RENAISSANCE IN ORADEA AND THE PRIME MERIDIAN

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Abstract. Renaissance flourished in Oradea, a city in the Northwest of Romania, due, largely, to the instrumental role played by Joan Vitéz of Zredna (Hungarian: Zdrednai Vitéz János; Croatian: Ivan Vitéz of Sredne; 1408 - 1472), bishop of Oradea (1444 - 1465) and afterwards bishop of Esztergom. Archbishop Joan Vitéz of Zredna cultivated his connections with several high priests of Italian origin, such as Giovanni de Milanesi da Prato, Giovanni de Cuirzola and Giovanni de Dominis da Arbe to promote the humanist values of renascentist era. His court became a place of gathering for great scholars and erudites, such as Philip Podocatharo from Cyprus, the Dalmatian Nicolaus Machinensis, the Italian humanist Marzio Galeotti from the court of Matthias Corvinus, the poet Gaspare Tribracco, etc. His personal relationship with the illustrious astronomer Georg von Peuerbach enticed von Peuerbach to write a geometry treaty and to establish an astronomical observatory in Oradea at his request. Joan Vitéz also benefited from the friendship of humanist Enea Silvio Piccolomini, who later became pope, as Pius the Second. In this paper we are presenting a brief history of the city, with a focus on the astronomical activities during this period, emphasizing the role played by the city of Oradea in European Renaissance. The tradition of research in astronomy is carried on in present days by teachers and students from Oradea at the astronomy club Meridian zero".

Key words: Astronomy in culture – Bishop Joan Vitéz – Astronomical observatory – Tabula Varadiensis – Prime meridian.

1. INTRODUCTION: A BRIEF HISTORY OF THE FORTRESS OF ORADEA

The geographic location of the city of Oradea is at the crossroads of commercial routes connecting the Orient with the Occident [3, 5, 6, 11 and 12]. The region has been continuously inhabited since early Neolithic. Many archaeological findings from the region (pottery, hand tools, coins, burial places) testimony this continuity.

At the end of the XI century King Ladislau I (1077-1095) erected a monastery and a church dedicated to Saint Mary in the vicinity of the river Crişul Repede. The fortress built around this monastery, Cetatea Oradea (Oradea fortress), developed into a fortified town, which became the centre of religious, administrative, political and military powers of the region [15].

Arguably one of king Ladislaus greatest deeds, the foundation of Roman Catholic Diocese of Oradea within the fortified town, was established at the same time as the

Fig. 1 – A tomb discovered in the fortress of Oradea (left). A vault discovered in the basement of the old cathedral from the Oradea fortress (right). Photo: Mihalka Nandor.

one in Zagreb. Besides the diocese, a chapter school known as *Capitlul* and consisting of the 24 cannons officiating at the cathedral was founded.

However, the first fortified town of Oradea was short lived, as it succumbed, according to a witness, the monk Ruggero of Puglia (Rogerius), to the great Mongolian attack of 1241. Its demise by fire is described in Rogerius poem Carmen Miserabile [19].

By 1245, shortly after the First Council of Lyon, a vast program of work on rebuilding the fortress as well as the area surrounding it had begun. A major undertaking was the erection of the Gothic cathedral, one of the largest in central-eastern Europe; the work began around 1342 and was completed during the episcopate of Demetrius (1345-1372).

The building of the Gothic Cathedral is depicted on two pages of the Chronicon Pictum (Vienna Illuminated Chronicle) written around 1368-1370 by Márk Kálti (*lat.* Marci de Kalt).

The second illustration shows the finished cathedral, suggesting that its completion can be placed around 1370. In 1401 Pope Boniface IX bestows the status of *basilica maior* on the cathedral, shared with other Papal churches, such as San Marc Basilica in Venice and Basilica of St. Mary of the Angels in Assisi, boosting the citadel and the cathedrals fortune and wealth. At the request of king Sigismund of Luxemburg, the cathedral even becomes an European pilgrimage site (from 1430). The bishops traditionally associated with the Cathedral had strong connections with Italy, either by birth or by their religious and humanist formation, and brought to Oradea the Renascentist values, thus shaping the city into an important cultural cen-

Fig. 2 – The statue of the King Ladislaus I in front of the Catholic diocese cathedral in Oradea (http://www.cetatea-oradea.ro).

