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SATURN, ARISTOTELIAN ASTRONOMY, AND CRACOW ASTRONOMERS: AN EPISODE FROM THE EARLY YEARS OF TELESCOPIC ASTRONOMY

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In the late summer of 1640, following a well established tradition, Albert Strażyc, professor of mathematics at Cracow University,[1] advertised a forthcoming public disputation with a leaflet presenting his theses on questions concerning astronomy.[2] Printed in Vienna, the leaflet consisted of twelve pages, to which a single double-sided leaf containing drawings and reports of observations was added in Cracow in September of that year, "to illustrate the theses".

Although at that time several members of university faculties had regular links with the scientific centres abroad (especially in Italy), Cracow University as a whole preserved to a large extent the late-medieval curriculum. As a rule, the published theses and disputations adhered strictly to an Aristotle-based philosophy of nature. To some extent this may have been the reason why historians of Cracow University have invariably neglected Strażyc's publication. Copies are extant in a small number of Polish libraries, but even the copy preserved at the Jagellonian Library[3] in Cracow has remained unnoticed. Yet, in a somewhat provocative subtitle, Strażyc raised a very timely question, "whether recent observations of the Jovian stars, sunspots, the roughness of the Moon, the courses of Mars, and other similar phenomena, contradict the principles established by ancient philosophers and astronomers?"[4] In what followed, Strażyc unequivocally promoted the new ways of understanding science and its rules. Without mentioning Galileo or Kepler (or Copernicus) by name, he argued for an astronomy arising out of their research and discoveries. The very first of the *conclusiones* stated that "Observations made recently by astronomers have their foundation in the science of measure"; furthermore, "there can be no doubt of the correctness of observations conducted with adequate care and evaluated by well established geometrical principles"; and "Astronomy was not born and did not mature in one stroke, but it is growing slowly thanks to numerous observations". Strażyc's discussion of Jovian satellites ended with the conclusion: "Don't expect me to believe that they [the moons of Jupiter] would be of different stuff from their master star."[6]

The next chapters dealt with sunspots and with the structure of the Moon's surface. Theses on Mars enabled Strażyc to denounce the inadequacy of ancient orbital models: "It is useless to explain the motions of Mars using the arguments, true and mean motions, equants, epicycles, proportional minutes, and 600 other [contraptions]. All this cannot explain satisfactorily and adequately the motions of the planet." As for the changing extremal positions of Mars in its orbit, "there is no way to

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explain them from the doctrine of solid celestial spheres". Besides, "the stars are not [fixed] like knots on a tree, but they move like fishes in the sea or birds in the air".[7] The seventh, final conclusion answered he question posed at the beginning: "One cannot uphold the solutions [*decreta*] of the ancient philosophers and astronomers, invalidated [*labefactata*] by recent observations."[8]

The University does not appear to have responded in favour of Straży's theses. In the same year a fellow professor in the Faculty of Arts contested them in another treatise, resorting to deferents and epicycles, and defending the concept of solid celestial orbs.[9]

The *Quaestio astronomica* remained a manifesto of a small but competent group of Galileo's followers. This "Galilean lobby" in Cracow had in its ranks an outstanding disciple of Galileo's teachings, Stanisław Pudłowski (1597–1645). A professor of civil law, Pudlowski was also a scientist of modern bent. A talented experimenter and mathematician, he was known for his private researches, which led him to Copernican astronomy; being well acquainted with the current literature, he performed experiments and observations in his own laboratory. Although Pudłowski never wrote on science, his professional competence in physics and mathematics is attested by his notebooks, preserved in the Jagellonian Library.[10] In May 1640, four months before Strażyc's publication, Pudłowski visited Galileo in Arcetri, on the way home from a stay in Italy. He had taken with him a letter of recommendation from Benedetto Castelli.[11] Two years later Pudłowski sponsored the publication in Cracow of the Latin translation of a short treatise by Castelli expanding on Galileo's projects for determining geographical longitudes.[12]

Strażyc's *Quaestio* is not only a document witnessing to the critical phase of transformation in European science (the "scientific revolution"). The two extra pages of the *Quaestio* (leaf "A3 *bis*"), printed and inserted in the treatise in Cracow, were filled with drawings of Jupiter with its moons, of Saturn and of sunspots, with reference to observations from "several days ago [*ante aliquos dies*]" in the first half of September 1640.

