direction (*şad*). Therefore, he requested from Isaiah that the opposite happen in order to recognize a miracle from God, and the shadow returned backwards 10 steps as Hezekiah had asked. The miracle thus resulted from God's miraculous creation (*hid-dush*) of vapors moving in that direction, and the ray of the Sun was impressed on them such that with their motion they brought it with wondrous speed to that place.

We learn from this passage that Levi thought it impossible for Hezekiah's miracle to involve the superlunary world, and he argued that it was the shadow and not the Sun that was displaced. If the miracle had taken place in the Sun, the Babylonians would have seen it in their own country without the need to inquire about it in Judea. Levi then interprets the displacement of the shadow in terms of refraction due to the intervention of a cloud or vapors that arrived at the appropriate moment, fortuitously but in no way contrary to natural law. Note that Levi speaks of steps and not of a dial, taking these to be the steps on the royal palace built by King Achaz, Hezekiah's father, as we learn from Levi's comment on 2K 20:11.

Paul of Sancta Maria, Bishop of Burgos, was a Jewish convert to Christianity: his knowledge of Jewish sources was extensive, and he

¹⁴ I have added these words to Levi's commentary as it appears in the Rabbinic Bible because they are to be found in an exactly parallel passage in his *Wars of the Lord*, 6:2.12 (ed. 1866, p. 458).

cites the works of Rashi, Ibn Ezra, and Maimonides. According to his contemporary admirers he made « mighty hypotheses » concerning the motion of the heavens.¹⁵ However, he is best known for his polemical work against his former coreligionists and his additions to the Biblical commentary by the Franciscan, Nicolas de Lyra (d. 1349), both of which appeared in numerous editions in the fifteenth and sixteenth centuries.¹⁶ The passage that interests us is to be found in his addition to Nicolas de Lyra's commentary on 2K 20:9-14. To set his views in the context of the tradition in which he worked, it is appropriate to consider the texts of Pseudo-Dionysius and Pseudo-Augustine that preceded the commentary of Nicolas de Lyra.

According to Pseudo-Dionysius's letter to Polycarp, the Sun, the Moon, and all the heavens were stopped by God at the request of Joshua and, indeed, the stars remained still for a whole day, i.e., the period of daylight was twice its normal duration. For Hezekiah the period of daylight was almost three times its normal duration because, in addition to the twelve (seasonal) hours of a normal day, there were ten hours during which the entire heaven turned backwards and another ten hours during which the entire heaven retraced its course.¹⁷ He adds a remark on the Sun's returning backwards but, by a corruption of the Greek text, *palintropon* (backwards) became *pentatropon* (fivefold?), and this was translated into Latin as *quinqueformem*. Medieval as well as modern commentators have resorted to various desperate measures to make sense of this « fivefold ».¹⁸

According to Pseudo-Augustine's *De mirabilibus sacrae scripturae*, the miracle of Joshua involved the Sun's standing still at midday (*in*

¹⁵ See BAER, *op. cit.* (n. 5), p. 142. Paul of Burgos's reputation as an astronomer is alluded to in a letter from Profiat Duran to David Bonet Bongoron, written ca. 1396: F. KOBLER, *Letters of the Jews through the Ages*, New York 1978, vol. 1: 280, 282n. For the original Hebrew text of this passage, see F. TALMAGE, *The Polemical Writings of Profiat Duran*, Jerusalem 1981, especially pp. 81-82.

¹⁶ On Nicolas de Lyra, see H. HALLPERIN, *Rashi and the Christian Scholars*, Pittsburgh 1963, pp. 137-145. I consulted a copy of the *Postillae* of Nicolas de Lyra with the *Additiones* of Paul of Burgos and the *Replicae* of Matthias Döring (Strasbourg ca. 1474-77) in the Library of Congress (Washington DC); cf. F. R. GOFF, *Incunabula in American Libraries*, New York 1964, p. 442: N-134.

