

ASTRONOMY EDUCATION IN SERBIA AND MONTENEGRO 2002-2005

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Abstract. Astronomy education in Serbia and Montenegro is reviewed with special attention paid to the changes introduced from June 1, 2002 to November 1, 2005.

1. GENERAL INFORMATION

Although astronomy is one of the oldest sciences, experiencing tremendous development in the last decades and attracting attention of millions of people, it does not have appropriate place in elementary and secondary education in Serbia and Montenegro. It is a part of the elementary and secondary school curricula but neither as a separate nor as a compulsory subject. Astronomy is taught as a separate course only in the Mathematical High School in Belgrade and in seven high schools of Serbia.

Education in astronomy at the University of Belgrade (the Great School before 1905) has a 120-year long tradition. Since 2002 the University of Novi Sad has introduced the astronomy study group simultaneously with a new "credit" system. At the universities of Niš, Kragujevac and Priština (Kosovska Mitrovica), fundamentals of astronomy and astrophysics are taught as one-semester courses at the physics study groups. Two astronomy courses are also taught at the University of Montenegro.

There is also an increased interest for astronomy among the general public. Five new amateur astronomical societies have been founded in Serbia and Montenegro during the last three years.

In this paper the present state of astronomy education in Serbia and Montenegro is reviewed with special emphasis on the changes introduced from June 1, 2002 to November 1, 2005. The previous period was covered in the paper by Milogradov-Turin (2002) and in references therein.

2. ELEMENTARY SCHOOLS

In elementary schools astronomy topics are taught within the courses of Natural History, Geography and Physics.

3. SECONDARY SCHOOLS

From 1969 to 1990 astronomy was taught as a separate course with one class hour per week in the fourth year of secondary schools. According to an act passed in 1990 astronomy topics are incorporated in Physics and partly in Geography. The current astronomy textbook, written by M. Dimitrijević and A. Tomić, had its sixth edition in 2005.

Astronomy is taught as a separate course, with one class hour per week, only in the fourth year of the Mathematical High School in Belgrade and in the equivalent grades attached to seven secondary schools in Novi Sad, Niš, Kragujevac, Kruševac, Kraljevo, Valjevo and Leskovac. There are no astronomy courses (in such grades) in Montenegro.

In the last three years several attempts have been made within the reform of elementary and secondary education to reintroduce astronomy as a separate and compulsory course, however without success.

In order to help secondary school teachers to keep pace with achievements in astronomy and methods of teaching astronomy, lectures on subjects related to astronomy are presented at regular annual meetings of physics and astronomy teachers. Four lectures on subjects related to astronomy have been presented within the last three-year period.

4. UNIVERSITY EDUCATION

There is a total of 13 universities in Serbia and Montenegro. Natural sciences are studied at six state universities. Astronomy topics are taught at all six of them.

University education in astronomy in Serbia started 120 years ago, in 1884, when Milan Nedeljković was elected to be suplent for the courses of astronomy and meteorology of the Great School. The University of Belgrade (the Great School before 1905) is the only university with the Department of Astronomy. Since 1962 students can enroll at the studies of Astronomy or Astrophysics.

Until now 217 students have graduated from the Department of Astronomy (Faculty of Mathematics) at the University of Belgrade, 56 students acquired M.Sc. degree and 27 students Ph.D. degree. Since 1981 the best student of the generation has been granted "Prof. Zaharije Brkić" award. Twenty one awards have been granted so far. Within the last three years, 20 students graduated in Astrophysics and 3 in Astronomy. Nine postgraduate students acquired the M.Sc. degree and one student Ph.D. degree.

For the third-year students of the Faculty of Physics of Belgrade (physics teachers division) there is a compulsory one-semester course "Fundamentals of Astrophysics". A compulsory course "Geodetic astronomy" (4th year) is taught at the Faculty of Civil Engineering of Belgrade. Since October 2003 one-semester optional course, "Fundamentals of Astronomy", has been introduced for the fourth-year students of mathematics.

Since December 2000 the Department of Astronomy has organized regular seminars on different topics in astronomy on every second Tuesday during the academic year. The seminars are organized on Wednesdays at the Astronomical Observatory in Belgrade.

The Department of Physics, the Faculty of Natural Sciences of the University of Novi Sad has introduced the study of astronomy since October 2002. Here the European Credit Transfer System (ECTS) was introduced for the first time. Optional courses in astronomy and astrophysics are offered already from the first study year. A student can graduate after three years as a teacher of physics and astronomy or as a physicist or an astronomer after four years of study.

