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Modern history of astronomy in Bulgaria

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A short story of the modern history of astronomy in Bulgaria is presented. This period starts in 1878, after the first university astronomical observatory was founded. This work presents the modern period of development of astronomy in Bulgaria and the construction and development of astronomical observatories, complexes, and societies in the country.

Keywords: Astronomy – Bulgaria: Astronomy – history: Astronomy – astronomical societies

1 Modern history of astronomy in Bulgaria: development of astronomy and education

1.1 Observatory of the Sofia University "St. Kliment Ohridski"

The first Bulgarian astronomer is Dimitar Koyuv Vitanov (∼1846–1877), who studied in St. Petersbourg, Russia, then he specialized his studies at the observatory in Malta. We cannot say too much about him but he translated into Bulgarian the first popular book on astronomy in 1875 entitled "Heavenly bodies or planetary and stellar worlds" by Ormsby M. Mitchel. The modern history of Bulgarian astronomy is about 140 years old. Astronomy in Bulgaria started with founding of the first University in 1888 – the Sofia University "St. Kliment Ohridski" (with official university status since 1904). Astronomy was introduced as an observation discipline in Physics and Mathematics Faculty of the University and there was a course "Spherical trigonometry with applications in astronomy". During the years 1891–1892, there were astronomy lectures for 3 hours per week (Kolev 2011). The history of the Department of Astronomy starts with Prof. Marin Bachevarov (1859–1926). He started teaching Astronomy in 1892, and in 1894 the Department of Astronomy was established, as well as the Observatory soon afterwards (Fig. 1).

In 1897 Prof. Bachevarov provided the first contemporary observing instrument in Bulgaria – a 6″ (15.2 cm) refractor, and in 1910 he established the Institute of

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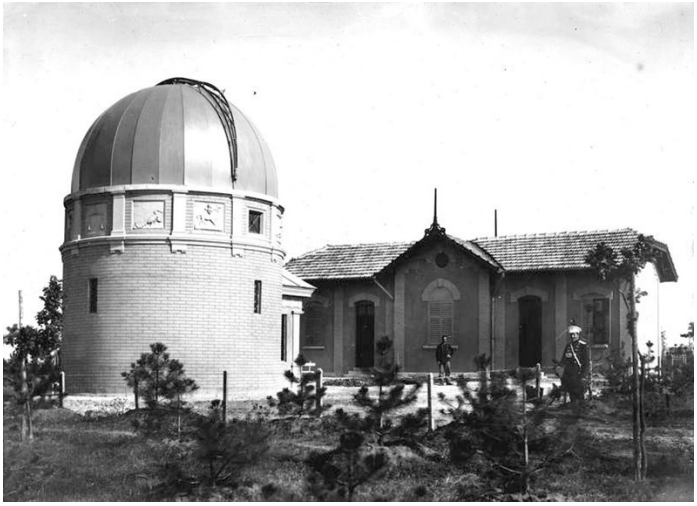


Figure 1 The first Bulgarian astronomical observatory established by Prof. M. Bachevarov, Department of Astronomy, Sofia University "Kl. Ohridski", Sofia. 26 Nov 1899, photo: Jordan Kovachev.

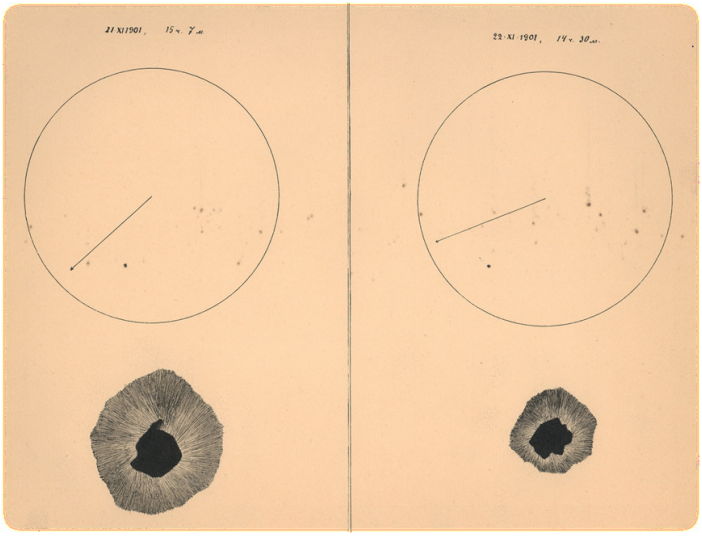


Figure 2 Scanned image of the original graphical representation of sunspots on 21 and 22 Sep, 1901 from University Observatory, Sofia, by K. Popov (archive Observatory Rozhen).

