Figure 17.1: *Bucharest Observatory*

17. Considering Heritage as Part of Astronomy – 100 Years of Bucharest Observatory

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Abstract

Anytime we are considering science's perspectives, thus astronomy, we have to go into the past for better knowing the observer's traditions or of the group in which we are working to see which are the main directions that can be continued or, on the contrary, what is already old and where should we go.

Astronomical experience in Romania is not an exception. There is evidence that proofs interests in knowing the sky of the local population – Sarmizegetusa Sanctuary, for two millennium and others more recently.

This year, the most important Astronomical Observatory from Romania is celebrating its 100 anniversary. Built in Bucharest by the first Romanian mathematicians at Sorbonne, it is nowadays nucleus of the Astronomical Institute of the Romanian Academy.

Marking the most important achievements in space research, in the last century but also those older, represents for the researchers and especially for the public an incentive for the advancement of astronomy in Romania. It happens that 2008, declared in our country the Romanian Astronomical Year, precedes the International Year of Astronomy. These two events brought together is favourable for education and information, and proves that, regardless of time, man can live increasingly better in a Universe that is increasingly knowing more profound.

17.1 Beginnings

Although we have very old testimonies of its existence on our lands, we can talk about Romanian scientific observatories only beginning with the last century. We have in mind the Observatory in the Charles I Park in Bucharest and the one on the right bank of the river Dniester (Nistru), at Dubasarii Vechi, today in the Republic of Moldavia (Moldova).

We can talk of astronomical traditions on our territories even beginning with the first millennium, when the Dacians built in the Meridional Carpathians, at Gradistea Muncelului, a sanctuary which still preserves evidence of their astronomical knowledge and implicitly, of an extremely precise calendar for those times.

Somewhat later, at the beginning of the 6^{th} century, the Christian Church tried to establish a chronology as adequate as possible for the religious celebrations, of Easter in particular, set up in keeping with various astronomical moments. Its author was Dionisie the Small (Dionysius Exiguus), a monk born in the territory of Dobruja (Dobrogea). In 528 A.D. he introduced in *Liber de Paschal* the counting of the years since the birth of Jesus Christ.

17.2 The Middle Ages and Early Modern Time

The centuries which followed led to the considerable development of astronomical knowledge, but its truly scientific foundation dates back only to the 16^{th} and 17^{th} centuries, that is why 2009 is the International Year of Astronomy.

In the period preceding Galilei there were various astronomical preoccupations on these lands, too. It is worth mentioning, for instance, the first astronomical observations made in this part of Europe by the bishop Ioan Vitez (János Vitez) (1408–1472), the teacher of prince Iancu of Hunedoara's children. The Observatory in Oradea, an important centre of renaissance culture in that period, was created by Ioan Vitez in 1445, namely one century before the one set up at Uraniborg by Tycho Brahe.

A century later, Johannes Grass (Honterus) published notions of cosmography in *Rudimenta Cosmographica* (1568). The work had an important impact at the time, being issued in 26 successive editions, which were used for a long time in Germany as astronomy textbooks.

We should also mention Conrad Haas (1509–1579) who wrote a book, kept in the Sibiu public records, in which he describes rockets in stages and uses this term for the first time.

The 16^{th} and 17^{th} centuries are epochs of important spreading of astronomical knowledge in the ever more numerous colleges which were set up in Transylvania, Moldavia and Wallachia.

From among the teachers of the epoch we shall mention only the name of Hrisant Notara, who was a collab-

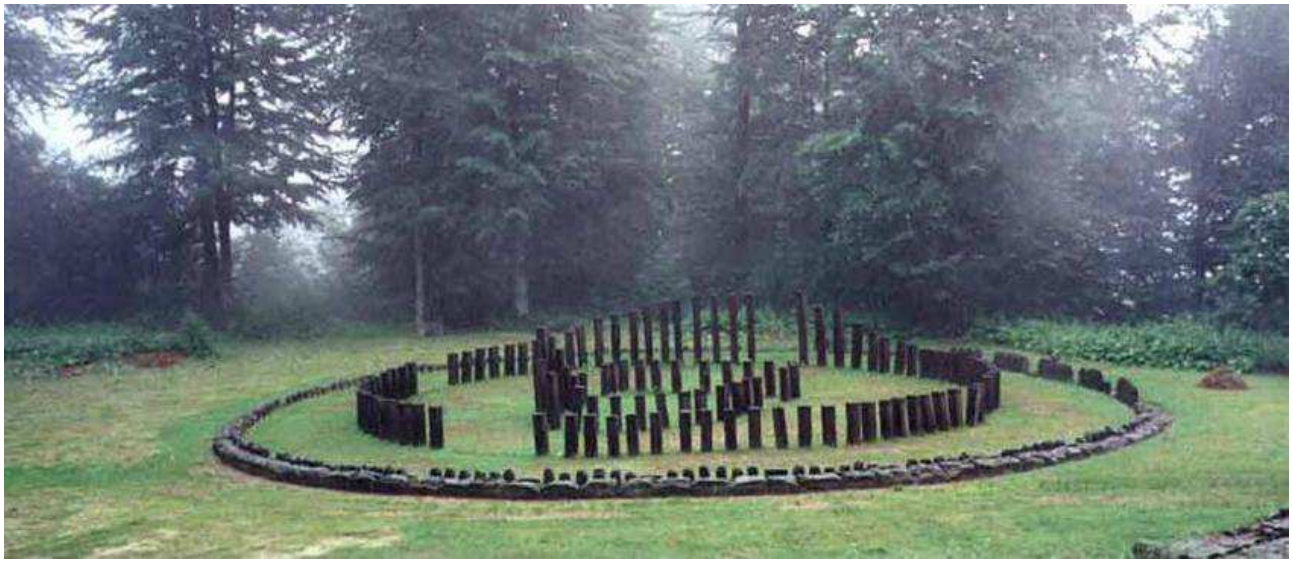

Figure 17.2: *Sarmizegetusa sanctuary*

orator of Giovanni Domenico Cassini (1625–1712), the first director of Paris Observatory, set up in 1667. He left us *Introductio ad geographiam et sphaeram* (published in Paris, 1716), the first scientific work with chapters dedicated to astronomy, where coordinates of Romanian cities are calculated.