The author (or authors) of the observations and of the drawings remained anonymous. Taking into account Pudłowski's competence in experiments and observations, as well as his active interest in astronomy as attested by his autograph notes, it seems justifiable to ascribe to him — possibly in tandem with Strażyc — the authorship of the observations and diagrams in question.

The upper part of the page (A3 *bis* recto, see Figure 1) presents the "Diagramma Iovis comitum", a series of four drawings of Jupiter with its Galilean moons. The captions present them as the result of observations made on five days, 5–8 and 11 September, with — at that period — Callisto swinging through maximum elongation and Ganymede in decreasing elongation.[13] The drawing of Saturn on the same page deserves the most attention. Although crudely drawn and then reproduced in printed form, the drawing displays features that distinguish it from other representations of Saturn drawn in the period between Galileo's discovery in 1610 and the solution of the Saturn enigma by Huygens in 1659. Some thirty drawings from that

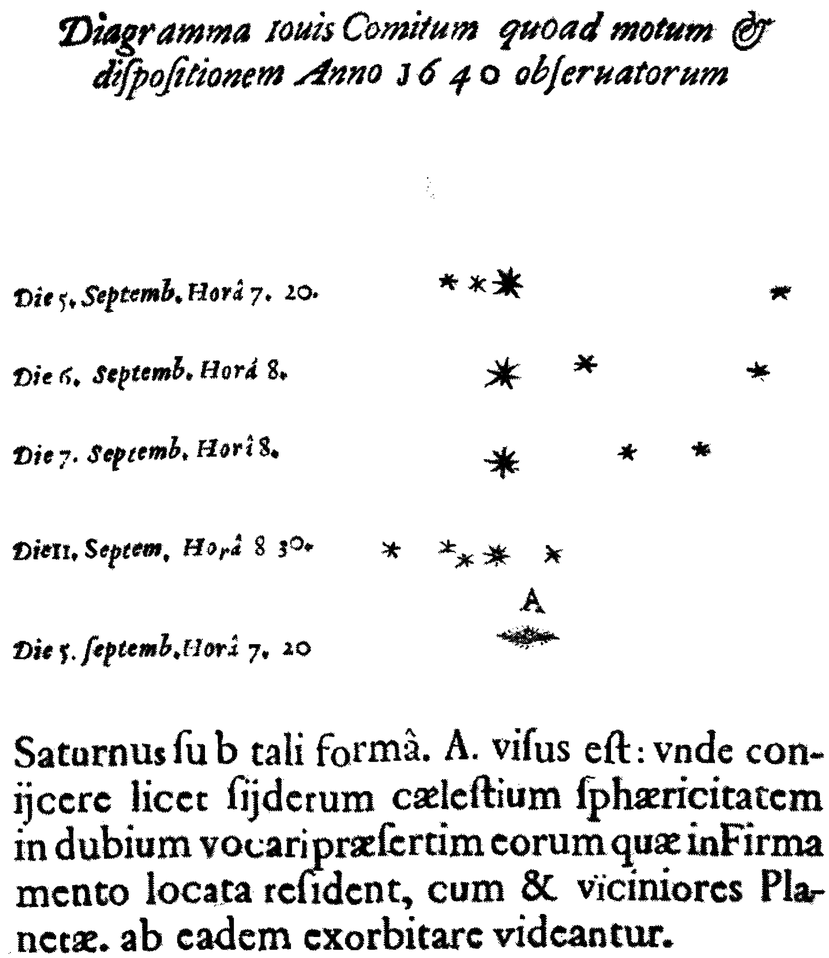


FIG. 1. Albert Strażyc, *Quaestio astronomica*, f. A3 *bis* recto: Jupiter and Saturn, September 1640. Courtesy of the Jagellonian Library.