Astronomy. Prof. Bachevarov was twice a rector of the University of Sofia and he worked in the Department of Astronomy until his death in 1926. Prof. Bachevarov was also the founder of the first meteorological station in Sofia which started the meteorological service in Bulgaria on 1 February, 1887, and he was the author of the first publication on climatology in Bulgaria*.

*http://www.phys.uni-sofia.bg/ astro/EN/history_EN.html



Figure 3 The Students' Astronomical Observatory – SAO Plana operates since the autumn of 2013. It was realized after two years of voluntary work and own funds of faculty staff, PhD students and students from the Department of Astronomy at the University of Sofia "St. Kliment Ohridski".

From 1899 to 1905 Prof. Bachevarov and four students started regular observations of sunspots from the Observatory in Sofia. The first known telescope used in Bulgaria was was made by "Mertz", Munchen, with 8 cm aperture. Observations included descriptions and graphical representation of the sunspots on the solar disk (Fig. 2).

Prof. Bachevarov's students included Jordan Kovachev, future professor in geology and technics in Agronomic-forestry faculty; and Acad. Kiril Popov, world famous mathematician and specialist in celestial mechanics. On 1 September 1928 as a regular associate professor (later academician) Nikola Bonev became head of the Department. In 1945, the first Bulgarian woman, doctor in Astronomy, Prof. Malina Popova, started working as an assistant professor in the Department of Astronomy. The changes in teaching astronomy in the Department are related to Prof. Nikola Nikolov, and he introduced the first courses in modern astronomy. A new discipline "Astronomy" opened in the faculty of Physics at University of Sofia "St. Kliment Ohridski" in 1966. Almost all professional astronomers in Bulgaria have graduated this discipline during their careers. From the end of 19th century up to date almost 300 astronomers have graduated in the Department of Astronomy. The first Bulgarian, whose university degree was recognized as equivalent to the French universities degrees, was Prof. Kiril Popov and he was also the author of the first published Bulgarian science paper in astronomy. Professor Malina Popova was the first woman, doctor of Philosophy in Astronomy in Bulgaria, and iIn 1945 she was assistant professor at the University Observatory. During the time of astronomy development in the University, in 1952, Professor A. Bonev established the Department of Astronomy at the Physical Institute of Bulgarian Academy of Sciences, and in 1957 he established the first Bulgarian astronomical society. Also, he is considered the inventor of super century-old, 176-years cycle of solar activity. In present days the Astronomy Department of Sofia University operates with another observatory at Plana, and there is a 35 cm reflector telescope and SBIG CCD 11000M. The Observatory is only 35 km away from Sofia and it is the ideal place for students' practices and education (Fig. 3).

1.2 Observatory of the Shumen University "Konstantin Preslavsky"

There is a high level of training and education in the field of physics and astronomy at Shumen University "Konstantin Preslavsky" which started in 1964, and then Shumen University trained teachers in science. Professor V. Shkodrov was professor of astronomy and rector of the University of Shumen in 1991–1994. In 2004 a new specialty, Astronomy, was founded. and since 2004 there has been an education program for Masters degree in Astrophysics. The PhD program Astrophysics began in 2012. The



Figure 4 Opening ceremony of the new astronomical observatory of the Shumen University, 19 April 2016.

Astronomical Centre was founded in 1999. Its base was mainly 3 m dome with 15 cm Cassegrain telescope (Fig. 3). There are still 3 small refractors, 5 sextants, Schnell photometer, and a computer room. In 2010, students of specialty Astronomy in Shumen University established Student Astronomical Society. It collaborates with similar foreign organizations from the Universities of Edinburgh, Istanbul, Hertfordshire, etc. It joined the international organization "Astronomers Without Borders". Students worked very effectively in the projects Killer asteroids and My Kepler, Students' practices in Astronomy at Rozhen Observatory. Prof. Diana Kjurkchieva, Prof. Dragomir Marchev, PhD Borislav Borisov, PhD Sunay Ibriamov, and more PhD students and assistants work at Shumen University now.

In 2010 modern equipment was provided thanks to funding by project SMART-NET: telescopes 40-cm LX200ACF Meade and 25-cm LX80 SC Meade as well as detectors: CCD camera SBIG ST-10 XME and spectrograph SGS ST-7/8/9/10/2000.