The other observatories were built in Transylvania during the 18$^{\text{th}}$ century. Thus, the construction of the astronomical tower conducted by Maximilian Hell (1720–1790) was completed in 1759. The tower was destroyed by a fire in 1798 and restored in 1805.

The second observatory was set up in 1795 at Alba Iulia by the bishop Ignatius Batthyány – who founded the famous library that was to be called after his name. The Observatory ended its activity in 1860.

Meanwhile, astronomy also developed in the land across the Carpathians. Thus, in 1762, the Jesuit Ruggero Giuseppe Boscovich, one of the greatest astronomers of that time and founder of the Brera-Milan astronomical Observatoy, performed determinations of longitudes and latitudes, as well as other astronomical studies at Galati.

In 1773 the Russian astronomer Stephen Rumowski published *Determinatio Longitudinis et Latitudinis quorundam Moldaviae et Wallachiae locorum deducta ex Observationibus Johanne Islenieff institutis*, a work which he elaborated on the basis of the astronomical determination of the geographical coordinates for Bender, Akerman, Chilia Nouă, Ismail, Bucharest, Focşani, Jassy and Brăila, carried out by the Russian astronomer Ivan Isleniev.

17.3 The 19$^{\text{th}}$ Century

At the beginning of the 19$^{\text{th}}$ century, the first amateur astronomer was recorded again in Moldavia. In 1823, the poet Costache Conachi bought a telescope in Vienna, which had a focal distance of 2 m and a diameter of 157 mm and was later used by students in their practical studies. This telescope was handed down by his heirs to the Observatory in Jassy.

During the period 1828–1832 astronomic observations for the determination of different geographical coordinates were performed. Ortemberg, Wrontchenko and others determined the coordinates of the Romanian towns of Jassy, Galaţi, Roman, Bucharest, Călăraşi, Turnu-Măgurele, Calafat, Craiova, Babadag, Constanţa, Gurile Dunării.

Together with the development of the elementary and secondary educational systems, the first astronomy textbooks were issued, such as those by Gheorghe Asachi (1838), A. Marian (1829 – the first astronomy texbook written in Romanian) and August Treboniu Laurian (1859).

At the middle of the 19$^{\text{th}}$ century there were profound transformations not only in Europe, but also on the Romanian lands. In 1859 Moldavia and Wallachia united and thus the first modern Romanian state was created. This fact called for not only a reform of the political and social life, but also one of education, directed to Western culture, to the French one in particular.

The foundation of the first Romanian universities (Jassy, in 1860 and Bucharest, in 1864) marked the beginning of academic instruction. The first professor of astronomy was Neculai Culianu (1832–1915) in Jassy. In December 9, 1874, together with Professor Stefan Micle (1820–1879), he observed the transit of the planet Venus across the Sun's disk. The poor facilities available did not allow then the obtaining of good results such as those reported by Theodor von Oppolzer and Edmund Weiss, whose observations performed in Jassy proved to be even more accurate than the similar ones carried out in Vienna. Dimitrie Petrescu (1831–1896) was the first astronomy professor who delivered lectures at Bucharest

University, where he was followed by Nicolae Coculescu.