period are known thanks to observations by P. Gassendi, F. Fontana, N. Zucchi, J. Hevelius and I. Boulliau, among others. The drawings of these observations were collected and described several times, beginning with Huygens himself (see Figure 2).[14] In 1842 a Dutch writer, E. M. Beima tabulated 26 drawings dating from 1610 to 1656 (Figure 3). They were reproduced and analysed by Dora Shapley.[15]

The first feature to note concerning the Cracow observation is that it is the only one from 1640, two years before Saturn's rings were to disappear from view. Secondly, the drawing in question has the distinction of showing the planet, even though in crude woodcut, as it actually appeared to the observer: with rings reduced to narrow triangular extensions of the planet's globe. The review of Saturn's images collected by Huygens shows that, in general, other observers in 1630s and '40s drew the planet as they supposed it ought to appear. The difference is also reflected in the drawings by the ratio of the full width of the planet's system to its (polar)

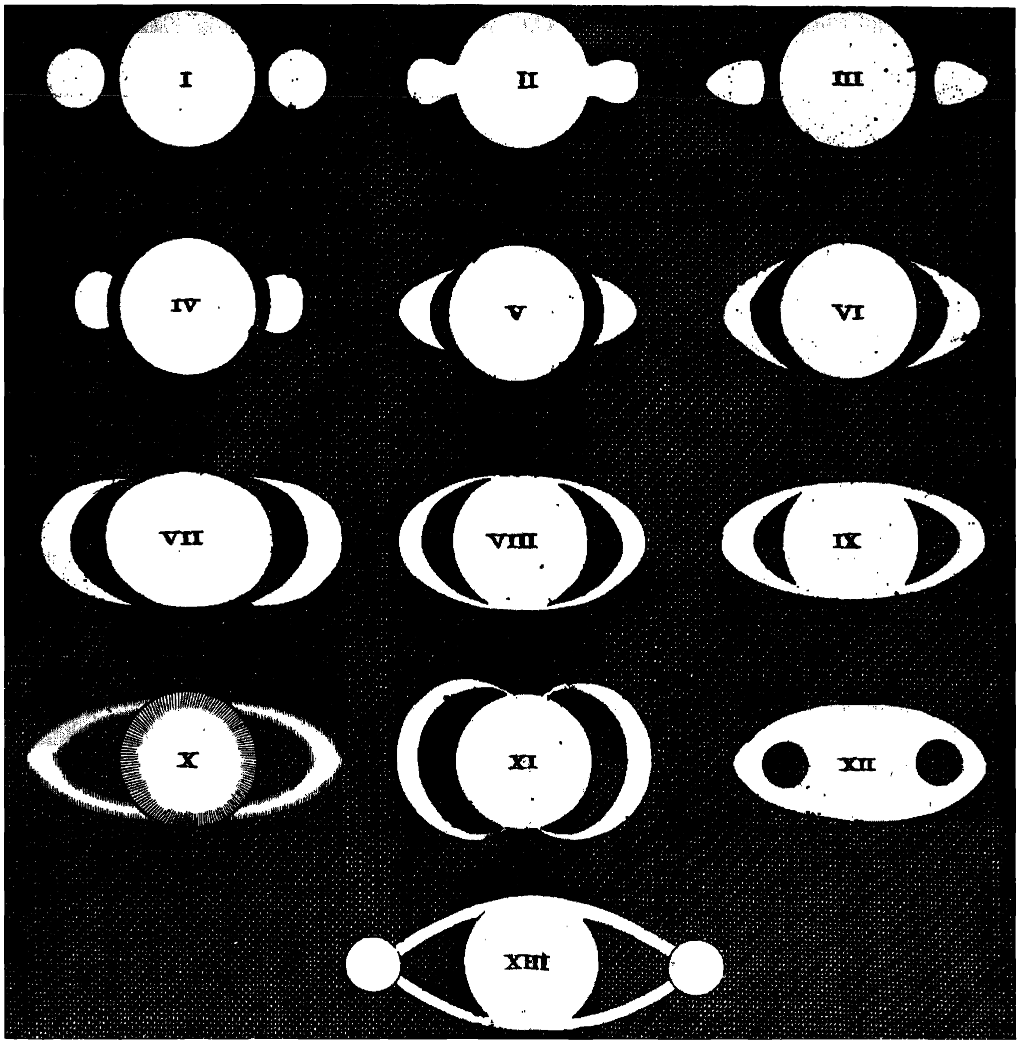


FIG. 2. Early drawings of Saturn, from Christiaan Huygens, *Systema Saturnium* (The Hague, 1659).

diameter, the actual ratio being 2.53. The estimated ratio of the Cracow drawing ranges from 2.6 to 3.8. By contrast, other observers tended to reduce the relative extent of the rings (or whatever the drawings represented); most of the Saturns in Figure 3 show ratios between 1.7 to 2.2.

Sunspots are presented as "Schema Macularum Solarium" on leaf A3 *bis* verso, with the drawing of a group of sunspots as observed on two consecutive days, 5–6 September 1640 (Figure 4). Separated by 20 hours, the two positions of the sunspots ("A" and "B") must have been registered by projection of the telescopic images on the same screen and drawn without correcting for the difference in the angular position of the Sun's axis against the vertical. However, the present writer's correlation of the observation from 5 September 1640 (sunspots "A") with an observation by Galileo[16] (Figure 5) aroused the uncanny feeling of *déjà vu*. The

