

Astronomy in Serbia and in Montenegro

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Abstract. After a brief survey of the foundations, development and the present status of astronomy education at all levels, a review of research in astronomy in Serbia and in Montenegro is given.

Keywords. History of astronomy, astronomy in Serbia, astronomy in Montenegro, astronomy education, research

1. Introduction

Astronomy education and research in Serbia have more than a 120-year long tradition (Dimitrijević, 2001). Namely, since 1880 astronomy has been taught together with meteorology at the Great School (the University of Belgrade since 1905). The first lectures were given in 1884, when Milan Nedeljković was elected to be the suplent (supplementary lecturer) for the courses of astronomy and meteorology. In 1887 Milan Nedeljković also initiated the foundation of the first Astronomical and Meteorological Observatory in Serbia. Since then numerous changes due to a turbulent political environment, institutional transformations, reforms of education and changes in research mainstreams have taken place.

Nevertheless, the histories of astronomy education and research in Serbia remained always strongly interlinked. In this paper we shall briefly describe the most important activities regarding astronomy education and research in Serbia and in Montenegro as well, since traditionally these two countries shared a common cultural area.

2. Astronomy education

In this section we give the status of astronomy education at all levels, from elementary school to PhD studies. Also, the activities of numerous amateur astronomical societies in public astronomy education are briefly summarized.

2.1. *Elementary and secondary school education*

Astronomy makes a part of the elementary and secondary school curricula, but not as a separate subject except in some cases mentioned below.

In elementary schools astronomy topics are taught within the courses of natural history, geography and physics. Recently, certain improvements of the program of physics concerning astronomy topics were introduced.

From 1969 to 1990 astronomy was taught as a separate course in the fourth year of secondary schools (in the beginning with one class hour per week and in the 1980s with two class hours per week).

However, due to a law passed in 1990, astronomy was integrated into the fourth year physics courses (with 10 classes in general and in social-sciences-oriented secondary

schools, and with 32 classes in natural-sciences-oriented schools). In order to help secondary school teachers to keep up with new achievements in astronomy and in methods of teaching astronomy, lectures on various astronomy topics are given at regular annual seminars for physics teachers.

At present astronomy is taught as a separate course only in the Mathematical High School of Belgrade and in seven high schools of other Serbian towns (Novi Sad, Niš, Kragujevac, Kruševac, Kraljevo, Valjevo and Leskovac). Astronomy is not taught as a separate subject in the high schools in Montenegro.

Many attempts have been made within the reform of elementary and secondary education to reintroduce astronomy as a separate and compulsory course, but without success until now.

Despite the situation, pupils of higher classes of elementary school and high-school students express great and permanent interest in astronomy. Recently they scored several significant results (Milogradov-Turin, 2004). Serbia and Montenegro participated at three International Astronomy Olympiads: the VIIth (2002), IXth (2004) and Xth (2005). One junior and three senior teams participated at IAOs and won one silver and five bronze medals in total.

Special emphasis should be put to the activities of the Petnica Science Center, near Valjevo, centre for talented high-school students interested in science. It organizes seven seminars per year, lasting 7–8 days with about 20 participants on average.

2.2. University education

Astronomy topics are taught at all five state universities in Serbia: Belgrade, Novi Sad, Niš, Kragujevac and Priština (since 2002/2003 academic year in Kosovska Mitrovica) and at the University of Montenegro (Podgorica, Kotor).

2.2.1. Astronomy education at the universities of Serbia

The beginning of higher university-like education in Serbia can be traced back to 1838 when *Licej* (the lyceum) was founded in Kragujevac (Milogradov-Turin, 2002; Simovljević & Milogradov-Turin, 1998). In 1841 *Licej* was moved to Belgrade and in 1863 it was transformed into *Velika škola* (the Great School). The traces of “physical” astronomy can be found in the curriculum of *Licej* in 1854/55 academic year.