Fig. 3 – Images from the Vienna Illuminated Chronicle depicting the erection of the Gothic cathedral (http://www.oradea.travel.ro).

tre, where scientist endeavour flourished alongside spiritual and religious activities.

One of the richest in the medieval Hungarian kingdom, the Oradea Diocese benefited from the protection of kings Charles I of Hungary and his son, Louis the Great, who encouraged the cultural life of the citadel. Thus, this favourable conjuncture allowed the extension of the European Renascentist ethos to central end eastern parts of Europe, and particularly to the region of Oradea.

Besides the Italian connections that favoured the import of Renascentist values originating in Italy, several other factors concurred to the development of the fortress into a significant Renascentist centre: Gutenbergs invention of the printing press, which contributed to a fast dissemination of ideas; the establishment of a plethora of libraries that could be freely consulted, such as, for example the Corvinian Library [17]; the great geographic discoveries that impacted on the development of cartography and on observational astronomy; the development of scientific methods based on observation and experimentation, rather than on dogma and scholastic authority, leading to the formation of scientists dedicated to the study of nature armed with mathematical tools and models.

2. JOAN VITÉZ, A RENASCENTIST HUMANIST

The city of Oradea bears testimony of the nascent passion for science that had captured the Renascentist elites: indeed, documents attest that by 1459 an astronomical observatory functioned here, even before the one in Nuremberg, established in 1471 [3, 11, and 12]. An explanation for this early interest in astronomy is related to the presence in the area of renowned scholars, such as Georg von Peuerbach (1423-1461) and Regiomontanus (Johannes Müller von Knigsberg[1] (1436-1476), as well as to bishop of Oradea, Joan Vitéz of Zredna's passion for science. A true Renaissance man, Joan Vitéz, cultivated the arts and sciences while serving the religious and spiritual needs of Oradea, as bishop, for over 20 years (1444 to 1465). An avid book collector, the bishop was a regular customer of publisher and librarian Vespassiano da Bisticci[2]. Joans impressive library formed the nucleus of the Corvinian Library. His humanist legacy was continued by his nephew and pupil Jan or Ivan Česmički. Better known under his Latinised name, Janus Pannonius (1434-1472), he became one of the most celebrated poet of his age [3], while at the same time serving as one of kings Matthew Corvin diplomats and Bishop of Pécs. Janus Pannonius spent his forming years in Oradea, where he studied at the Charter School and where he was for a short while cannon in 1454. For the occasion of his departure from the city he wrote one of his most beautiful elegy Abiens valere jubet sanctos reges, Varadini. He who leaves and bades goodbye to the venerated kings of Oradea, Búcsú Váradtól in Hungarian) in 1451. In the poem Janus mentions his library with its rare book

collection, which was left behind at his departure.

Another famous alumnus of the Chapter School, and presumably a pupil of Joan Vitéz as well, was the future king Matthias Corvinus (1458-1490). During his kingdom Oradea was placed geographically at the heart of the Hungarian kingdom, which facilitated its position as a cultural and religious centre of European class. But even at the time of bishop Joan Vitéz, Oradea occupied a special place in the kingdom as the "seat of the new muses" [10] as another of Oradeas sons, historian and Catholic cannon Frakni Vilmos[3] (1843-1924), described in 1878 the citys cultural atmosphere. Indeed, Joan Vitéz assembled at the Episcopal court a number of prominent international scholars and humanists, such as the Polish scholar and philosopher Gregory of Sanock and Nicolaus Lassocki, Byzantine Filip Podocatharo, the Dalmate Nicolaus Machinensis, and the Italian Marzio Galeotti (1427-1497) a veritable "Literarum asylum", as Gregory of Sanocks biographer put it[4].

3. ORADEAS FIRST ASTRONOMICAL OBSERVATORY AND THE PRIME MERIDIAN

Interested in the new science of astronomy, Joan Vitéz established an astronomical observatory in 1459, arguably the first of the kind in Europe. Fascinated by eclipses, which were associated with natural calamities in the popular culture of the time, Bishop Joan Vitéz sought to obtain scientific expertise on the subject from Viennese astronomer Georg von Peuerbach. At that time von Peuerbach was part of a network of scientists gathered by humanist scholar Enea Silvio Piccolomini a close friend of Joans and the future Pope Pius II at the court of Emperor Frederick III. Von Peuerbach had been instrumental in advancing mathematics as a science auxiliary to astronomy[5]. He is considered the founder of observational astronomy and his work paved the road for the research that later led to the Copernican revolution. Following on the footsteps of Johannes von Gmünden, and together with his disciple Johannes Müller (also known as Regiomontanus), von Peuerbach founded the first School for Mathematicians at the University of Vienna[6] [11].