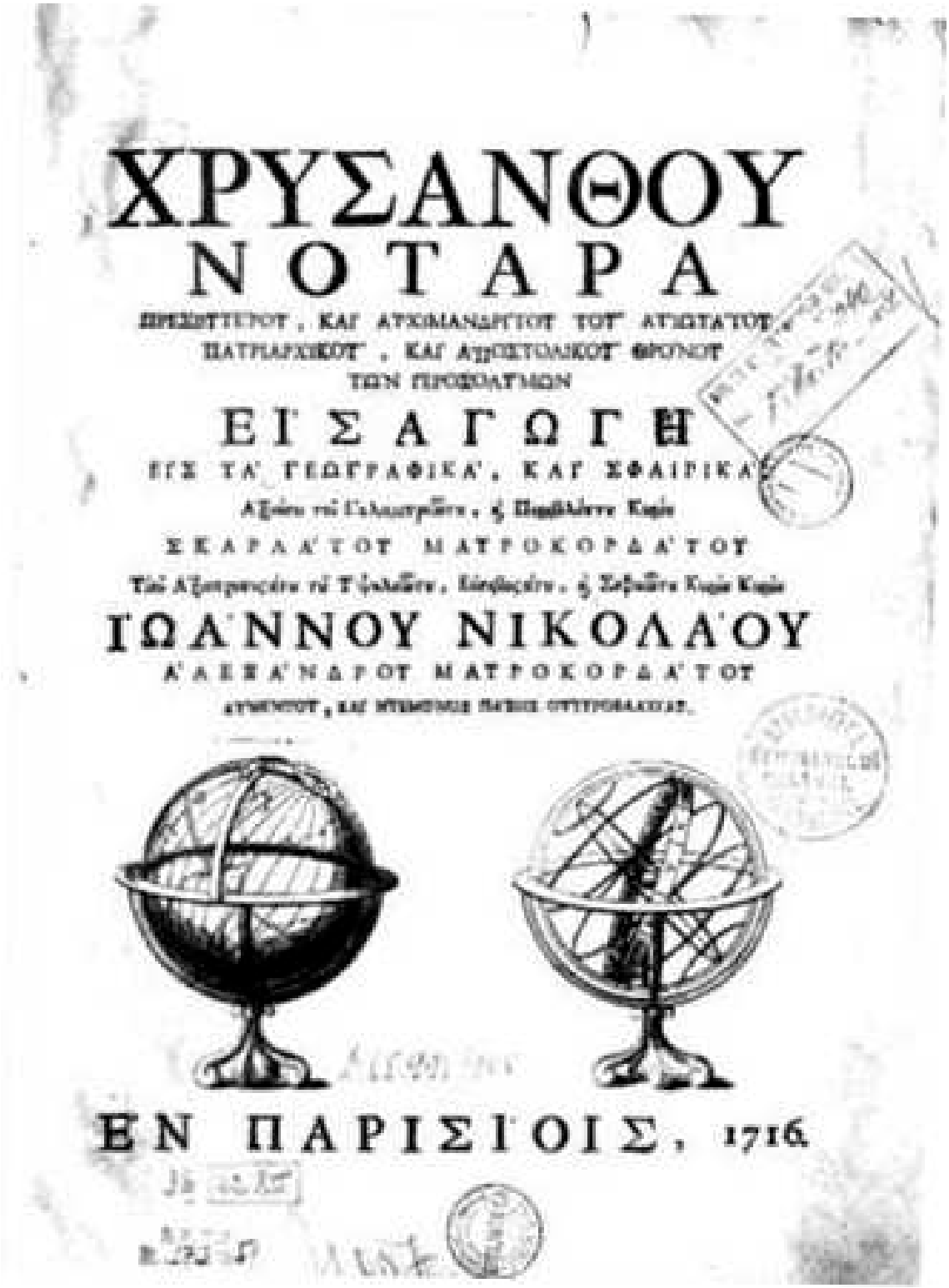

Figure 17.3: *Hrisant Notara: Introductio ad geographiam et sphaeram (Paris 1716)*

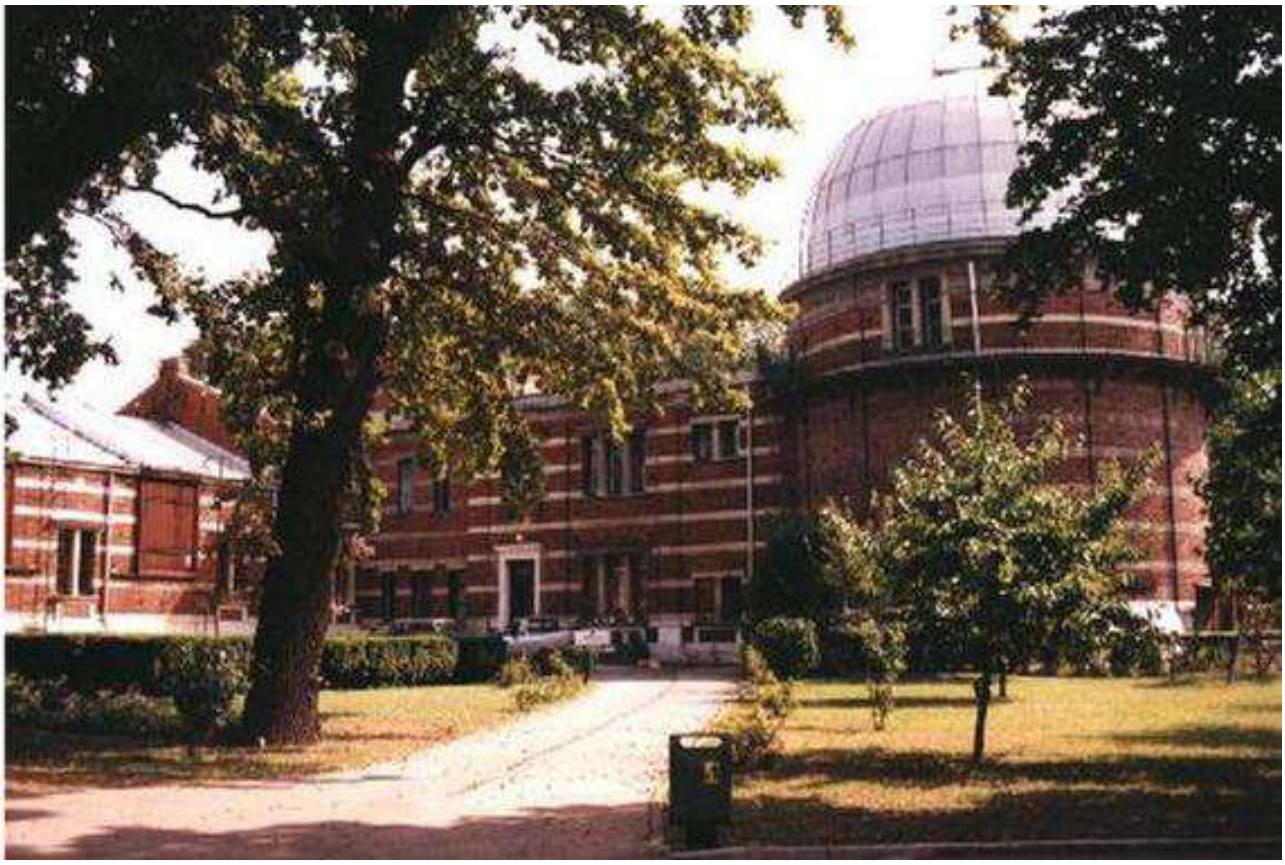

Figure 17.4: *Bucharest Astronomical Observatory*

Due to the development of astronomical academic education a large number of young students were sent abroad to improve their training in astronomy. It is worth mentioning especially Constantin Căpităneanu (1849–1895). After performing another training stage in Naples, he returned home (1873), were he was assigned a task of high responsibility, i. e., to draw up an accurate map of the country.