Teaching of astronomy together with meteorology was introduced in 1880 and the lectures started in 1884, when Milan Nedeljković (the founder and the first director of the Astronomical and Meteorological Observatory of Belgrade) was elected to be suplent for the courses of astronomy and meteorology at the Great School.

He became professor in 1886. The year 1880 is taken to mark the foundation of the Chair of Astronomy in Belgrade, although jointly with meteorology until 1924. When the University of Belgrade was founded in 1905, the Chair of Astronomy and Meteorology remained within the Faculty of Philosophy. Milutin Milanković, the most famous Serbian astronomer of the XX century, well known for his astronomical theory of climate, was elected professor of the University of Belgrade in 1909 and remained at the post for more than four decades. He taught a number of subjects related to applied mathematics. According to new regulations of the Faculty of Philosophy introduced in 1925, astronomy was for the first time taught as a separate subject. Vojislav Mišković, who obtained his PhD in France, became professor of the University of Belgrade in 1925. A separate study group for astronomy was established in 1927.

After the foundation of the Faculty of Mathematics and Sciences of the University of Belgrade in 1947, the Chair of Celestial Mechanics and Astronomy was formed. It was separated into two chairs, the Chair of Mechanics and the Chair of Astronomy, in

1962. In the process of the latest reorganization in 1995, the Chair of Astronomy became the Department of Astronomy and remained within the Faculty of Mathematics. The University of Belgrade is still the only one in Serbia with a Department of Astronomy.

Astrophysics was introduced as an obligatory course at the Chair of Astronomy in 1958 and it developed into several courses since then. Important changes in curricula were introduced in 1961 when two separate study groups were formed: Astronomy and Astrophysics.

Until 1988 these two groups had the same curricula at the first two study years, to become completely separate programmes afterwards.

The undergraduate studies last four years. About 4–6 students graduate each year from the Department of Astronomy in Belgrade. So far 222 students have graduated from the Department of Astronomy of the University of Belgrade, 58 students received an MSc degree and 28 students a PhD degree. The first astronomy student graduated in 1936, the first MSc degree was obtained in 1968 and the first PhD degree in 1958. It is interesting to note that 41 per cent of all graduated students are women, whereas this percentage grew to 57 per cent in the last 20 years.

At the Department of Astronomy six professors and three assistants teach fifteen subjects at the study groups of Astronomy and Astrophysics and two astronomy subjects at the study groups of Physics and Mathematics.

Apart from the courses in mathematics, physics and computer sciences, the study program in Astrophysics comprises the following two-semester astronomical courses: General astronomy (I year), General astrophysics (II), Practical astrophysics (III), Astronomical data analysis (III), Theoretical astrophysics (IV), Structure and evolution of stars (IV), Radio astronomy (IV), Stellar astronomy (IV) and Methodology of teaching astronomy and the history of astronomy (IV). In addition to being entitled to do research in astrophysics, students graduated in Astrophysics are also entitled to teach physics and astronomy in secondary schools.

Apart from the courses in mathematics and computer sciences, the study programme in Astronomy comprises the following two-semester astronomical courses: General astronomy (I year), General astrophysics (II), Spherical astronomy (II), Practical astronomy (III), Astronomical data analysis (III), Theoretical astronomy (IV), Ephemeris astronomy (IV), Celestial mechanics and the motion of artificial satellites (IV) and Stellar systems (IV). In addition to being entitled to do research in astronomy, students graduated in astronomy are also entitled to teach mathematics and astronomy in secondary schools.

Many of the students graduated from the Department of Astronomy in the last ten years enrolled at PhD studies in the USA, Canada and Australia, and lately in the EU countries as well. Most of them have already continued their research and gained post-doctoral positions.

At the University of Belgrade astronomy is also taught as a compulsory one-semester course, “Fundamentals of astrophysics”, for the third-year students of the Faculty of Physics (physics teachers division), a compulsory course, “Geodetic astronomy” (4th year), at the Faculty of Civil Engineering, and a one-semester elective course, “Fundamentals of astronomy”, for the fourth-year students of mathematics.