The team of the Astronomical center of Shumen University participated recently in large European projects creating innovative educational technologies in natural sciences: COSMOS, Pathway, LD Skills, GeoThink, Distance Learning and Student's practice. Moreover, the astronomers took part in different international observational initiatives: YETI, DWARF, etc. Since 2010, Shumen University is part of the consortium of National roadmap of scientific infrastructure. In 2015 the new building

of the Astronomical observatory of Shumen University was constructed thanks to the funding of the European program for development of human resources – of the Department of Natural Park "Shumen plateau" (Fig. 4).

Shumen Astronomical Observatory is located in Natural Park (NP) "Shumen Plateau" and has coordinates: latitude $N = 43°15'27"$, longitude $E = 26°55'23"$ and is 493 m above the sea level. The building was constructed with funding project "Management and Planning NP Shumen plateau" under Program "Environment 2007–2013". The infrastructure of the observatory includes: 5.5-m and 3-m domes, a computer room, a training room, a meeting hall, an exhibition hall, and the possibility for a planetarium.

1.3 People observatories and astronomical centres

The rapid development of space exploration since the mid-twentieth century provided the opportunity and impetus to popularize and develop many centers of astronomy in Bulgaria. Many people's observatories and astronomy clubs were established in 1960–1984 (Table 1). In 1961–1962 the first people's observatories were opened in Dimitrovgrad and Stara Zagora. In 1962 in Dimitrovgrad the first country planetarium was opened with 8-meter dome and 50 seats. This planetarium is a unique homemade device with 47 lens viewer made by the amateur astronomer architect Milko Milanov (Fig. 6).



Figure 5 Arch. M. Milanov with his projector (left) and the planetarium building (right).

Smolyan planetarium dome with a diameter of 12.5 meters has 150 seats, it is the biggest in Bulgaria. Since 1975 the planetarium has had over 2.5 million visitors. Peoples observatories have important role in popularizing to all citizens the achievements not only of the astronomy but of the science as a whole. Unfortunately, today's chaos in the educational system in our country is not conducive to fully exploit the enormous potential that these facilities have.

Of course there are a lot of astronomical clubs in Bulgaria, and here we note two of them. The first is Astronomical Association Sofia (AAS) established in Febru-

Table 1 People's astronomical observatories in Bulgaria, year of opening and web addresses.

"Yuri Gagarin" Stara Zagora	1961	www.aogagarin.com
"Jordano Bruno" Dimitrovgrad	1962	www.naopjbruno.bg
"Nicolaus Copernicus" Varna	1968	www.astro-varna.com
"Slavey Zlatev" Kardjali	1970	aovega.wordpress.com
People Observ. Yambol and Sliven	1971	www.naop-yambol.com
People Observatory Smolyan	1975	planetarium-sm.org
People Observatory Gabrovo	1984	planetarium-gb.eu

ary 1994 (www.aas.bg). The second is Astronomical Association "Stellar Society" (AASS) established in October 2009 (http://stellarsociety.org/). Both publications of AAS (Andromeda magazine and Telescope newspaper) present the latest developments in Space and Earth sciences and amateur astronomy, both nationally and on the European and global level. The activity of the societies is aimed at lovers of astronomy from all ages and all people interested in the sky, its beauty and those who like to look up and to ask questions. The societies are required to promote the knowledge and education in astronomy. The main promotional activities of the societies include: organizing and conducting demonstration of astronomical observations with telescopes; summer schools for observational astronomy; expeditions in connection with specific astronomical events; working groups for example telescope building, astro photography, etc.; lectures, talks, discussions, educational programs, performances on astronomy and its related sciences; screenings of popular science and educational films; creation of educational science films and specialized software applications in astronomy.

1.4 IRIDA observatory

The NAO attracts all amateur astronomers in Bulgaria. Every year, the Observatory hosts several national meetings of amateur astronomers from various associations and clubs in astronomy. Different presentations and night observations with private astronomical devices are provided during such meetings.

In 1960 Art Code with their employees in Wisconsin, USA used a minicomputer with 4 KB memory to automate 8 inch photometric telescope (Genet 2011). They created observatories with remote control and also fully robotic observatories. There is increasing cooperation between professional and amateur astronomers for the implementation of very specific astronomical tasks. There are currently about 127 robotic astronomical observatories worldwide which are built, to be completed or are at the project stage.

In the summer of 2012, Bulgaria's first remote-controlled astronomical observatory facility (IRIDA) was established on the territory of Rozhen National Astronomical Observatory (Fig. 6). The facility consists of two astronomical domes with a diameter of three meters, each equipped with the necessary astronomical devices. The remote control observatory works through the network of NAO Rozhen. The investment for the construction of Observatory IRIDA was completely private. It is envisaged that the remote controlled observatory would be included in the observational program

of IANAO and would participate in scientific tasks, according to the technical capabilities of the equipment (IRIDA, http://www.irida-observatory.org/). Main topics of IRIDA investigations are binary stars, exoplanets, and comets (Kjurkchieva et al. 2015, 2016a, 2016b).