It is known that von Peuerbach sent Bishop Joan Vitéz a celestial map, considered the first of its kind in Eastern Europe. In a letter to Joan Vitéz, the Viennese astronomer describes his efforts to compile a table of eclipses (*Tabulae eclipsium*)[7]: "*It was your intention to gather [at the episcopal court* n.n*] mathematicians and those who study quadriviumul*[8]*, as they are the only ones who bring forward the essence of knowledge and most of its advantages, and what is more, those who like us, study the celestial changes and the certain and undoubtedly data that govern them, that is, us who determine their exact positions and, moreover, who demonstrate with numerical values from tables and with the aid of instruments, and who calculate their motions, all things you consider a wonderful gift. As you have expressed your desire to learn*

about eclipses from tables in an easy and clear way, I have endeavoured to satisfy your wish, and tried to compile the tables, based not only on the prior knowledge of my predecessors. Based on these data, one can calculate in an easy way the eclipses of both shining stars [Sun and the Moon, n.n] that will occur in the future. The tables were calculated on the basis of the meridian that passes through Oradea, and for this reason, I estimated that it is right and proper to call them Tabulae Varadiensis, the Oradean tables."

Fig. 4 – Statue of Joan Vitéz in Esztergom (personal collection of the authors).

The *Tabulae eclipsium*, probably compiled by 1459, represents von Peuerbachs most impressive work, and was used throughout the sixteenth century. Though critical to the tables Tycho Brache used them by the end of the sixteenth century[9].

An important number of manuscript copies circulated until Tabulae eclipsium was first printed in Vienna in 1514. Two versions of the tables are known. The original version, calculated for the meridian that passes through Vienna, is also the version that was published later, with some minor revisions of the instructions. The second manuscript version, as the letter to Joan Vitéz attests, is based on a translation of the reference point by 0:30 h (an error for 0:22 hours) to the East to adjust the calculations to the meridian that passes through Oradea; this version, dedicated to

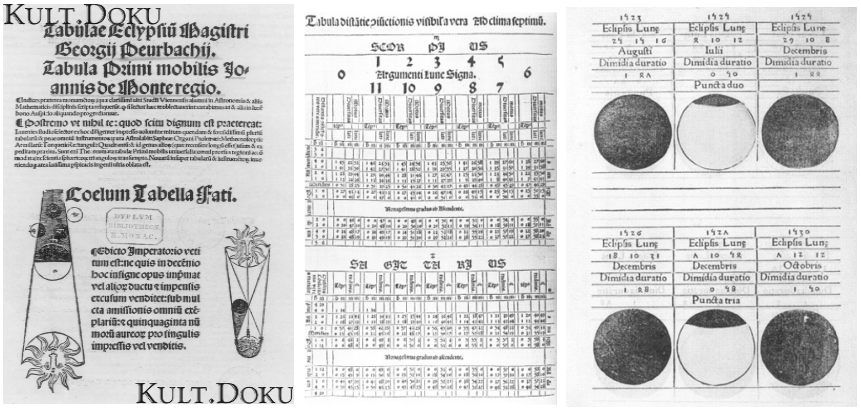

Fig. 5 – *Tabulae eclipsium* (http://www.sites.hps.cam.ac.uk/starry/tables.html)

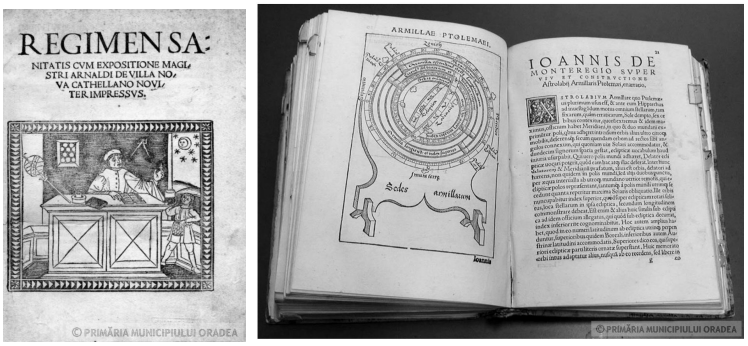

Fig. 6 – Medieval astronomical manuscripts (Oradea municipality collection)

Bishop Joan Vitéz, is known as Tabulae Varadienses.