A telescope (field glass) for latitudes, two refracting telescopes, a chronograph, chronometers etc. were ordered for this purpose. These facilities helped him to construct in Jassy (1875) the first meridian dome on the Romanian territory. Seven years later a similar hall was also erected in Bucharest. In 1881 Căpităneanu and Kihnert published in Bucharest *A Determination of the longitudinal differences between Jassy and Cernăuţi.* This was the first publication of astronomical observations carried out by a Romanian scientist in his own country.

17.4 The First Doctoral Theses in Astronomy

The first theoretical studies in astronomy were also reported at the end of the 19$^{\text{th}}$ century. Out of the first four Romanian scientists who took their doctor's degrees in mathematics at Sorbonne, in Paris, three devoted their theses to celestial mechanics.

Spiru Haret (1851–1912) dedicated his doctoral thesis (1878) to the study of the invariability of the major axes of planetary orbits. Felix Tisserand, professor of celestial mechanics at the Sorbonne, later resumed this study and reached the same conclusions and even recommended that young Haret's methods be extended to other astronomic calculations.

At the same time, the well-known French mathematician Henri Poincaré highly appreciated Haret's thesis, concluding that is was a "great surprise". The same subject was resumed in 1955 by Jean Meffroy. Therefore, Spiru Haret can be considered as the first Romanian astronomical theorist.

In 1882 another Romanian got his PhD in Paris, namely Constantin Gogu (1854–1897), who concentrated on long-periodic inequalities in the Moon's orbital motion, confirming the accuracy of Delaunay's calculations against Stockwell's errors.

The third Romanian doctor in astronomy from the Sorbonne was Nicolae Coculescu (1866–1952) who gave a description of the interrelated movements of the three bodies for a particular case. His thesis (1895) concentrated on the perturbation function and supplied the approximated expressions of its higher order terms which were later mentioned in *Leçons de mécanique céleste* by H. Poincaré.

17.5 The Foundation of Bucharest Observatory

As the three scientists returned home, they could hardly go on with the work so brilliantly commenced abroad because of the lack of an adequately equipped astronomical observatory.

As early as 1870, P. S. Aurelian, an enthusiastic scholar and statesman, ventured to "ask the Government and the Legislative Bodies how long it would still take the Romanians to provide such an important research institution as those which already existed in other countries, whose national revenue was ten times lower than Romania's or even smaller". In 1873, he challenged the authorities again by stressing the necessity of building-up an astronomical observatory in Romania and wondering "... which of the ministers will have the honour of being regarded as founder of the Bucharest astronomical observatory?" The same questions were resumed later by S. C. Hepites, particularly in his notes to the Academy, as well as in his papers related to the history of astronomy (he distinguished himself as the author of the first history of Romanian astronomy).

It was in 1888 that the Minister of Agriculture succeeded to acquire the land of C. Bozianu, ex-councilor of the first Romanian Prince A. I. Cuza and for short time prime minister. This land is situated on the Filaret Hill (Cuţitul de Argint Street) and was used for the construction of the Meteorological Institute and Weights and Measures Centre (1889). Typical for the beginnings of any science in a country, in Romania meteorology was also at first mingled with geodesy and astronomical studies. The first astronomical requirement consisted in an accurate determination of the mean time.

The Set-up of the Observatory in Bucharest – 1 April 1908

After N. Coculescu returned to Romania, a master of an advanced scientific insight, greatly enriched by the total solar eclipse expedition which he had joined in Senegal (1893), he was appointed professor at the Bucharest University and managed to win the cooperative support of another astronomy supporter, Spiru Haret, who was at that time the minister of Public Instruction and Religious Affairs. Therefore, Coculescu came to be remembered as founder of the first modern astronomical observatory in Romania – one of the earliest scientific establishments of the country.

However the set-up of the astronomical Observatory on 1 April 1908 (including a meteorological department until 1920) marked the beginning and not the end of an unceasing strive for the development of this science in our country. Thus, during the same year (November 1908), in a relevant letter published in *Astronomische Nachrichten* N. Coculescu (Director of the Bucharest Observatory) pointed out:
"Since the existing meteorological institute, set up 24 years ago, is located in a most suitable area, it has been decided that an astronomy department be created on the same site. We only have a transit telescope of a simple design for keeping time and a 108 mm refracting telescope. In view of the astronomical research currently pursued at the Observatory, we have decided to order a twin refracting telescope provided with a 30 cm lens and 6.70 m focal distance. The mechanical part will be achieved by Paul Gautier and the lens by the G. & S. Merz Optics Institute. The design and construction of the building provided by an 11 m diameter dome have been entrusted to A. Engels, an architect of the Brussels (Uccle) Observatory." The staff of the facility was made up of only two astronomy students: A. Teodosiu and Maria Teohari. The latter can be considered the first Romanian woman astronomer, although there are previous records of observations made by two other women, namely Elena B. Vermont and F. Boerescu, on 4 February 1906, at −17.7°C!

In the same year when Bucharest Observatory was set up, Gheorghe Demetrescu (1885–1969), who was to become the founder of the Romanian astronomical research, was sent to Paris Observatory for a training period. There he concentrated on the study of variable star photometry, photographic determination of the precise position of minor planets and comets, solar physics related to the photospheric phenomena, lenses of astronomical instruments, interpretation of seismographic data.

The instruments ordered by N. Coculescu were installed after the main building was erected (1912). The first one was the refracting telescope, a Prin-Merz, mounted in 1912, tested in 1925, operational since 1930, and modified by Gheorghe Petrescu in 1935.

The Meridian circle Gauthier-Prin (mechanical part), Steinheil-Merz (optical part) was ordered in 1910, delivered in 1924, and installed in 1926 by G. Demetrescu.

17.6 Other Observatories

Also in 1908, on the right bank of the river Nistru, at Dubasarii Vechi, another astronomical observatory, this time a particular one, was created. It was founded by Nicolae Donici (1884–1956?), one of the most remarkable personalities of Romanian and world astronomy. His destiny was similar to that of the troubled lands where he was born. A founding member of the International Astronomical Union, an active participant in the first congresses of this union, an honorary member of the Romanian Academy, the author of important astrophysical works, the observer of no less than six total solar eclipses, the last years of his life are still surrounded by mystery, as there is no document left which should testify the date and place of his death.

