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The Teaching of Astronomy in Jesuit Colleges in the 18th century

Juan CASANOVAS

Specola Vaticana, V-00120 Città del Vaticano, Italy
E-mail: jcc@specola.va

Kivonat: Csillagászatoktatás a 18. századi jezsuita kollégiumokban
A nagyszombati egyetemi csillagda alapításának 250. évfordulója kapcsán érdeklődésre tarthat számot a Jézus-társaság kollégiumainak működése. Az obszervatóriumban a jezsuita irányítás csupán két évtizedig tartott, mivel különféle erők nyomásának engedve, 1773 július 23.-i, *Dominus ac Redemptor* kezdetű bullájával XIV. Kelemen pápa megszüntette a jezsuita rendet. A rend által világszerte sikeresen működtetett kollégiumokat bezárták, államosították, vagy a helyi püspökség felügyelete alá kerültek. A nagyszombati egyetem esetében a király röviddel az államosítás után Budára költöztette az intézményt, mely több mai felsőoktatási intézmény őse lett.
Amikor a napóleoni háborúk után VII. Piusz pápa visszatért Rómába, egyik legelső teendője a Jézus-társaság újjáélesztése volt 1814-ben. A rend tagjai között találjuk a hányattatásokat végigélt egykori jezsuitákat, valamint a fiatalabb nemzedéket Lengyelországból és Oroszországból, ahol a rendet valójában soha nem oszlatták fel. Legfontosabb kollégiumát, a római Collegium Romanumot a rend 1823-ban kapta vissza. Sok más kollégium végleg elveszett, de új intézmények alapításával lehetővé vált a rend korábbi sikeres tevékenységének folytatása.

Abstract:
On the occasion of the 250th anniversary of the foundation of the astronomical observatory at the college and seminary of Nagyszombat in 1755, it may be of interest to say something about the colleges of the Society of Jesus. The presence of the Jesuits there was brief, only two decades, as under the pressure of various external forces, the Jesuit Order was suppressed by Pope Clement XIV with the bull *Dominus ac Redemptor* on 23 July 1773. All the colleges that the Society had been running successfully all over the world either were closed, taken over by the governments, or given to the local

bishops. Shortly after the Jesuits left the college of Nagyszombat, the king transferred it to Buda, where it gave rise to modern institutions of higher education derived.
When Pope Pius VII returned to Rome after the Napoleonic wars, one of the first things he did was to reestablish the Society of Jesus in 1814. Old Jesuits, survivors of so many disgraces, joined younger Jesuits from Russia and Poland where in fact the order had never been suppressed. The most important of the Jesuit colleges, the Collegium Romanum in Rome, was given back to the Society of Jesus in 1823. Many other colleges were lost forever, but new ones were founded to continue the Society's previous successful activity.

Colleges

Why did the Society of Jesus have colleges? It is well known that in its very beginnings, around the mid-16th century, the religious order the Society of Jesus had no plans to establish schools. The first Jesuits had attended established and well known universities, in particular the University of Paris. However, once the membership of the Order grew it was not practical to send all the young Jesuits to these universities.

Young members joining the Order needed to receive a good knowledge of Latin, Greek and Hebrew, philosophy and finally theology to prepare them for the priesthood. It was necessary to provide schools or seminaries for their formation. While the Jesuit order's founder, Ignatius of Loyola, was still alive, many requests were sent to Rome asking to allow outsiders to attend lectures at those schools, at least for the humanities. The accessibility to studies in towns far away from the main universities, and the quality and preparation of the teachers, made the Jesuit colleges very attractive. We noted above that the first Jesuits had attended the University of Paris, and therefore they introduced a new method of teaching into Italy. Eventually, every major town in the Catholic countries had a Jesuit college. Ignatius Loyola insisted that attendance at the Jesuit colleges should be gratuitous, the same as it was for all the other apostolic activities of the Jesuits. At the same time, Loyola wanted the teachers to be free from financial concerns; therefore an endowment was required for every college. Unfortunately after the restoration of the Society of Jesus in 1814 for various reasons this provision could not been maintained.