With his appointment as Archbishop of Esztergom in 1465, Joan Vitéz leaves Oradea, taking with him his books and astronomical instruments. Still passionate by astronomy, Joan Vitéz stayed in touch with Regiomontanus, whose scientific works he had copied for his library.

Enlisting the help of his former pupil, Matthias Corvinus, by then king of Hungary, Joan Vitéz envisaged the foundation of a university in Pozsony (Bratislava today). On 29 May 1465 Pope Paul II authorised Joan Vitéz and Janus Pannonius to establish a university modelled after the University of Bologna. Two years later, on 20 July 1467, the new university, Academia Istropolitana, opens its gates to the first cohort of students. Thanks to Joan Vitézs international connections, the university boasted some respected professors, such as Regiomontanus and his good friend Martin Bylika [20]. But Academia Istropolitana did not last long, due to the deaths of both its founders in quick succession: Joan Vitéz died in 1471 and Janus Pannonius

in 1472. Soon afterwards the universitys fortune declined, and the university ceased to exist. Despite the short span of its existence, Joan Vitéz is remembered as the founder of the first Hungarian university.

Regiomontanus found a new protector in the person of Bernard Walter, another passionate of astronomy, who offered him the means to found a new observatory in Nuremberg and facilitated the printing of his scientific works.

4. POSSIBLE LOCATION OF THE ASTRONIMICAL OBSERVATORY

The sixteenth and seventeenth centuries were marked by numerous wars and instabilities that were not propitious to the flourishing of arts and sciences; on the contrary, Oradeas Catholic Cathedral was to be destroyed during the Unitarian rebellion of 1565 and its rich possessions confiscated; in these circumstances, the citys priorities shifted towards military defence. A particularly serious threat was presented by the expansion of the Ottoman Empire towards neighbouring Timişoara. In 1552 this was annexed to the Ottoman Empire and the Timişoara Eyalet was set up. At this point, with the Ottomans so close by, the necessity of strengthening Oradeas defence capabilities, became urgent, and the heads of the Transylvanian Principality hired Italian architects and master masons for the job. By 1618 the external fortress was consolidated and the interior castle, which mirrors the pentagonal shape of the fortress, was erected between 1618 and 1650 [15].

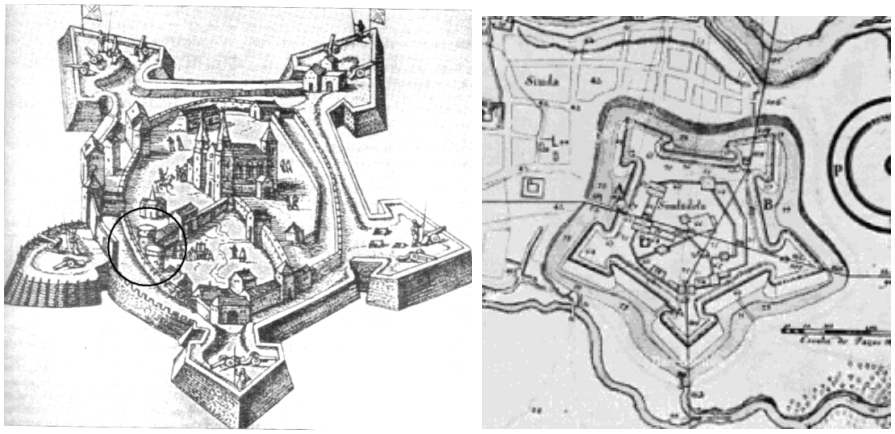

Fig. 7 – The Oradea citadel in 1598 (Oradea municipality collection)-left; Map of 1691 (Oradea municipality collection)-right.

A comparison between Figures 7-left (the 1598 map) and 7-right (the 1691 map) shows the extent of the work to enhance the citys defence capability. One can see that the two circular towers marked with a circle on Figure 7-left do not exist

on Figure 7-right. As the fortress was destroyed and rebuilt according to the new norms of defence, it is impossible to know with certainty the place where Joan Vitézs astronomical observatory once stood. Bellow is a few educated guesses.

Fig. 8 – Oradea Citadel in the seventeenth century (Drawing by Georgius Haufraglius - Collection of the Romanian Academy library).