After the Observatories in Bucharest and Dubasarii Vechi, another observatory was soon set up in Jassy (1913), headed by Professor Constantin Popovici (1878–1956) until 1937 and yet another one in Cluj (1920), un-

der the leadership of Gheorghe Bratu (1881–1941). The Observatory in Timisoara was built much later (1959) through the efforts of Professor Ioan Curea (1901–1977).

Constantin Popovici and his pupil and collaborator Vintila Siadbei (1898–1944) did their best to endow the Observatory in Jassy with a meridian refractor, a Ressel equatorial, two chronometers (for mean and sidereal time), a Graff photometer, all largely deteriorated during WW II. Their work was continued by another outstanding astronomer, Victor Nadolschi (1911–1996), who was also the director of the observatory between 1948 and 1966.

17.7 The Astronomical Observatory of Cluj

Founded in 1920, built between 1924 and 1934, it belongs to the University of Cluj, later to the Romanian Academy. Moved in Timisoara (1940–1945) during WW2, then back in Cluj, it changed location in 1978, then moved to its actual site, in the Botanical Garden, in 1982. The University's didactical staff with astronomical tasks shares the building with the researchers of the Astronomical Institute of the Romanian Academy.

The main instruments were moved in 1976 to an observation station, situated on Feleacu Hill, 8 km southward the town, with excellent observational conditions. Since 1977 the station belongs to the Astronomical Institute.

Main Instruments

Prin refractor (20/300) and Newton reflector (50/250) – equatorial mounting, functional since 1934; Coudé refractor (15/225) (1982), Meade reflectors: (40/406; 30/245) endowed with CCD cameras (1995 and 2006, respectively).

Main Research Programs

Catalogue of the Photographic Map of the Sky, 20th Century, Zone +20 Degrees (1933–1947) – cooperation with Observatoire de Paris; artificial Earth satellite observations (Tracking Station 1132 – COSPAR): Interobs, Eurobs, Spin, Atmosphere, Moonwatch; observation of RR Lyrae-type variable stars (cooperation with the Odessa Observatory, Russia); Physics and Evolution of Stars (cooperation with the Academies of Sciences of the Central and East European countries); archiving of photographic plates (cooperation with the Institute of Astronomy of the Bulgarian Academy of Sciences).

In 1922 Romania accepted formally the invitation to join the International Astronomical Union (IAU) set up in Brussels in 1918. Romania was represented in the first General Assembly of this organization (May 1922, Rome) by its delegate, Nicolae Donici, elected as a member of two IAU Commissions: for Solar Physics and Physical Observations on Planets, Comets and Satellites. Other Romanians became step by step members of the IAU and of its commissions. Romania is represented in IAU and, beginning with 1990, in the European Astronomical Society and other international organizations by the Romanian National Astronomical Committee (RNAC), set up in 1930. Its first president was Nicolae Coculescu. Topics of the first RNAC meeting held on 4 April 1931 included the calendar and official time reform, as well as the participation of Bucharest Observatory in the world campaign of longitude measurements to be initiated in 1933.

To prepare for this world campaign, two pendulum clocks (a sidereal Leroy-type and a mean time Riefler-type one) and a reception station for wireless telegraphy time signals were installed in the basement, under constant pressure and temperature conditions.

During the next ten years the activities related to the programme for minor planets and comets concentrated on steadily obtaining accurate photographic positions whose magnitudes were however limited (to about 12.0). Bucharest Observatory largely contributed to the results acquired in this field.

To embark on the strenuous tasks of star cataloguing, the carrying out of investigations and data processing, as well as of theoretical studies, a new group was successively appointed in the years 1928 to 1930: Constantin Drâmbă (1907–1997), Gheorghe Petrescu (1905–1965), Călin Popovici (1910–1977), Nicolae Dinulescu (1907–1989) and much later Ella Marcus (1909–1982).

During 1937 to 1943 Constantin Popovici was appointed director of the Bucharest Observatory and worked at various studies on the effect of cosmic dust in the neighbourhood of stars, the effect of the solar radiation pressure upon planetary and cometary orbits and on equilibrium points of trajectories.

Another distinguished astronomer, Constantin Pârvulescu (1890–1945) performed most original studies (also at Bucharest Observatory) concerned with globular clusters. His work was referred to in W. M. Smart's book *Stellar Dynamics*.

Following WW II, Romanian Astronomy was given a new impetus. All of the observatories were considerably provided with updated equipment.

Bucharest Observatory, which had been managed by the University until 1951, was subsequently taken over by the Academy and headed by Gheorghe Demetrescu, 1943 to 1963, followed by Constantin Drâmbă, 1963 to 1977. In 1977 the Academy lost its institutions and the Observatory was integrated, along with other departments, into a Center of Astronomy and Space Research within the Central Institute of Physics.