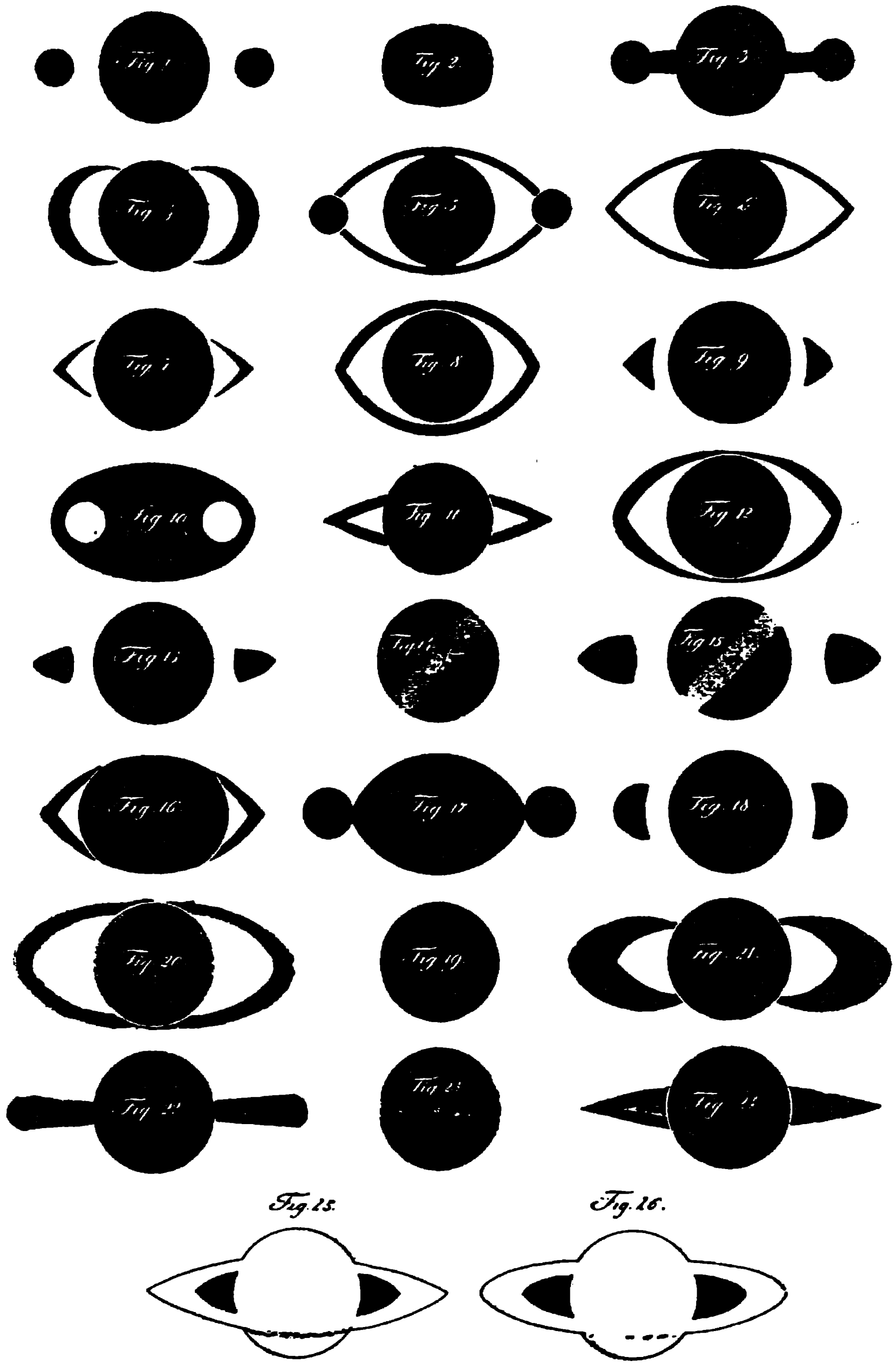