We will suppose that, as with all astronomical observatories, the site would have to be at a certain elevation above the earth and would offer an adequate space for the astronomical instruments, such as, for example a stable, stationary, platform. A fortification tower would, therefore, be a good candidate. All the fortresss square towers, however, have roofs and are embedded in the external wall.

Circular towers, in contrast, were located inside the fortifications and were designed for the storage of valuables, such as documents, and therefore incorporated small rooms for guards to live in. The two circular towers marked on Figure 8.a are good examples. On the print one can see that the tops were flat and possibly protected by a banister. Astronomical instruments placed on such a roof could be oriented in all directions. What is more, the towers were about twice as a high as the city walls. Estimating the city walls at about 3-4 m, we conclude that the circular towers were about 10 m tall. This figure is supported by the heights of circular towers dating from the same time as those in Oradea, and that are still standing in the area, such as, for example the tower of the Bologa fortress (Cluj-Napoca county), depicted in Figure 10. This tower is relatively well preserved and therefore it can serve as a standard. A comparison of the dimensions of this tower (as measured by the authors of this article) with other towers still standing, and the analysis of epoch prints and maps leads to the following conclusions: the tower would have been about 15 m tall, with an external diameter of 10 m, and an internal diameter

(inhabitable) of 6 m and a wall thickness of 1.5 - 2 m. The tower comprised four levels, separated by thick planks of wood. The access to the tower was permitted by external mobile stairs. The Bologa tower can still be accessed by stone stairs on the interior of the thick wall; the stairs were narrow (0.8) allowing only one reason at the time to climb. The actual room was located on the third level; it had only two windows located by the sitting niches, a fireplace and a built in chimney [30] (http://www.taracalatei.ro/atractii/cetatea-bologa/).

Fig. 9 – View over the Bologa Cluj fortress (2016) (Personal collection of the authors).

Thus, based on this analysis, we located the most probable position of Joan Vitézs first observatory as shown in Figure 11; this satisfies most of the conditions required for an observation point and for lodging of the personnel in charge of the observatory.

Observational astronomy continued in Oradea, even though in a lower key compared to its flourishing period of Joan Vitéz and Regiomontanus. Astronomy was still a subject of the curriculum of the Chapter School at the beginning of the sixteenth century, when another famous student, Nicolaus Olahus (1493-1568), was enrolled there. "Museul Ţării Crişurilor" contains a collection of astronomical instruments from the sixteenth century (Figure 12) [21].

Besides Astronomy, Nicolaus Olahus, a native of Sibiu (Hermannstadt), studied Latin, eloquence, poetry, music, astronomy and religion at the Oradea Chapter School. After graduating from the Chapter School Olahus continued the educational tradition of the fortress of Oradea, and played an important role in managing institutions of higher education in Hungary: in 1554 he reorganized the Catholic school

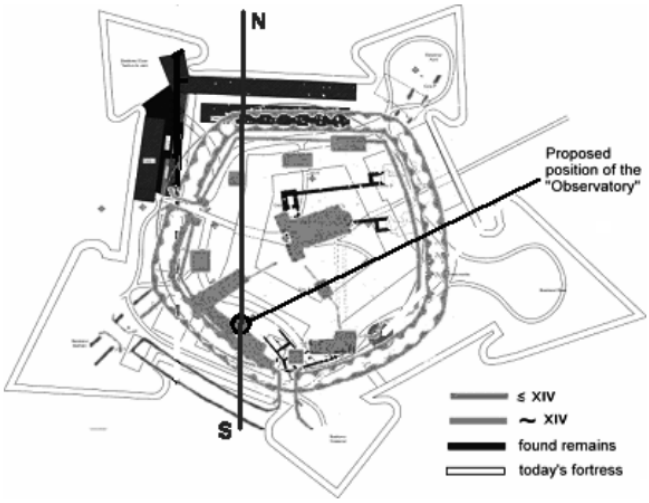

Fig. 10 – The most probable location of Vitéz's astronomical observatory in the Oradea citadel.

of Nagyszombat (today Trnava, in Slovakia) and in 1561 he funded the Jesuitical Seminary of Nagyszombat, unique in Hungary. A good friend of Erasmus, has career progressed from page at the court of King Ladislaus II of Hungary to Primate of Hungary and Emperor Ferdinand Is deputy.