The closing in of the International Geophysical Year, which began in 1957, brought a series of new instruments: in 1952 a transit instrument (100/1000 mm), in 1957 a solar refractor (130/1950 mm) for visual and photographic observations of the solar photosphere in integral light. A H-alpha filter (6563 Å) of Halle-Lyot-Öhman type, mounted on a special refrac-

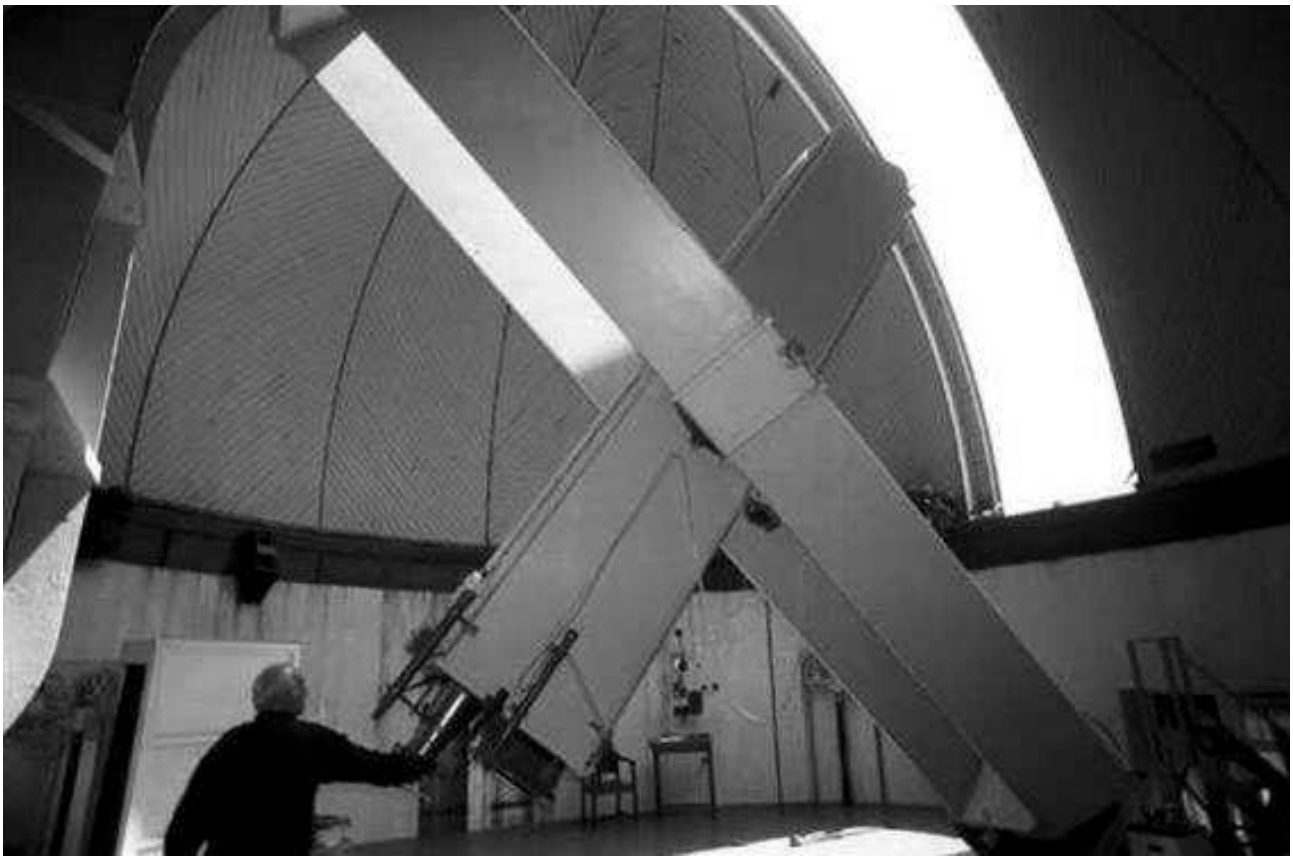

Figure 17.5: *Refracting Telescope of Bucharest Observatory*

tor (80/1200 mm), is used for photographic observations of chromospheric formations (filaments, prominences, flares) and in 1964 a Cassegrain telescope (500/7500 mm) was bought for the photometry of variable stars.

The time service was first endowed with Belin, then with Rohde & Schwarz quartz clocks. However, the 1980s brought a great recession, ranging from electric power or paper economies to the ceasing of the international relations, with the countries of the communist block included.

The publication of the Observatory's journal (*Studies and Researches in Astronomy and Seismology*, 1956–1962, then *Studies and Researches in Astronomy*) was stopped in 1974. The only publications which did not cease to be issued were those of tables, which did not raise any risk of interpretation, namely *Observations Solaires* and *Astronomical Yearbook*.

17.8 Development after 1990

Immediately after the events of December 1989, Romanian astronomy, as well as the entire society, took an extraordinary turn. On 8 January the Institute's board of administration was changed and on 1 April the Astronomical Institute was set up under the aegis of the recently re-established Romanian Academy; the Institute was made up of three observatories: Bucharest, Cluj and Timisoara. It was headed first by Magda Stavinschi (1990 to 2005) and then by Vasile Mioc (beginning with 2005).

The institute journal was immediately set up again, under the name of *Romanian Astronomical Journal*, with two annual issues.

Collaborations extended to very many countries. Important international meetings were organized by the Astronomical Institute, as, e.g., "CCD and photometric receptors applied to the Observations of the Saturnian satellites during the 1995–1996 opportunity" – PHESAT 95, 1994; NATO Advanced Research Workshop intended to prepare the 1999 total solar eclipse, 1996; International Seminar "Solar Researches in the South-Eastern European Countries: Present and Perspectives", 2001; Journées "Systèmes de référence spatio-temporels", 2002; IAU WG meeting "The Future Development of the Ground-Based Astrometry", 2002; and many others.

A remarkable event was the total solar eclipse of 11 August 1999, whose maximum was in Romania. On that occasion were organized the first international workshop before an eclipse and an Advanced Study Institute right in the period when the eclipse took place, both sponsored by NATO. In that period an International School for Young Astronomers under the aegis of IAU and UNESCO was also organized. The event was used also to obtain special funds from the government for the consolidation and restoration of Bucharest Observatory

Figure 17.6: *Bucharest Observatory ready for the total solar eclipse of 11 August 1999 – Mass media and the total solar eclipse*

buildings, and also for the construction of a special pavilion for a Planetarium (of 65 places and 8.5 m diameter), which is still without a projector.