¹⁷ For the Greek and Latin versions of this letter, see J.-P. MIGNE, *Patrologia Graeca*, Paris 1857, vol. 3: 1077-1080.

¹⁸ For example, DE GANDILLAC, *op. cit.* (n. 2), p. 334, explains this fivefold motion as: « the four seasons plus the miraculous movement ». As we learn from HATHAWAY, *op. cit.* (n. 2), p. 137, this explanation is taken from a Greek scholion. Hathaway's own interpretation is equally farfetched, but he does add the useful notice that *pentatropon* is a *hapax legomenon*. The emendation of the Greek text to read *palintropon* was suggested by Dr. A. C. Bowen.

medio die), and that day lasted twice its normal duration. But the other heavenly bodies also stopped so that nothing was disturbed, « for if one heavenly body should move while another rest, it would disturb the accustomed course of the days, months, and years ». He further argued that by stopping the Moon from its normal waxing and waning, the tides were stopped as well « although it was left unsaid by the voices of scripture ». For Hezekiah the problem was that Isaiah had given him two contrary prophecies on the same day, and he sought a sign to confirm the one that would happen. So God had the Sun reverse its direction going back to its rising for ten hours. This was an appropriate sign because just as the Sun was ready to set it was brought back to its rising, so the king, expecting death, was recalled to the joys of life beginning.¹⁹

Nicolas de Lyra cited the opinion of Pseudo-Dionysius explicitly and perhaps alluded to the passage by Pseudo-Augustine. It is also worth noting that Nicolas de Lyra often explicitly depended on the Biblical commentary by the eleventh century French Rabbi, Solomon Iṣḥaḳi, usually called Rashi. In this case Rashi understands the miracle of Hezekiah to have taken place on a sundial (Hebrew: *orlogin*) « made by craftsmen »; the ten hours of lengthened daylight were to compensate for a reduction of ten hours in the length of daylight on the day that King Achaz died (Rashi on *Isaiah* 38: 8, and more briefly on 2K 20: 11). In contrast to Josephus, Pseudo-Dionysius, and Pseudo-Augustine, Rashi refers unambiguously to a sundial: presumably he depended on the *Targum*, an Aramaic version of the Bible (final redaction before 700 A.D.) which translates the « steps » of Achaz as the « stone of hours » (*even sha'ayya*: cf. *Mishna, Kelim*, 12,4, where this clearly refers to a sundial), and the « ten steps » as « ten hours ».

Nicolas de Lyra also says that this miracle involved a sundial (*horologium*) for finding the time of day from the Sun's shadow: however, it is perhaps more likely that he depended on St. Jerome's commentary on *Isaiah*, chapter 38, which contains a fragment of a lost Greek version of the Hebrew Bible by Symmachos (ca. 200 A.D.) in which the ten « steps » were understood as ten « lines » (*lineae*) and the « steps » of Achaz as a « sundial » (*horologium*).²⁰ St. Jerome (d. 420) was also

¹⁹ For the Latin text of this work ascribed to St. Augustine, see J.-P. MIGNÉ, *Patrologia Latina*, Paris 1902, vol. 35: 2148-2202. The miracle of Joshua is described in Book 2, chap. 4 (ed. Migne, 2175-2176), and the miracle of Hezekiah in Book 2, chap. 28 (ed. Migne, 2188-2189).

²⁰ For the passage in St. Jerome's commentary on *Isaiah*, see J.-P. MIGNÉ, *Patrologia Latina*, Paris 1845, vol. 24: 391-392. See also H. LESÊTRE, *Cadran Solaire*, in *Dictionnaire*

responsible for the Latin translation of the Bible known as the Vulgate, and in it one finds *horologium* here. In any event, Nicolas de Lyra continued: « Some say that two lines corresponded to one hour in which case the 'artificial' day was increased by ten hours, i.e., five hours for the Sun to return backwards, and five hours for it to retrace its course. Others say, and it would seem more appropriately, that each line corresponded to one hour in which case the 'artificial' day was increased by twenty hours, ... ». The first view seems to reflect the mistaken *quinqueformem* in the Latin version of Pseudo-Dionysius's letter, later cited explicitly by Nicolas. He adds that the Babylonians paid particular attention to the courses of the stars and that some say that astronomy was invented in Babylon. Thus it was that upon hearing of this miracle, the king of Babylon sent letters inquiring about the miracle that took place in the land.