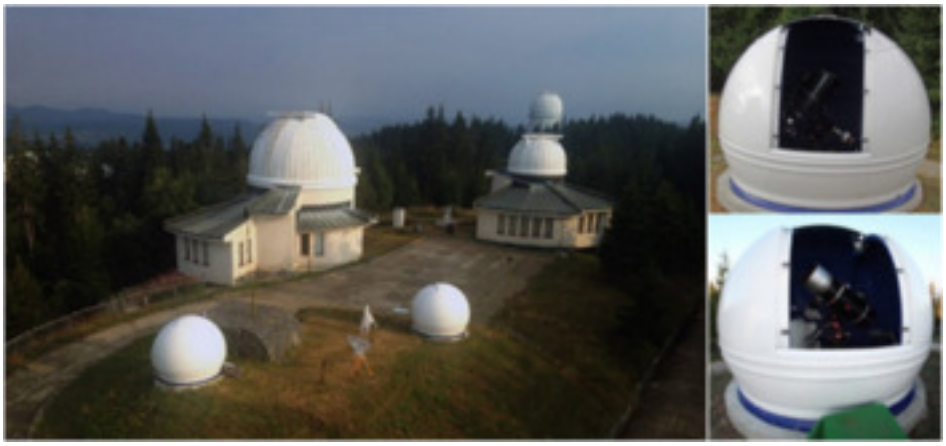


Figure 6 Panoramic view of the telescopes for night observation of NAO Rozhen. In the foreground (left) are two telescopes of the Observatory IRIDA. IRIDA has two 3 m domes and 30 cm reflectors (right).

1.5 Astronomical Observatory Belogradchik and National Astronomical Observatory ROZHEN, Bulgarian Academy of Sciences

Humanity develops due to the continuous search for new knowledge. The main question for us remains the mystery of the universe, and in the past few decades we have achieved a lot in this direction. From the middle of the last century, there has been rapid development of advanced technology and we have been remarkably successful in extending our knowledge of the nearest cosmos. The high requirements and specifications of the equipment of modern astronomical observatories have led to the development of better instruments, in areas such as electronics, mechanical engineering, computer sciences, etc. Astronomy has always been a cornerstone of the technological advancement throughout human history. Now we cannot imagine how it will progress, but fundamental research does not always reach a final satisfactory answer – most likely we will be surprised.

Bulgaria also has its quest for astronomical knowledge. The efforts of several generations of astronomers and scientists led to the construction of the first professional and modern astronomical observatory in Belogradchik in 1965 (Fig. 8).

In 1976 the Astronomical Observatory in Belogradchik (AOB) became part of the Department of Astronomy (DA) at the Physical Institute of Bulgarian Academy of Sciences (BAS). The telescope of AOB, equipped in 1970 with a modern (for its time) electro photometer developed by Mikhailovich (1940–2009), an astronomer from the Crimean Astrophysical Observatory, has conducted many valuable photometric observations of stars and galaxies. In August 1969, the 60-cm Cassegrain telescope



Figure 7 Main building of the Astronomical Observatory Belogradchik.

was mounted in the 6 m dome of the observatory. Its focal length is 7500 mm. It is equipped with an electro photometer working in photon counting regime with UBV filter system, and a CCD camera FLI PL-9000. In 1994, the automated 35 cm "Celestron" equipped with a CCD-camera Star-1 was installed in 3m dome of the Observatory (AOB, http://www.astro.bas.bg/ aobel/equipment.html).

The crown of the astronomical facilities of Bulgarian astronomy is establishment of the National Astronomical Observatory (NAO) Rozhen. Throughout the modern history of Bulgaria all astronomers have given much of themselves to have NAO. In December 1941, Academician N. Bonev said: "Enough has been said about "poverty" of the country! As long as we cultivate a sense of inferiority among us! We must finally create something worthy of Bulgaria ... We need to reach and exceed at least our neighbors and to have a Courthouse, a National Theatre, a National Bank, etc. As not all countries have, so we can and we must have one worthy of us and our central location of the Balkan medium furnished Astronomical Observatory ... ". He talked about a new University Observatory with 1-m telescope but a quarter century later there was no new observatory.

On March 13, 1981, the Bulgarian National Astronomical Observatory Rozhen was officially opened (Fig. 8). It was the final result in the long sequence of dreams, ideas, projects, decisions and actions of many people and institutions which placed Bulgaria among the modern nations possessing their own resources to investigate the Cosmos. The astronomical observatory is the biggest one-time Bulgarian investment in scientific infrastructure and a leading astronomical center in the South-East Europe (IANAO booklet 2008).