Since the original intention was the preparation of young Jesuits for the priesthood, there was no provision for the teaching of science, except for the philosophy of nature, which was mostly Aristotelian. It was at the insistence

of Fr. Christopher Clavius, well known for his contribution to the Gregorian reform of the Calendar in 1582, that some lectures on arithmetic, geometry, astronomy and music were introduced in those schools open to non-Jesuits, as in the universities. Clavius was not satisfied merely with the introduction of mathematics in the Jesuit schools; he felt it necessary to write some books to help the teachers in their job. Thus he wrote many books on arithmetic, and on Euclid's geometry; and in particular he wrote the *Commentarius in Sphaeram Ioannis a Sacrobosco.* This author, Johannis a Sacrobosco (1200–1250), had written a small book with the title de Sphaera used by most universities since the 13th century. One finds numerous copies of this booklet in all the libraries and archives and it went through many editions after the invention of the printing press. This apparent success was probably due to the fact that de Sphaera was a very short book; as a matter of fact it was nothing more than a series of concepts and definitions. Professors of astronomy were required to explain and comment on it. Even Galileo was expected to comment on de Sphaera when he was a professor at the University of Padua. Clavius's commentarius is an excellent large book of astronomy that contains all the astronomy known at the second half of the 16th century.

The Ratio Studiorum

It was found convenient from the beginning to issue a sort of official document to help make the teaching in the Jesuit colleges uniform. This document is known as the *Ratio Studiorum.* It is not a treatise on paedagogics, but rather a book on how to arrange the various teachings, from Latin Grammar to theology. The title of this document can be been translated into English as *A Syllabus for Teaching,* or as *Studienordnung* in German. It contains a series of general rules addressed to the general superiors, then other rules for the rectors of the colleges, then rules for the teachers of humanities and philosophy, and finally rules for the professors of theology. These rules deal with how to allot the time available, the topics to teach, public exercises, etc. Anyone interested in the *Ratio Studiorum* should look at the bibliography given at the end: see the official documents in *Monumenta Paedagogica* (1) and, for Northern European countries, see Koch (2), Pachler (3), Duhr (4) and Barbera (5).

One criticism of the *Ratio Studiorum* was that there was little or no space given to the study of vernacular languages and literature. But this was the general practice in the schools and universities in Europe at that time. Latin was the universal language, not only for philosophy and theology but also for

science. It was the written language of Kepler, Newton, Euler and even up to Gauss. Only in the 17th century was there an opening for national languages in science, beginning with Galileo.

Teaching of astronomy and observatories in the Jesuit colleges

We mentioned above that there was no room in the first version of the *Ratio Studiorum* for mathematics, much less for astronomy, and that they were included thanks to the insistence and advice of the prestigious Fr. Clavius. In practice, much depended on the teacher of astronomy. He could prefer to emphasize geometry or he could include more astronomy. It could depend also on the students.

Mathematics was taught in the second year of philosophy, when the students were introduced to the study of natural philosophy also called physica. That normally included a commentary on the Aristotle's books *Physica* and *De Coelo.* The rules for the professor of mathematics were precise:

> *The teacher has to give to the students of Natural Philosophy Euclid's* Elements *during three months. Afterwards and for two months, geography and Sacrobosco's* De Sphæra, *things that are received with pleasure. One day each month, instead of a lecture, they have to repeat publicly what they have learned in front of an assembly of students and other teachers.*

As a matter of fact, this was not much, but it was sufficient for the majority of those who intended to study mainly philosophy and theology. However we read in the rules for the Superior:

> *All students of philosophy, in the second year, have to attend the lectures of mathematics for three quarters of an hour. If there are some among them well gifted and with peculiar interest for these studies, they should receive private lectures after the regular course.*

This was the practice in the Jesuit colleges. This further study was done in the so-called *academies.* Academies were not restricted to mathematics; there were also academies for humanities, theater, philosophy and theology. Fr. Clavius, mentioned above, ran a famous academy frequented by great Jesuits including Grienberger, Maelcote, Grassi, Zucchi and Gulden, and those who

initiated astronomical activity in far away China: Matteo Ricci, Ursis, Schreck and Adam von Schall. Among the activities of the academy were teaching the practical use of astronomical tables in accordance with various cosmological models, the tables of Tycho Brahe and later those of J. Kepler, the calculus of solar and lunar eclipses, etc. Students also became familiar with the study of Theoricae Planetarum and alternative geometrical models of planetary orbits. Gnomonics was important because it was a sort of exercise in geometry.