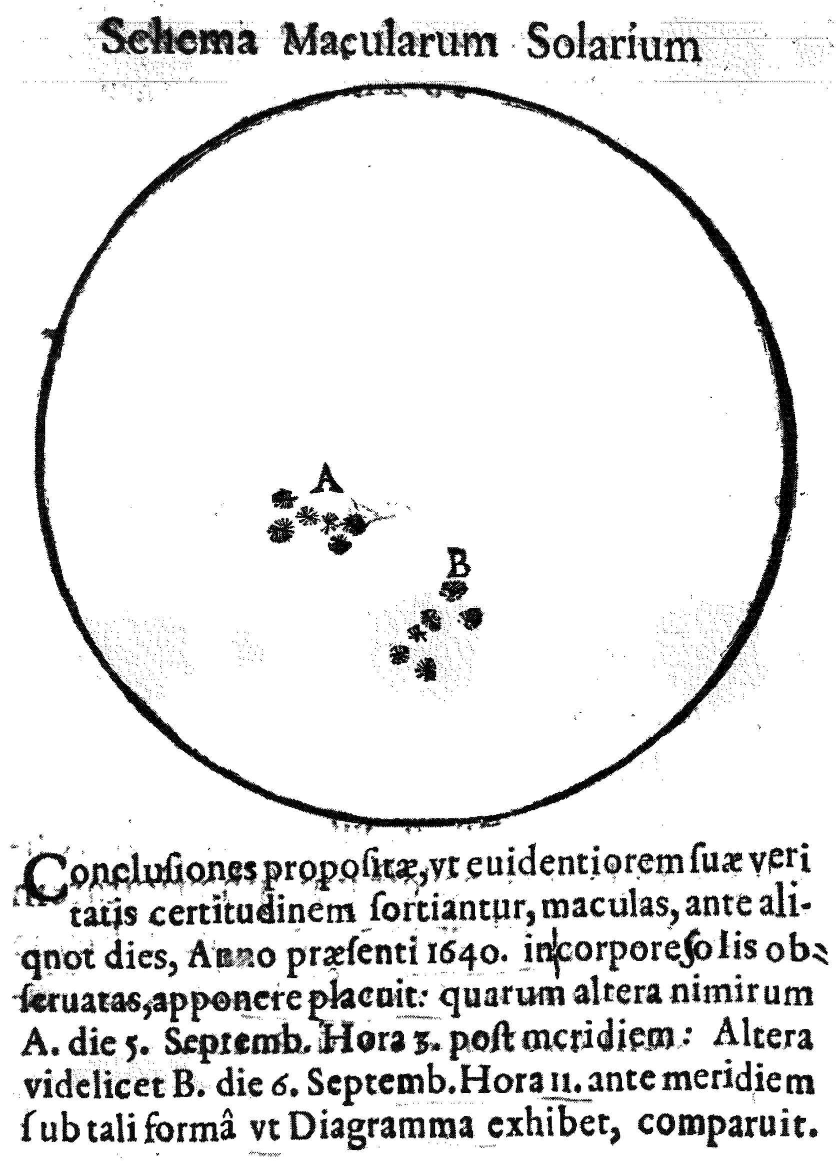