NAO Rozhen is the main observatory of the Institute of Astronomy, BAS. From the beginning NAO Rozhen also has at its disposal two small telescopes for optical observations: 50/70 cm Schmidt telescope and 60 cm Cassegrain telescope. At present, both telescopes are equipped with CCD cameras with thermo-electric cooling. The relatively big field of observation makes the telescopes suitable for photometry of vari-



Figure 8 View of the largest dome with 2m telescope of NAO in the Rhodope Mountains at 1750 m altitude and coordinates: longitude 1h 38m 58s and latitude 41° 41′ 48”.

able and fast moving objects, as well as of nearby galaxies. Since 2005 NAO Rozhen has also had a 15 cm Lyot coronagraph with Ha filter, designed for observations of quiescent, eruptive, and active prominences in the low solar corona, and a solar refractor, which is in preparation for observations in white-light and H-alpha line (the solar activity in the photosphere and chromosphere). There are also a center for visitors equipped with an 18 cm telescope, a conference room and a small museum in NAO Rozhen.

The main topics of investigations of the Institute of Astronomy and NAO are of the Sun, solar system objects, stars and stellar systems, galaxies and cosmology, and archival astronomical observations.

The study of the Sun is essentially significant for the fundamental aspects of astrophysics, as well as for the applied scientific branches, such as nuclear physics, plasma physics and magnetohydrodynamics. The solar activity is a basic topic of solar researches in IANAO. It is the basic mechanism that drives the space weather and its influence on the Earth's atmosphere. The quiescent and eruptive prominences are basic objects of observation and study (Petrov et al. 2013, Nikolov et al. 2013, Nikolov et al. 2014).

The small bodies (asteroids and comets) are remains from primordial material of the Solar system formation and their investigation gives the answers to questions, for example, how was the Solar system created? What were the conditions in the protoplanetary cloud, which led to planet formations? On the other hand, these objects are a future source of raw materials for the Earth technologies. The investigations of the Solar system became especially topical after the discovery of extrasolar planets and planetary systems.

The successful participation in the world-wide campaign International Halley Watch initiated investigations of the dust, neutral and ion components in the cometary atmospheres and the influence of the Sun over them, and these investigations continue. Nowadays the cometary studies continue with the modeling of the processes in their atmospheres. The comparison of the observations with the models gives the parameters of cometary nuclei (Borisov et al. 2014, Shkodrov et al. 1996, Denchev 1993).

The main goal of our studies is the complex study of the atmospheres of chemically peculiar stars. As a result of spectroscopic observations carried out at NAO Rozhen, for the first time we reached the conclusion that stars with higher tides in the atmospheres exhibit smaller excess of heavy elements. The chemical composition of the stellar atmospheres of metal-rich stars was derived by use of the spectral synthesis method. Half a dozen new spectroscopic binary stars with metal-enriched atmospheres have been discovered (Iliev et al. 2014, Tomov 2016, Tomov et al. 2016).

Physical processes and chemical abundance in galaxies, systems of galaxies and the Universe are basic fields of interest. Photometry and Surface photometry of normal and active galaxies and galaxies in Voids are carried out. Disk profiles and star formation in galaxies, irregular galaxies, and the movement of ionized gas are investigated. The monitoring of blazars, novae and supernovae is conducted and the structures of galaxies and clusters of galaxies are searched for and observed (Slavcheva-Mihova et al. 2014, Bachev et al. 2012, Vucetic et al. 2015).

The astronomical observations made in NAO Rozhen, are archived and will be prepared for inclusion in the international virtual observatory in the future. NAO Rozhen possesses an archive of more than 10000 photographic plates, obtained with the 2 m RCC and 50/70 cm Schmidt telescopes. The Wide-Field Plate Database (WFPDB) is the basic source of information for the photographic wide-field astronomical observations, stored in the archives of 125 observatories worldwide, whose total number for the period 1872–2002 is estimated to be 2 200 000. The new development of WFPDB is connected with the forthcoming creation of a Bulgarian Virtual Observatory as a part of the global international net of virtual observatories. (Tsvetkova et al. 2013, Tsvetkov et al. 2012, Poljancic et al. 2014).

Archived observational materials from all observatories in the world offer a unique observational data for a wide range of astronomical tasks. The determination of the proper motions of stars and galaxies or deep changes in photometry of long time variables, can be performed only with the use of archival observations (Nikolov 2016).

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