The old astronomy taught in the ordinary lectures and in the academies was simply geometric. Before Galileo, astronomy was more or less restricted to geometrical schemes in the perspective of a cosmological model in order to calculate the ephemerides of the planets. With the advent of the telescope, there was an interest for a while in the physical properties of the Sun, of the Moon and of the Planets. However the telescope had little to offer to the astronomer; the early optics were full of aberrations and chromatic error. One had to wait until the arrival of the spectroscope for the development of the study of physical properties of celestial bodies, what we call today astrophysics.

The mathematics/astronomy teacher would explain the various cosmological systems, old and new; this can be seen from some students' class notes that have survived. But it is important to note that the teacher of mathematics was not supposed to give the physical value of each world system but only provide an explanation of the various hypotheses useful to obtain good numerical predictions. He was supposed to give the mathematical description and how to derive and calculate the astronomical tables, considering the advantages of each system, etc. It was the exclusive duty of the professor of philosophy of nature to give the final word, as part of his lectures on the Aristotle's books de Coelo and Physica. As an example, there is a very good treatise on the Philosophy of Nature written by Fr. Giovan Battista Tolomei (6), with the title *Philosophia mentis et sensuum.* He describes all cosmological systems with all possible combinations of Ptolemy, Tycho Brahe, Riccioli and Copernicus, giving the advantages and disadvantages of each one and how well each one fit the observations, in an unbiased attitude. Of course, he had to remind the reader about the 1616 decrees and the condemnation of Galileo, which insisted on a literal interpretation of the Holy Scripture as against the new cosmology. Recall that the Aristotelian explanation of the Milky Way, comets, the spheres, etc. had long been made obsolete by Tycho Brahe and Galileo's discoveries. It was obvious that the job of the professor of Philosophy of Nature was becoming uncomfortable even by the end of the 17th century.

The definitive blow to the old physics was given by Newton. This author was introduced in the Collegium Romanum by Fr. O. Borgondio (1679–1741). He

provided Newton's *Principia Philosophica* to his best students, among them Fr. Ruggiero Boscovich (1711–1787). The Ratio Studiorum recommended that the professor present his teachings in a solemn public dissertation to which teachers and students of the college were invited. Boscovich frequently gave such public dissertations. It is interesting to see the titles of his subject matter, such as the aberration of light, on the comets, on the sea tides etc. These topics show that Boscovich was well acquainted with contemporary physics and astronomy. Some of his talks were provocative, like the mutual perturbations of Jupiter and Saturn, or the calculus of cometary orbits, topics openly Copernican. This is most evident when Boscovich presented the observation of the aberration of light recently discovered by James Bradley in 1728. Boscovich tries first to fit the Bradley's observation to the old cosmology. But at the end of his talk, just in a short paragraph, he shows to everybody how easy and elegant was the interpretation given by Bradley. As a matter of fact, this was one of the first proofs of the motion of the earth and a good measure of the speed of light (7).

It is noteworthy that Pope Benedict XIV funded Boscovich's expedition to measure two degrees of the earth meridian in the Pontifical States. This was during the time of the controversy about the figure of the earth, which was shown to have a shorter polar radius than equatorial radius due to its rotation. It was a truly Copernican question. In addition, Boscovich was able to confirm the deviation of a plumb line from a true vertical line due to the mountains. All these were clearly demonstrations of the earth's rotation and of Newton's general gravitation theory. The time was ripe for Pope Benedict XIV to cancel the decree against the Copernican hypothesis, which occurred in the new edition of the Index of Forbidden Books of 1759 [5].

What did Jesuit astronomers believe before 1759? There is no easy answer to this question because no one could print anything openly in favor of the earth's motion. Recall that the Jesuits, belonging to a religious order, were supposed to ask for permission before publishing a book. The cum permissu Superiorum was required, along with other forms of permission like the *Imprimatur* and the *Nihil Obstat.* All this was very effective. The Society of Jesus was very anxious not to create problems with the Holy Office and other religious orders, since the real question was the literal interpretation of the Holy Scriptures. We have already seen their practical way to deal with this problem: to explain the various cosmological hypotheses and how to use them mathematically as specifically allowed in the decrees of 1616.