FIG. 3. Pre-Huygens drawings of Saturn, from E. M. Beima, *De annulo Saturni* (Leiden, 1842).



Concluſiones propoſitæ, vt euidentiorem ſuæ veri tatis certitudinem ſortiantur, maculas, ante ali- qnot dies, Anno præſenti 1640. in corpore ſolis ob- ſeruatas, apponere placuit: quarum altera nimirum A. die 5. Septemb. Hora 3. poſt meridiem: Altera videlicet B. die 6. Septemb. Hora 11. ante meridiem ſub tali formâ vt Diagramma exhibet, comparuit.

FIG. 4. Albert Strażyc, *Quaestio astronomica*, f. A3 *bis* verso, sunspots 5–6 September 1640. Courtesy of the Jagellonian Library.

coincidence of both the structure of the group of sunspots and its location in both pictures suggests a borrowing from Galileo's publication (available in Cracow, like all Galileo's works). The different position "B" of the sunspots for 6 September does leave some possibility that we are indeed dealing with genuine observations (or sightings) of sunspots — without more precise positioning for them on the solar disk, and with recourse to Galileo's drawing to produce an impressive representation.

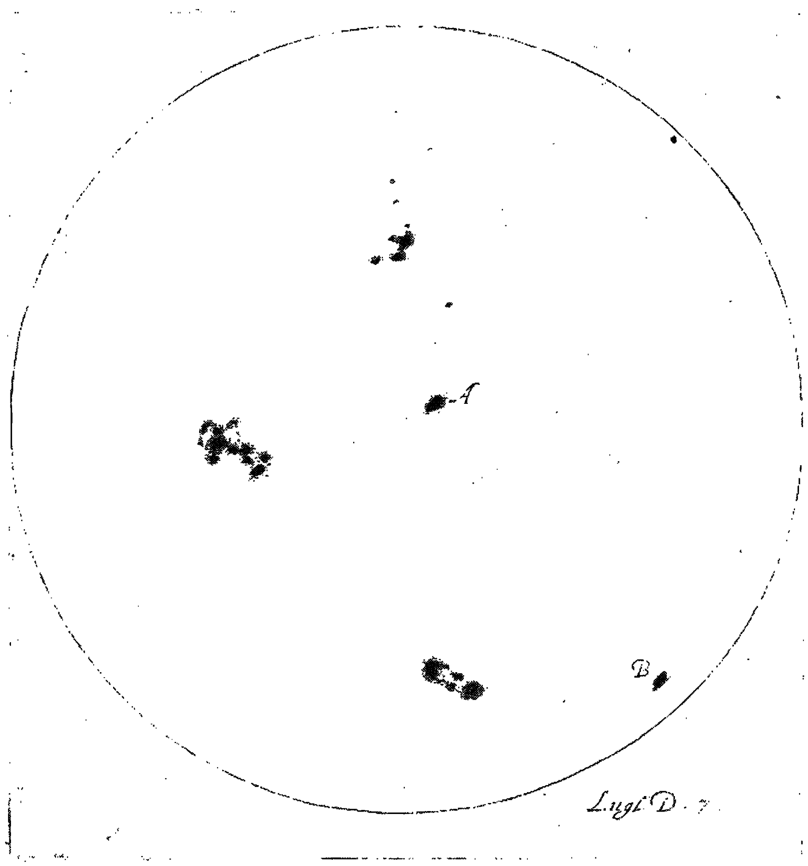


FIG. 5. Galileo's drawing of sunspots on 7 July 1611, from Galileo, *Istoria e dimostrazioni intorno alle macchie solari* (Rome, 1613), 92. Courtesy of Owen Gingerich.

In any case, it served to illustrate Strażyc's strictly Galilean stand: as the parallax shows, the sunspots cannot be elsewhere than on the Sun's surface.[17] Similarly, the satellites of Jupiter were invoked to attest the identity of matter within the planetary system, while the irregular shape of Saturn was one more argument against the ancient physics of the planetary system.

As mentioned above, the *Quaestio* did not influence the University's curriculum. It is likely that Strażyc did not hold the expected public session, as no precise date for it was stated in the leaflet. Notwithstanding several attempts at revision made throughout the seventeenth century, the university teaching stayed unchanged till the 1770s, when the University was modernized within the context of a radical nation-wide reform. To a large extent this was realized as a result of the efforts of another Cracow mathematician-astronomer, Jan Śniadecki,[18] founder of the University's astronomical observatory. But this is part of quite a different story.