Though Paul of Burgos had access to Hebrew sources, I know of no explicit reference by him to Levi ben Gerson. Nevertheless, despite some obvious divergences, there is a striking similarity in their views. He begins his additions to Nicolas de Lyra's commentary with some remarks on the nature of miracles citing texts of Augustine (*Ad Volusianum*) and Thomas Aquinas (*Summa theologiae*). Paul presents several objections to God's performing a miracle of the highest degree for Hezekiah when a lesser miracle would have been sufficient. Firstly, it is surprising that no astrologer anywhere reported a day that exceeded its normal length by twenty, or even ten, hours, and one would expect that even ordinary people would notice it which would be known reports in ancient chronicles. Let us note in passing that once again two alternative durations are considered based on the misreading in the text of Pseudo-Dionysius. Paul of Burgos continues: indeed, the Sun would have crossed the meridian two additional times on the same day and this would be quite noticeable. Secondly, if this miracle produced on the dial of Achaz in Jerusalem were due to the Sun's returning backwards, it should have been seen on dials in Babylon and everywhere else. Why then should the infidel Babylonians believe it was connected with the cure of Hezekiah? Thirdly, the increase of ten or twenty hours to that day would introduce serious errors in astronomical calculations. Similar difficulties arise concerning the Sun's standing still at the time of Joshua, but one might say that at that earlier time astronomy had not yet been

de la Bible, ed. F. VIGOROUX. Paris 1926, vol. 2,1: 23-28. St. Jerome, in turn, probably depended on the *Hexapla* of Origen: cf. J.-P. MIGNÉ, *Patrologia Graeca*, Paris 1859, vol. 16: 1883-1886.

invented, and so there was no astronomer to record the event. However, by the time of Hezekiah there certainly were astronomers, as we learn from the prophet Isaiah, « Let now the astrologers, the stargazers, and the monthly prognosticators stand up and save you ... » (*Is.* 47:13).

To resolve these difficulties Paul of Burgos argues that the miracle did not affect the Sun at all, but only those rays that touched the dial of Achaz producing the shadow on it, a great miracle but not one of the highest degree. The day of the miracle was neither longer nor shorter than usual, and the solar motion was not at all modified as others imagine. Indeed, God allowed the Sun to continue towards its setting at the same time that some rays with their shadow returned backwards ten lines on the dial of Achaz and then retraced their course until they met the solar rays that followed their natural course. This return backwards and retracing lasted less than two hours, and hence the day had its normal duration even on the dial of Achaz. If the Sun had in fact returned backwards, this would have been an even greater miracle than that of Joshua, for a contrary motion contradicts a given motion more than standing still. Paul concludes with a remark on the passage in 2 Chr 31:32 concerning the Babylonians who were sent to Hezekiah to inquire about the miracle that took place in the land. He notes that scripture says in the *land*, not in the *Sun* or in the world (*mundus*), and the *land* must refer to the land of Judea where Hezekiah was king. Otherwise, it would not have been necessary for the Babylonians to inquire about it.²¹

Before comparing Paul's interpretation with that of Levi ben Gerson, let us consider the reply of Matthias Döring (d. 1469), of the Friars Minor, printed in many editions immediately after the additions of Paul.²² In general, Döring supported Nicolas de Lyra against the criticisms of Paul when they did not agree. In this case, Döring argues most vehemently against Paul's views, for a light that would cast a shadow in the daytime would have to be considerably brighter than the Sun, and hence not a minor miracle at all. He cites Pseudo-Augustine to support the claim that all the celestial bodies were involved in both the miracles of Joshua and Hezekiah, and so astronomical calculation would not have been disturbed. To refute Paul's assertion that astronomy had not yet been invented at the time of Joshua, he cites Josephus who tells us that

²¹ PAUL OF BURGOS, *Additio* to Nicolas de Lyra, on 2K 20.