Since 2002 the University of Novi Sad, the Department of Physics (Faculty of Natural Sciences) has opened an astronomy study group with several astronomy and astrophysics courses.

At the universities of Niš, Kragujevac and Priština (now situated in Kosovska Mitrovica), “Fundamentals of Astrophysics” (3rd study year), “Astrophysics and Astronomy”

(3rd study year) and “Fundamentals of Astronomy” (2nd study year), respectively, are taught as one-semester courses at the physics study groups.

2.2.2. *Astronomy education at the University of Montenegro*

Two astronomy courses are taught at the University of Montenegro: a two-semester course “Astronomical navigation” (2nd study year) at the Faculty of Maritime Studies of Kotor and a one-semester course “Geodetic astronomy” (3rd study year) at the Department of Geodesy, Faculty of Civil Engineering of Podgorica.

2.2.3. *Reform of university education*

According to the act passed in September 2005 the new European Credit Transfer System (ECTS) is to be introduced at all universities in Serbia and in Montenegro.

The Department of Physics of the University of Novi Sad was the first to introduce this system in 2002 together with opening of the new study group of Astronomy. At the University of Belgrade new study programs of Astronomy and Astrophysics are going to be introduced starting from 2006/2007 academic year. All existing two-semester courses are reorganized and divided into one-semester courses. Some new courses are introduced as well. The model 4+1 for the first two degrees (bachelor and master) is accepted. The first two study years of the third (PhD) degree feature compulsory and elective courses, whereas the third year is dedicated to the work on the PhD thesis.

2.3. *Public outreach*

Public astronomy education in Serbia and in Montenegro is realized by the way of lectures at public universities, radio and TV programmes, popular journals and books, lectures in two Planetaria (Belgrade and Novi Sad), in public observatories and fifteen amateur astronomical societies. The activities offered by amateur societies cover public observations of all major events, lectures, courses, conferences, schools and camps.

There are 14 astronomical societies in Serbia (two in Belgrade, two in Novi Sad, one in each of Valjevo, Kragujevac, Niš, Zrenjanin, Vršac, Bor, Prokuplje, Loznica, Knjaževac, Novi Pazar) and one in Montenegro (Podgorica). As there is an increased interest in astronomy among the general public, five of them were founded in the last three years.

The largest and the oldest society of amateur astronomers is the AS “Rudjer Bošković” of Belgrade, founded in 1934. The Society organizes astronomy courses each autumn and spring, Belgrade Astronomical Weekends, Summer Astronomical Meetings and Summer Schools of Astronomy, typically lasting a week. The non-profit astronomical journal “Vasiona” (“The Universe”), published by the Society, has a 54-year long tradition.

Since 1998 the largest astronomical web site in the country, Internet magazine “Astronomical magazine” (www.astronomija.co.yu) has been maintained by the AS “Lyra” of Novi Sad. Since 2003 the Society publishes “Astronomija”, a paper magazine of high-quality presentation.

More details about the activities of the amateur astronomical societies can be found in Milogradov-Turin (1996, 2000, 2002) and Atanacković-Vukmanović (2005).

3. **Astronomy research**

Astronomy research in Serbia is for the most part performed in two astronomical institutions: the Astronomical Observatory of Belgrade and the Department of Astronomy at the Faculty of Mathematics of the University of Belgrade.

3.1. *Astronomical Observatory in Belgrade*

The Belgrade Astronomical Observatory is one of the oldest scientific institutions in Serbia. It was founded (together with the Meteorological Observatory) in 1887. Prof. Milan Nedeljković was appointed its first director. In 1924 the Observatory was divided into two separate institutions: the Astronomical Observatory and the Meteorological Observatory of Belgrade University. From 1930 to 1932 a new astronomical observatory, 6 km southeast of Belgrade's centre, at the 253-m high hill Veliki Vračar, named Zvezdara since then (zvezda=star), was built under the direction of Prof. Vojislav Mišković. The observatory has grown into a modern institution under his supervision. Prof. Mišković won the French Academy Prize in 1925 for his studies in stellar statistics, whereas the most important of his later works were related to minor planets. Among the distinguished scientists who served as directors of the Observatory over the years, let us mention Prof. Milutin Milanković, widely known for his explanation of the ice ages phenomenon and the history of the climate of Earth and other planets, who was at the head of the Astronomical Observatory from 1948 to 1951.