Other important astronomical events involved the astronomers both in research programmes, as well as in those dedicated to astronomical education: Venus transit in 2004, mutual phenomena of the satellites of Jupiter, Saturn, or Uranus.

Romania was an important factor in the setting up of the South-Eastern European network, at first through the formation of the South-East Branch of European Astronomical Society, then through that of the Sub-Regional European Astronomical Committee – SREAC under the aegis of UNESCO-ROSTE and recently under that of UNESCO-BRESCE.

A special attention has been paid to astronomical education, especially in the conditions when the reduction of the school curricula led to the elimination of astronomy. At first it was the initiative of the resolution concerning the teaching of the astronomy (Sydney, Australia, 2003), Special sessions for Astronomy education in Europe during the JENAM meetings (starting in Budapest, 2003) were initiated, then the presidency of the IAU Commission 46 for 2006 to 2009.

Several young people, from the institute or from outside, obtained their doctoral degrees under the guidance of researchers of the institute. Some of them, at present, associated researchers of the Institute, work at important world research centers.

17.9 The Main Research Directions

Naturally, the scientific activity of Bucharest Observatory has continued in the first place the traditional one begun in 1908 and even before.

The presence of an instrument extremely good at the time, the meridian circle, has led to the development of a strong department of Meridian Astrometry.

In 1953 a collaboration agreement was concluded with the Soviet colleagues on "The Set-Up of the Inertial Reference System of Stars", a study concentrated on relating the positions and movements of stars to the distant extragalactic nebulae and the solar system.

Having gained experience in making up stellar catalogues the Meridian Group was invited to bring its own contribution by drawing up a catalogue for the FKSZ main faint stars (645 stars) and a KSZ faint star (4000 stars) catalogues, The Romanian Academy highly appreciated the work and awarded the Meridian astrometry group headed by Ella Marcus the prize "Gheorghe Lazar" – 1972. Many other catalogues followed.

In the recent times the studies for the acquisition of stellar images continued with the elaboration of software for image processing by means of the new Apogee 47p CCD camera mounted on our 6000/380 Prin-Merz astrograph. The project of building an interface to be used for areas around extragalactic radio-sources was accomplished. In order to include the accurate time coordinate in the computational process of CCD images, GPS time receivers were used. The studies concerning the reference stars to be used for extra-galactic radio-sources were continued. The Romanian contribution consists of the observation of the optical parts of ICRF sources and the elaboration of the intermediary reference catalogue.

Photographic astrometry was carried out many years. As far as the Solar system astrometry is concerned, the observations on Neptune and minor planets were completed. The computation program was build to improve orbital elements of the asteroids and an application of this program was finalized.

Lately, the collaboration with other observatories has been extended, especially with the Bulgarian colleagues, not only for the observation with other instruments, but also for the storing of the photographic plates gathered throughout the decades in Bucharest and Cluj.

Together with Jean Kovalevsky, the working group "Future Development of the Ground-Based Astrometry" (2000–2006) was organized, replaced now by the IAU Division I WG "Astrometry by Small Ground-Based Telescopes".

Naturally, the beginnings of Romanian astronomy marked by important thesis and studies in the field of celestial mechanics continued.

For several years, studies on terrestrial rotation were made. Under the supervision of C. Drâmbă, the rotation of the Earth was studied in the more general framework of elastic deformations. Thus, on the basis of the Euler generalized equations, the existence of the Chandler ellipse described by the instantaneous pole of the Earth's rotation was theoretically established and so was the analytical expression of the Chandler period. Starting from the elasticity differential equations in relation to a system of rotating driven axes converted into global equations and applied to the Earth (small inertia products), the differential equations for the trajectory of the instantaneous rotation pole were determined.

The Time Department participated in the MERIT international campaign (Monitoring of the Earth Rotation and Intercomparison of the Techniques and Methods), whose results actually led to the replacement of the classic ground-based techniques with modern space ones.

Starting from 1957, the studies about the motion of artificial Earth satellites (AES) gained a place of choice. Tracking stations were set up in Bucharest, Cluj, and Timisoara. Their observations were reported, along many years, to the data centers in Europe and USA. Paralelly, theoretical studies of the AES motion under various perturbing factors were developed. The perturbing influences of such factors were tackled analytically, in various approximations.

Another field of choice was the motion of celestial bodies in post-Newtonian fields (relativistic or not). Many results were obtained in the two-body or the (general or restricted) three-body problems associated to the models of Schwarzschild, Schwarzschild – de Sitter, Manev, Fock, zonal-satellite problem, etc. For most of these models the qualitative methods of the theory of dynam-