²² DÖRING, *Replica* to the *Additio* of Paul of Burgos, on 2K 20. See also F. MERSHMAN, *Döring*, in *The Catholic Encyclopedia*, New York 1907, vol. 5: 135; and HAILPERIN, *op. cit.* (n. 16), p. 2.

Abraham taught astronomy in Egypt, and hence Paul is wrong again. This allusion to Josephus is cited by later authors and I suspect they relied on Döring.²³

When we compare the interpretations of Paul and Levi we are struck by their rejection of a miracle affecting the superlunary world. Indeed, for an orthodox Aristotelian no change is possible there.²⁴ We also find that both authors seek support for their interpretations from the passage in 2 Chr 31. However, their views differ on two important points: (1) Paul takes the steps of Achaz to be a sundial whereas Levi never mentions a sundial, and (2) Paul explains the miracle by introducing a special miraculous light whereas Levi has recourse to clouds and vapors. It may be that Paul depended on Levi indirectly, but that is difficult to demonstrate unless additional sources can be located.

We next turn to Alonso Tostado, Bishop of Avila, who was briefly condemned for heresy in 1443 by Pope Eugene IV, notably for his strict view on the forgiveness of sins, a position he immediately retracted. His works run to about 60,000 pages including extensive commentaries on the books of the Bible. He was considered most learned by his contemporaries for his knowledge of scholastic and classical texts as well as his mastery of profane sciences, including astrology. Moreover, he was familiar with the Jewish exegetical tradition in the original Hebrew, particularly the works of Rashi and Ibn Ezra.²⁵ In his commentary on 2K 20 (Question 22), he introduces a description of the sundial (*horologium*) of Achaz: it was located in the royal palace and served to find the time of day from the Sun's shadow; it was in the shape of a hemisphere made of bronze (*aes*), or of some other material, in the center of which was a gnomon, and on it were lines drawn at equal angles to indicate the hours. He then tells us that when the Sun returned backwards for ten hours, the shadow returned backwards passing ten lines on this dial.²⁶ In another passage on the miracle of Joshua (Question 70) he tells us that, according to Nicolas de Lyra, when Joshua commanded the Sun to stand still, it was on the meridian. However, Alonso does not accept this view, and concludes that the Sun was about

²³ See n. 34, below. The same passage from Josephus is cited by an earlier author, Cassiodorus (sixth century), in the context of an apology for the study of astronomy: see J.-P. MIGNE, *Patrologia Latina*, Paris 1847, vol. 70: 1203-1204.

²⁴ For Levi ben Gerson's views on the physics of the celestial spheres, see TOUATI, *op. cit.* (n. 12), pp. 175-185, 301-307.

²⁵ Cf. GONZALO MAESO, *op. cit.* (n. 6), especially pp. 159-160, 171-172, 177.

²⁶ Alphonsi Tostati Hispani Episcopi Abulensis, *Opera omnia*, Venice 1596, and Cologne 1613; ed. 1613, vol. 7: 345a.