After 1759 things were different. The above mentioned Fr. Boscovich confessed that he had always respected the decrees of the Holy Office of 1616 as a priest and a Jesuit. But he also confessed that he didn‘t consider himself a

Ptolemaic nor a Copernican but a Newtonian. In other words, he believed that not only the earth moved but so did the Sun.

As far as the astronomers were concerned, the new edition of the Index of Forbidden Books of 1759 gave free space for the new astronomy. For instance, Guglelmini began experimenting with fall of bodies and deducing the rotation of the Earth. J. Calandrelli tried to measure the annual parallax of a star right in Rome. Believing to have found it, he announced it in a printed paper without any problem. However, later on, after the restoration of peace in Europe once the Napoleonic wars were over, a professor of the Roman university La Sapienza, Giuseppe Settele, was preparing the printing of a text book of astronomy (8). But the prefect of the Sacred Palace, A. Anfossi, whose duty was also that of giving permission for publication of books, denied it on the grounds that although the prohibition of printing books defending Copernicanism were omitted from the Index, the decrees against Galileo were still there. The Holy Office itself fought for the permission to print Settele's book. But until this late resistance was overcome, the Copernican question was not definitively settled.

Astronomical observatories in the colleges of the Society of Jesus

The 18th century saw the spread of observatories in Europe. It began with the Observatoire de Paris, then of Greenwich, etc. That century after Newton saw the emergence of astrometry. At the end of the the 17th century, astronomers had at their disposal the astronomical telescope described by Kepler, which gave an image in the prime focal plane where an *ocular micrometer* was installed. It was a real jump in precision. That permitted the discovery of the aberration of light, the proper motions of stars, the existence of double stars, precise planetary motions and various anomalies.

In the 17th century observations were made simply with portable telescopes taken outside in the open, usually on a terrace at the upper and clear part of a building. That was not practical any more with the new meridian circles, provided with a pointiang telescope and a micrometer. These meridian circles had to be fixed solidly to a wall. An observatory was normally a tower built in the upper part of the college provided with large windows facing all directions of the horizon. The use of domes came much later.

Unfortunately these new instruments were very expensive. Only a few of the Jesuit colleges could afford such instruments. The true observatories were

mostly those that were financed by governments, like the observatory of Vienna, built by the government and given to the University which was run at that time by the Jesuits. The same can be said of the observatory in the Prague university. However, the Jesuit astronomers enjoyed this new activity only for a short time because everything came to an end in 1773 with the suppression of the Order. Anyone desiring to know more about the Jesuit observatories before 1773, should read the newly edited book of Agustín Udìas. (9)

This interest in astrometry in the 18th century is clearly manifested in the work of the Hungarian Fr. Maximillian Hell, mentioned above. His life is an example of the sort of astronomy that was prevailing in the Jesuit observatories in the 18th century. After working on the construction of the Nagyszombat college and observatory, he was appointed director of the Vienna Observatory in 1755. A transit of the planet Venus across the Sun was predicted for August 3th 1769. Astronomers used this event as an occasion to measure the solar parallax, from which the distance of the Earth to the Sun could be derived. Most European countries were preparing expeditions to various parts of the Earth in order to measure the transit from different points as distant as possible. The Danish King invited Fr. Hell to go to Vardø, Lappland, on a place located at the geographical latitude 70°.1 where there was a military garrison. After a very long and difficult voyage Fr. Hell arrived there in time to observe the transit. The observations were presented to the Academy of Science of Copenhagen the next year and published with the title *Observatio Transitus Veneris ante discum solis die 3 iunii 1769 Wardoehusii* (Copenhagen, 1770). Hell soon found himself in the midst of an unpleasant controversy. The French astronomer Lalande (Astronomie, liv. XI, Paris, 1792, p. 502) complained that Hell was late in sending the observed data on the transit and said that Hell had had time to alter them after comparing them with the observations of his colleagues. Hell's reputation was not redeemed until the American astronomer S. Newcomb made a thorough study, from which it turned out that Hell's observations were of high quality, but that someone who was not able to read the original notebook correctly had misinterpreted them (10). The transit observations and Hell's activity in the calculation of the astronomical almanac until his death in 1792.

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