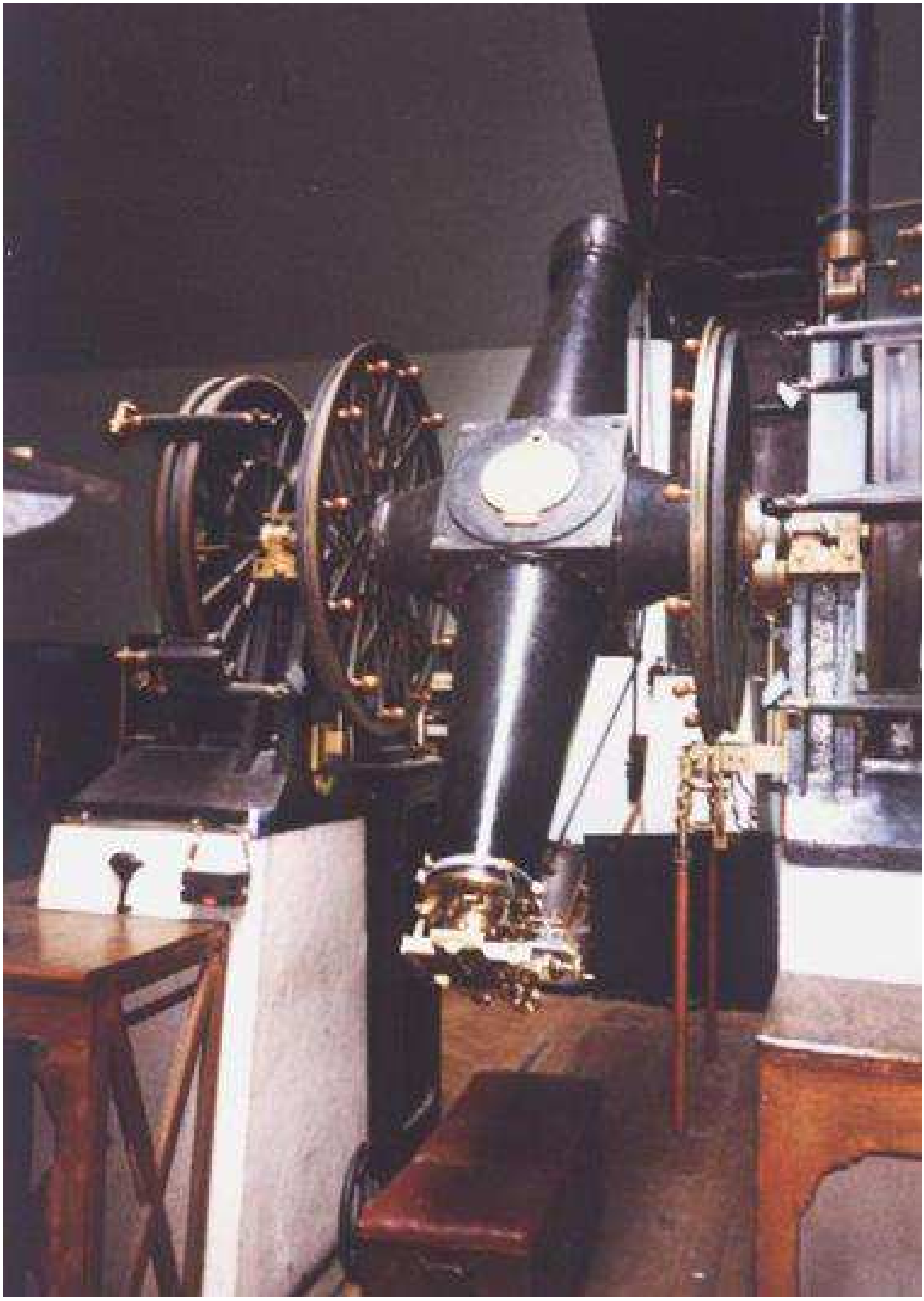

Figure 17.7: *Meridian circle of Bucharest Observatory*

ical systems were used. This led to a general geometric characterization of all the orbits. This worked also in more general problems, as, for instance, Maxwell's $(n + 1)$-body problem in Manev's or Schwarzschild's fields.

Lately an ever greater emphasis has been laid on studies of solar and stellar physics, as well as on extragalactic astronomy and cosmology.

As to solar physics, our research focuses on the data analysis and interpretation using ground based and space observations. We are interested in studying the active regions evolution and their implications in the chromospheric and coronal activity.

We search magnetic reconnections before and after flares or CMEs and the opening of the filed lines during these events in 3D extrapolation of the coronal magnetic field from MDI magnetograms. We also study filaments and prominences activity in connection with their end in coronal mass ejections. The magnetic topologies during the evolution of an event reveal a coronal dynamics that allows us understand the solar active phenomena.

Another topic of our interest is the follow up of a CMEs from the Sun to the interplanetary space. The halo CMEs from the solar source to the Earth's effects are also studied. The observational work is sustained by MHD 2D numerical simulations.

Our research framework belongs to the major scientific topics of the International Heliophysical Year.

Concerning the extragalactic astronomy and cosmology, at the Bucharest Observatory such studies begun in the early '80s, as a theoretical branch, directly related to the computational facilities available in our Observatory. Starting from a little Z8080 computer (early '80s) to a superscalar supercomputer of 44 processors (now), our cosmology team developed models, methods and techniques related to: the investigation of 2D and 3D catalogues of galaxies, clusters and superclusters; investigation of the log tails of the 2-points correlation functions; cosmological simulations (N-body + SPH) of the Large Scale Structure of the Universe (LSS); investigation of environmental effects in clusters of galaxies; application of neural methods in cosmology.

The use of such models and techniques allowed us to study problems related to: correlated signals in the long tail of the correlation functions for galaxies, clusters and superclusters (due to baryon oscillations); HD simulations of the LSS and of the evolution of the first and secondary Web structures; studies of the epochs of the formation of DM halos in a LCDM scenario (earlier than z$\sim$15); studies of the evolution of halos and galaxies due to the parental merging phenomena; decelation of the Butcher-Oemler and Oemler-Butcher effects in far or nearby clusters; studies of E+A galaxies; study of the synthetic spectra of galaxies and of the chemo-spectro-photometrical evolution of galaxies (for z<30); photometric redshifts determination (for z<10).

The observational study of variable stars and their theoretical modeling represents the scientific framework for the three groups from Bucharest, Cluj-Napoca and Timisoara. The main directions of investigation are focused on the observation and the light-curve analysis of eclipsing binary stars and Delta Scuti, RR Lyrae and Delta Cephei type stars, in order to determine their elements and evolutionary status. It is also built up a relevant data base for several types of variable stars, including close binaries, eclipsing binaries, interacting binary stars, late-type active stars, early-type O-B stars. Other important directions of research are represented by the studies on stellar evolution, stellar pulsations, asteroseismology and searching of extrasolar planets, especially in the frame of the HELLAS and KASC Consortium and ESA/COROT, NASA/MOST, NASA/KEPLER space missions, in which we are actively involved. Important international collaborations in these fields were established with the Observatories of Paris-Meudon (France), Athens (Greece) and Belogradchik (Bulgaria).