to set.²⁷ In a later passage on the text of Joshua (Question 88) he argues that the daytime of Joshua's miracle lasted 24 hours whereas the daytime of Hezekiah's miracle lasted 32 hours. Hence, the daytime for Hezekiah was longer, in agreement with the views of Nicolas and Dionysius.²⁸ Alonso does not cite any Jewish commentators by name in this context, but he does refer to them in a general way. One such case occurs in a comment on the miracle of Hezekiah (Question 23): « Why did God perform this miracle of the Sun's turning back ten lines [on the dial of Achaz]? Some Hebrew commentators (*Hebraei*) say that God did so to demonstrate the saintliness of Hezekiah in contrast to the wickedness of his father, Achaz ... ». This seems to be an allusion to Rashi's comment on this passage.²⁹ A more serious problem of sources is raised by Alonso's attributing to Nicolas de Lyra the claim that the miracle of Joshua took place at noon. This is Levi's view, not that of Nicolas: is this then an allusion to Levi? I am inclined to answer in the affirmative because Alonso says that at noon there would still have been enough time for the Israelites to defeat their enemies, an argument that serves to refute Levi's view, cited above. However, it must be acknowledged that in the text of Pseudo-Augustine we read that the miracle took place at midday, where « midday » replaces the expected « mid-heaven » without comment. Thus it is possible that Alonso had the text of Pseudo-Augustine in mind, but I think the context argues against that interpretation.

Let us return to the text of Galileo. Josephus does not hold the view ascribed to him, for concerning the miracle of Joshua he merely recounts the story, concluding: « That the length of the day was increased on that occasion, and surpassed the customary measure, is attested by Scriptures that are laid up in the temple ». ³⁰ We might emend Galileo's text slightly, substituting the Bishop of Avila (mentioned at the end of the preceding sentence) for Josephus, in which case the text would read: according to the Jewish authors endorsed by the Bishop of Avila, the Sun did not really stand still but merely appeared to do so by reason of the shortness of the time during which the Israelites defeated their enemies. But that does not work because the Bishop of Avila opposed this view and, in any event, he does not ascribe it to Jewish authors.

²⁷ TOSTADO, *op. cit.* (n. 26), ed 1613, vol. 5: 345e.

²⁸ TOSTADO, *op. cit.* (n. 26), ed. 1613, vol. 5: 346f.

²⁹ TOSTADO, *op. cit.* (n. 26), ed. 1613, vol. 7: 345e. Rashi (*ad Isaiah* 38:8) claims that when King Achaz died the day was shortened in order that he not be mourned.

³⁰ JOSEPHUS, *op. cit.* (n. 11), vol. 2: 29.

It remains for us to consider Magalhaens's commentary of 1612 as Galileo's real source. Here we find extensive citations of all the texts mentioned by Galileo. For example, Paul of Burgos's explanation of Hezekiah's sundial is quoted at length.³¹ Later, Magalhaens cites « the doctors of the Hebrews (*Hebreorum doctores*) mentioned by the Bishop of Avila in his commentary on 1 Chr, chap. 4, Question 18, concerning the Sun's standing still ... », and then on the same passage: « according to the interpretation of the Bishop of Avila, Nicolas de Lyra, Cajetan (i.e., Thomas de Vio), and some Hebrews (*Hebraei aliquot*) ... ».³² When we look at the Bishop of Avila's commentary, the « Hebrews » are indeed mentioned: « However, certain Hebrew commentators (*Hebraei*), holding that the Sun stood still, ... ».³³ For these reasons I suggest that Galileo read Magalhaens's text and then cited it from memory leading to various divergences from his source, which he only mentions in passing.

Finally we can again consider Galileo's reference to Josephus. As noted above, Döring cites Josephus as informing us that Abraham taught astronomy in Egypt. This reappears in Magalhaens's commentary where it also serves to refute the views of Paul of Burgos, though Döring is not given credit for this argument.³⁴ I found no related context in which Josephus is mentioned, and so once again I am inclined to conclude that Galileo has confounded his sources.

This ends the discussion of Galileo's interpretation of the two miracles. It seems that Galileo did well to choose Magalhaens as his primary source for the exegetical tradition because the main themes of this discussion are fairly and accurately represented by him. To be sure Galileo's purposes were rather different from those of his predecessors: for them the interpretation of scripture was the goal, whereas for Galileo the principal aim was to demonstrate the consistency of these Biblical passages with the Copernican system.