The history of the origins of the notion of a prime meridian is a long and interestingly complex one [44]. As early as 220 BC, Eratosthenes made the Alexandria meridian as a prime meridian. Around 160 BC Hipparchus used as reference meridian the one passing through Rhodes. Three hundred years later, Ptolemy, a geographer and mathematician from Alexandria mapped and determined the coordinates of over 8000 places with respect to the Canary Islands. His book Geographia was published at Bologna in 1447. On the map of cartographer Ribeiro dated from 1519 the prime meridian is shown to the west of the Canary Island, while on Girolamo Verrazanos map of 1529 there are two reference meridians, one to the west of the Canary Islands and the other to the west of Madeira. The Canary Islands (more specifically, El Hierro, the westernmost of these islands) were also chosen as reference on Mercators map in 1531.

As the setting of the prime meridian appeared to be arbitrary, for a while it was sought to place the prime meridian along the line where the magnetic North, indicated by the compass, coincides with the geographic North indicated by the Polar star. However, navigators Columbus and Magellan noticed in their circumnavigation that the zero magnetic deviation did not follow a meridian, and the method was abandoned. Thus, the development of cartography and the associated idea of a prime meridian were greatly determined by navigation, which in turn, was stimulated by

Fig. 11 – Astronomical compass, celestial sphere, and sun dial in the Collection of the "Museul Ţării Crişurilor".

commerce. In the era of expeditions led by great navigators, such as Christopher Columbus (1492, 1493–1496, 1498–1500, 1502–1504), Vasco da Gama (1497, 1498 and 1499), and Magellan (1519–1522), accurate maps were absolutely crucial [38]. The positions of the vessels were determined by measurements of the altitude of the Polar star at various moments of times and the displacement northward or southward until the Polar star reached the desired angle [43].

The calculations involved in determining the position of ships were greatly improved between the thirteenth and fifteenth centuries, when an instrument already known to the Byzantines and Arabs, the astrolabe, was perfected by Europeans. At the same time, the accuracy of tables of solar declination, as well as solar and lunar eclipses, was improved.

However, though the determination of latitudes of any place on the globe using the Polar star was relatively easy, the determination of the longitude presented insurmountable problems until the eighteenth century. Until then, the longitude was basically determined with the aid of tables of lunar eclipses. The best paper known were the tables calculated by Georg von Peuerbach (*Tabulae eclipsium*). The breakthrough came when Joan Harrison, a self-educated English carpenter and clockmaker invented the marine chronometer in 1773. The measurement of the longitude with a clock was based on the rotation of the earth, motion supposed to be uniform. Any longitude determined in this way was given with respect to a reference, the prime meridian.

In this context, by 1800 French mathematician and physicist Pierre Simon Laplace suggested the adoption of an international, unique reference meridian. Naturally, the Paris Observatory presented a good option, and between 1875 and 1884, the location of the prime meridian was debated at international congresses of geography [45]. When finally, a decision was taken, the Greenwich Observatory in England was preferred [47]. Various reasons influenced this decision, among which the ac-

Fig. 12 – Nicolaus Olahus (Source: Old public domain work, https://commons.wikimedia.org/wiki/).

curacy of its instruments for timing the passage of stars across the local meridian (Airy Transit Circle) [48] certainly played a great role. There is a vast bibliography on the reference meridian, see for example [44 to 49]. In summary, Georg von Puerbachs Tabulae Varadiensis privileged the Oradea Observatory as the location of the "prime meridian", and thus, Oradea played an important role in the history of early navigation.

5. CONTINUING THE TRADITION OF OBSERVATIONAL ASTRONOMY IN ORADEA

While several historic events contributed to the demise of the Oradea Observatory, its long and fruitful scientific tradition, initiated in Renaissance, cannot be omitted, as the European Community (EC) specifically recognizes the importance of Europes role in developing and unifying its nations; in this context, Oradea can be seen as a major European player.

The interest in astronomical observation was recently rekindled in Oradea: motivated by the discovery of some notes [15] and by the curiosity triggered by the mechanism which represents the moon phases of the Church with Moon in Oradea (Figure 15 a and b.), as well as the astronomical instruments in the "Muzeul Ţării Crişurilor" (Figure 12) the astroclub Meridian 0 Oradea was founded by two professors Marin Bica and Nicoleta Pazmany and engineer, Graian Hofer [21].