REFERENCES

1. The personal data of Albert Strażyc [?–1650] are scarce, due to the loss of the Cracow University files from the first half of the seventeenth century. He studied in Cracow, obtaining the Ph.D. degree in 1634. From the later 1630s he held the newly-founded chair of practical geometry and geodesy. After 1646 Strażyc took up medical studies in Italy, where he died shortly after doctoral promotion at the University of Padua. His published works were limited to two almanacs and two "Quaestiones".
2. "Quaestio astronomica in Alma Academia Cracoviensi, florentissimo Regni Poloniae Gymnasio; a M.Alberto Raymundo Strazyc, in eadem Academia professore, publice ad disputandum proposita...."
3. Shelf mark: 56457 I St.Dr.
4. "Quaestio: U[trum] Recentiorum observationes, de Jovialibus stellis, maculis solaribus; asperitatibus Lunae, ascensu et descensu Martis, aliisque similibus phaenomenis factae, antiquorum tam philosophorum quam astronomorum repugnent decretis, nec ne?" (f. A3 recto).
5. Second corrolary to the first thesis, f. a3: "Demonstratis via Geometrica observationibus, si cum omnibus requisitis fuerint expeditae, nusquam error subesse potest." This echoes Salviati's declaration in the third dialogue in Galileo's *Discorsi e dimostrazioni matematiche* (Leyden, 1638), 175: "... le dimostrazioni matematiche che sono i fondamenti di tutta la seguente struttura."
6. F. A4 recto, concl. II, 7th corollary: "Diversae naturae eos [satellites] a suo principali cui adherent sidere, non crediderim."
7. F. A5 verso, 5th corollary to the sixth thesis: "... velut pisces in mari, aut aves in aere"; *cf.* Psalm 8, 9: "The fowl of the air, and the fish of the sea."
8. "Decreta antiquorum et philosophorum et astronomorum, per observationes a recentioribus factas labefactata, stare non possunt" (f. A6 recto). One of the corollaries stressed the unity of the matter in the universe: "Coelorum compages, ex eadem materia ex qua et res sublunares constructae ... coalescit." The present resumé deals with the main issues of Strażyc's text; there is more in the leaflet both of fundamental issues and of topics of less importance (though not necessarily correct in detail).
9. Thoma Canevesius, in *Quaestio astronomica ... de harmonia motus Lunae ad Solem* (Cracow, 1640): "Hypotheses, non Chimeras formare Astronomos existimo, quando totalem coeli Planetarij molem, in orbes partiuntur."