The literature on the sundial of Achaz has continued unabated to this day both among Biblical commentators and specialists on sundials.³⁵ Recent scholarship on Hezekiah's miracle seems to be unanimous that the « steps of Achaz » refer to a sundial, but perhaps a note of caution is in order. As Roland de Vaux points out, there is no other text in the

³¹ MAGALHAENS, *op. cit.* (n. 8), vol. 2: 351a.

³² MAGALHAENS, *op. cit.* (n. 8), vol. 2: 352b.

³³ TOSTADO, *op. cit.* (n. 26), ed. 1613, vol. 8: 98e.

³⁴ MAGALHAENS, *op. cit.* (n. 8), vol. 2: 351b.

³⁵ A recent example is: J.-P. PARISOT, *La rétrogradation de l'ombre dans les cadrans solaires analemmatiques*, « Journal of History of Astronomy », 26, 1985, pp. 43-48, especially pp. 47-48.

Hebrew Bible that indicates the use of hours to measure time in ancient Israel³⁶ and, generally speaking, it is best not to depend on a difficult text to establish the existence of cultural phenomena. Egyptian use of dials and of the division of the day into hours is frequently cited in support of various reconstructions of Hezekiah's miracle,³⁷ but Egypt is not Israel even if it was nearby. My own view is that this approach has reached a dead-end and that another is needed: the focus of attention should be to determine the proper context for this miracle, but I leave that for future consideration.³⁸

Acknowledgements. This paper was originally presented at the International Symposium on the History of Sundials in Brugine and Padua, Italy (May 1985). For their assistance with regard to the Greek and Latin texts I wish to thank D. Jacquart, A. Segonds (Paris); A. C. Bowen, and M. L. Gill (Pittsburgh).

SUMMARY

In his *Letter to the Grand Duchess Christina* Galileo considered two astronomical miracles in the Bible (the Sun standing still for Joshua, and the Sun's shadow going backwards on the steps [or dial] of Achaz), citing seven discussions of them in the previous literature. After examining the relationship of these texts to one another as well as to other early Biblical commentaries on which they depend, it is argued here that Galileo probably did not examine all seven works at first hand but that his real source was Magalhaens's commentary on Joshua published in 1612 (the most recent of the seven in which the other six are mentioned) and, in addition to the confusion already in the texts cited, Galileo added some confusion of his own.

³⁶ R. DE VAUX, *Ancient Israel*, New York and Toronto 1965, vol. 1: 182-183.

³⁷ See, for example, Y. YADIN, *The Dial of Abaz*, « Eretz-Israel », 5, 1958, pp. 91-98 (in Hebrew), p. 88* (English summary). He makes use of a variant reading in a manuscript of the Dead Sea, *The Scroll of Isaiah*, but I am unconvinced that in this case it deserves to be given greater weight than the traditional text. He also relies on various Egyptian antiquities, depending largely on R. W. SLOLEY, *Primitive Methods of Measuring Time with Special Reference to Egypt*, « Journal of Egyptian Archaeology », 17, 1931, pp. 166-178.

³⁸ This context includes the reform that involved the introduction of the Babylonian calendar in Israel. For example, H. L. GINSBERG (*The Israelian Heritage in Judaism*, New York 1982, p. 124) has argued for dating this calendar reform to the reign of Menasseh (698-642 B.C.), Hezekiah's son. But I think there is evidence that suggests an earlier date, during the reign of Hezekiah (cf., for example, 2 Chr 30: 1-5). If this can be shown, one should then pay special attention to the visit of the Babylonian ambassadors to the temple in Jerusalem that Isaiah found objectionable (*Isaiah* 39:1-7). See now B. R. GOLDSTEIN and A. COOPER, *The Festival Calendars of Israel and Judah and the Literary History of the Pentateuch* to appear in the « Journal of the American Oriental Society ».