Among the Astroclubs activities are observing sun and moon eclipses, the transit of planets Venus and Mercury, measuring the radius of the Earth with Eratosthenes-

Fig. 13 – a) The Church with Moon (Orthodox Cathedral); b) Clock mechanism in the tower (Personal collection of the authors).

Fig. 14 – Picture taken at the moment of establishing of the "Astroclub". Among the founders: Professor Dr Cristina Blaga from BB-Cluj University, Dr. Mircea Rusu from the University of Bucharest and Professor Lucia Erika Suhay, member of the Romanian Committee of Astronomy. (Photography collection of the "Astroclubul Meridian Zero, Oradea").

type experiments, as well as observing galaxies and comets. A touch of 21st century is added by robot building; the club members, dream of using the robots to travel to the Moon and to Mars. But some of their activities do not remain in the realm of dreams; one of the former club members, a graduate of the Aeronautics Department

Fig. 15 – Observing the partial Sun eclipses in March 2015 at the Orthodox High School Episcope Roman Ciorogariu", Oradea. (Photography collection of the "Astroclubul Meridian Zero, Oradea").

Fig. 16 – Celebratory events at the tenth anniversary of the Astroclubs foundation in Oradea (Photography collection of the "Astroclubul Meridian Zero, Oradea").

of the Polytechnic University from Bucharest, works for Airbus in Germany and takes part in actual launching of satellites. Several of the club members, such as Dr Annabele Pardi, actually in Germany, Vlad Gavra at Delft, Alexandra Văcaru at the University of Cluj-Napoca, are pursuing courses in higher education in astronomy and astrophysics at prestigious European universities.

Recently a team of high school students, Alexandra Văcaru, Natalia Bot, Miruna Oana, Sebastian Oana, Ilie Dindelegan i Victor Georgie, participated to the competition European Astro Pi Challenge, Mission Space Lab, organised by the European Space Agency. Their programme was to detect the areas of lower light pollution over a given territory and was run on the space station, much to the enjoyment of the

Fig. 17 – The secrets of robotics are revealed (Photography colection of the "Astroclubul Meridian Zero, Oradea") .

whole team. Over the 12 years since its establishment, the "Astroclub Meridianul-0" through its successes such as, for example the naming of asteroid 4633 after one of its founders, Marin Bica has contributed to the revival of observational astronomy in Oradea, as part of the life of the community. We hope that all the successful members of the Astroclub will, in their turn, carry on the tradition of the Oradea fortress, rich in educational and scientific endeavours, and will disseminate the love for science among the future generations.

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6. APPENDIX1

1. Károly Simonyi, A cultural History of Physics, CRC Press 2012 p.165.

2. Bánfi 1940, p.830; Jakó 1977, p.45,48.

3. He studied Roman Catholic theology and philosophy, and was ordained a priest in 1865. He followed a successful ecclesial career: became canon of Nagyvárad (Oradea) in 1878, titular abbot of Szekszárd in 1879 and titular bishop of Arbe in 1892. Fraknói began studying Hungarian history at an early age. He published his first work in 1868, at the age of 25, about the life of Péter Pázmány the

greatest figure of Hungarian Counter-Reformation in three volumes. He wrote about other famous Catholic personalities, like János Vitéz nd Tamás Bakócz, the Renaissance archbishops of Esztergom, works written in 1879 and 1889; https://en.wikipedia.org/wiki/Vilmos_Fraknoi .

4. Gregory of Sanok (1403- 1477), Polish bishop, a professor at the Kraków Academy, metropolitan archbishop of Lwów, scholar, philosopher, and a major figure of Polish Humanism.

5. Apud http://www.newworldencyclopedia.org/entry/GeorgvonPeuerbach "Tabulae ecclipsium".

6. His trigonometric tables went along with Christopher Columbus on his trip to the "New World" [11]. Unfortuately the source of this letter A táguló Magyarország hirmondói. XV-XVII század. Válogatta, bevezetéssel és jegyzetekkel ellátta Waczulik Margit, Budapest, 1984, p. 39-40 does not specify the year it was written.

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7. APPENDIX2

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1- Personal collection of the authors
2- Photography collection of the Astroclubul Meridian Zero, Oradea" (various photography of the club members)
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6- Romanian Academy Library from Bucharest
7- Posters from touristy maps and papers of Oradea history and presentations
8- Images from "Károly Simonyi, A Fizika Kulturtörténete, Gondolat kiado, Budapest, 1978",
9- Images from internet sites:

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