3.1.1. *Instruments*

The instruments procured by M. Nedeljković from Germany, on account of the First World War reparations, were mounted in 1934 and constitute still the observing basis of the Observatory. These are:

- Large Refractor - equatorial Zeiss 650/10550 mm
- Solar spectrograph Littrow type, collimator lens 200/9000 mm, grating Bausch & Lomb 600 lines/mm
- Large meridian circle Askania 190/2578 mm
- Large vertical circle Askania 190/2578 mm
- Large transit instrument Askania 190/2578 mm
- Astrograph Zeiss 160/800 mm
- Photovisual refractor Askania 135/1000 and 125/1000 mm
- Transit Instrument Bamberg 100/1000 mm
- Zenith telescope Askania 110/1287 mm

The large meridian circle was, unfortunately, burnt up in May 1999.

Recently, a Meade reflector of 40 cm diameter has been procured and is used for CCD observations of solar system objects.

A project (initiated in 1986, but not implemented at the time) of a new astronomical station of the Belgrade Astronomical Observatory in southern Serbia is being carried out. The observatory is to be situated on the mountain Vidojevica near Prokuplje at an altitude of 1155 m. In the first phase, a reflector Astro Optik ($D = 60$ cm) is to be mounted. Later on, a larger telescope is planned.

3.1.2. *Research activities*

Research activities at the Astronomical Observatory cover a wide range of topics. Starting with 1935 the services for minor planets and solar observations, for time and latitude, for double stars and for variable stars were established. Since 1960 research in astrophysics has developed. It started with the photometry and polarimetry of eruptive stars and later it was directed towards stellar and solar physics and astronomical spectroscopy in general. Nowadays, research is carried out mostly in dynamical astronomy (solar system bodies, double stars, Earth rotation), astrophysics (solar physics, close binary stars, astronomical spectroscopy, galactic astronomy, extragalactic astronomy, cosmology, astrobiology) and history of astronomy. Thirty-five of 49 staff members

are researchers. They participate in eight scientific projects financed by the Ministry of Science and Environmental Protection of Serbia and in several international projects.

The researchers of the Astronomical Observatory participate in the undergraduate study programmes at the Universities of Belgrade and Novi Sad, as well as in the Master and PhD study programs of Astronomy and Astrophysics at the Belgrade University.

3.1.3. Publications

Since 1936 the Astronomical Observatory has published *Bulletin de l'Observatoire astronomique de Belgrade*. From No. 145 (in 1992) it appeared under the name *Bulletin astronomique de Belgrade*, after merging with *Publications of Department of Astronomy* (founded in 1969). From No. 157 (in 1998) the name was changed into *Serbian Astronomical Journal* (<http://saj.matf.bg.ac.yu>). Along with this main journal, since 1947 the Belgrade Observatory has published *Publications of the Astronomical Observatory of Belgrade*. All the publications of the Belgrade Observatory are distributed to about 200 scientific institutions all over the world.

3.2. Department of Astronomy of the Faculty of Mathematics of Belgrade

The research activities of the staff of the Department cover the following topics: Earth's rotation, dynamics of asteroids, motion of artificial satellites, stellar kinematics and dynamics, stellar structure, radiative transfer, solar and stellar atmospheres, radio astronomy, supernova remnants, active galactic nuclei and history of astronomy. All this research is carried out together with the colleagues from the Astronomical Observatory in the framework of the common projects.

The first solar radio interferometer in Serbia was constructed by the staff of the Department of Astronomy in 1960. It worked till 1966 for daily observations and later served only for teaching purposes.

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