10. Jagellonian Library MSS. 495, 2390 and 2468. In astronomical notes (dated 1634–39, MS 2468) there are references to Galileo's *Sidereus nuncius* (1610), *Dialogo sopra due sistemi* (1632) and *Discorsi e dimostrazioni matematiche* (1638). Other notes deal with Pudłowski's own observations and optical experiments. Two drawings on f. 270 show Galileo's "Saturnus tergeminus", and the ellipse-shaped planet devoid of rings; they accompany Pudłowski's own note: "Saturnum componi ex tribus stellis et proinde oblongum videri indicavit Galileus" [repr. by T. Przypkowski in *Studia i materialy z dziejów nauki polskiej*, vol. C12 (Warsaw, 1967), 56].
11. Galileo's closest pupil and assistant, Benedetto Castelli, warmly recommended Pudłowski's erudition and his esteem for Galileo in a letter of 1 May 1640: "[Pudłowski] da questo ella puo argumentare che il suo sapere e piu che ordinario". Castelli went on to quote Pudłowski, who found in the works of Galileo all that was worth learning ("che tutto quello che ha inteso di buono lo riconosce dall'haver iste dell opere [di Galileo]", *Opere*, ed. by A. Favaro, xviii, 185).
12. *Nova methodus longe accuratior observandi locorum longitudines: Scripta et proposita Italico idiomate per ... Benedictum Castelli, in Studio Romano Matheseos Professorem, Modo vero in utilitatem publicam, cultu verborum latino, ornata et per V. D. Cromer ... in Academia Cracoviensi candidatum in publicum edita* (Cracow, 1642). Pudłowski wrote the preface to it.
13. The periods of the moons' revolutions were listed in the chapter on Jupiter (2nd corollary) as $1^{d}18\frac{1}{2}^{h}$, $3^{d}13\frac{1}{2}^{h}$, $7^{d}4^{h}$ and $16^{d}18^{h}$, respectively.

14. His *Systema Saturnium* of 1659 presented a table of thirteen early Saturn drawings.
15. F. M. Beima, *De annulo Saturni* (Leiden, 1842); Dora Shapley, "Pre-Huygenian observations of Saturn's ring", *Isis*, xl (1949), 12–17. A valuable review of the early telescopic observations is presented by A. F. O'D. Alexander, *The planet Saturn* (London, 1962), chap. 4. The most recent study on the subject is that by A. Van Helden, "Saturn and his anses", *Journal for the history of astronomy*, v (1974), 105–21, and "Annulo cingitur: The solution of the problem of Saturn", *ibid.*, 155–74. Recently Galileo's early observations have been discussed by B. M. Deiss and V. Bebel, "On a pretended observation of Saturn by Galileo", *Journal for the history of astronomy*, xxix (1998), 215–20.
16. Galileo Galilei, *Istoria e dimostrazione intorno alle macchie solari* (Rome, 1613), 92.
17. F. A4 recto, 3rd conclusion, 1st corollary: "Maculas Solares non posse esse alibi, quam in ipso Solis corpore evincit parallaxis; quamvis refractio easdem aliquando extra discum reponat."
18. Jan Śniadecki (1756–1830), an eminent scientist of the Enlightenment, mathematician and astronomer; from 1807 professor of the university in Wilno (Vilnius), and rector 1807–15.