At the Institute of Physics at the University of Kragujevac there is a one-semester obligatory course, "Astrophysics and Astronomy", at the third year of the physics studies.

At the Department of Physics at the University of Niš there is a one-semester course, "Fundamentals of Astrophysics", at the third year of physics studies.

At the University of Priština (since academic year 2002/2003 in Kosovska Mitrovica) a one-semester course, "Fundamentals of Astronomy", is taught at the second year of physics studies.

Two astronomy courses are taught at the University of Montenegro. Two-semester course "Astronomical navigation" (2nd year) was taught at the Faculty of Maritime Studies of Kotor. Since October 2004 a one-semester course "Geodetic astronomy" (3rd year) has been taught at the Department of Geodesy, Faculty of Civil Engineering in Podgorica.

An university textbook "Opšta astrofizika" ("General Astrophysics") by Mirjana Vukićević-Karabin and Olga Atanacković-Vukmanović was published in 2004. Also, an auxiliary university textbook "Fizika Sunca" ("Physics of the Sun") by Dragan Gajić was published in 2005.

According to the act passed in September 2005 the new system (ECTS) is to be introduced at all universities of Serbia and Montenegro.

5. PUBLIC EDUCATION

Public astronomy education in Serbia and Montenegro is realized by the way of lectures at public universities, radio and TV programmes, popular journals and books, lectures at two Planetaria (Belgrade and Novi Sad), at public observatories and numerous amateur astronomical societies. The activities offered by amateur societies cover public observations of all major events, lectures, courses, conferences, schools and camps. The major astronomical events observed were: the great opposition of Mars (August 2003), transit of Mercury (7 May 2003), partial solar eclipse (31 May 2003), the transit of Venus (8 June 2004) and eclipses of the Moon (9 November 2003 and 28 October 2004).

There are 14 astronomical societies in Serbia and one in Montenegro.

(1) The Astronomical Society (AS) "Rudjer Bošković", founded in 1934 in Belgrade, has about 700 members. The Society organized courses each autumn and spring, with a total of about 10 680 participant×lecture in the last three years. Twenty participants passed the final exam. The total number of visitors of the Public Observatory and the Planetarium of the AS "Ruđer Bošković" in this period was about 130 000. On several occasions the Planetarium of the Society was also used for art happenings, exhibitions and performances. The Society has regularly informed on astronomical events through local radio and TV programmes and the "Politika" newspapers.

The courses were given by the staff of the Public Observatory and Planetarium, professional astronomers from the Astronomical Observatory and the University in

Belgrade, students of astronomy, and partly by amateur astronomers. The equipment of the Society is used for the training of the students of astronomy and astrophysics.

The Society kept on organizing the Belgrade Astronomical Weekends (BAW) in June every year on various astronomical topics. From 2002 to 2005 the XX-XXIII BAWs were held, each with 200-380 visitors. The AS "Ruđer Bošković" went on organizing also the "Summer Astronomical Meetings" (end of August - beginning of September) on a particular astronomical topic. The 5th SAM, held in 2002, was dedicated to the small bodies of the Solar system (6 lectures, 530 listeners). The topic of the 6th SAM, held in 2003, was Mars (5 lectures, 430 listeners), that of the 7th SAM, held in 2004, was Saturn (3 lectures, 157 listeners), whereas the 8th SAM, held in 2005, was dedicated to the life and work of Albert Einstein (6 lectures, 300 listeners).

In 2002 the AS "Ruđer Bošković" bought amateur telescope TAL-200K (D=200mm, F=2000mm) of Russian production.

With the Faculty of Natural Sciences and the University Astronomical Society of Banja Luka the AS "Ruđer Bošković" organized the Summer School of Astronomy at Motajica from 11 to 15 August 2002. Together with the AS "Andromeda" from Knjaževac, they organized the Summer School of Astronomy on Stara planina (Old Mountain) from 10 to 15 August 2004 (62 participants). From 7 to 14 August 2005 the Summer School of Astronomy was held on Tara mountain (42 participants).

Collaborators of the AS "Ruđer Bošković" observed various celestial objects (Solar system bodies, stars, star clusters and nebulas) with the aim to estimate the transparency and light pollution of the Earth atmosphere. During 2003 and 2004 the employees of the AS "Ruđer Bošković" gave 7 invited popular lectures. They took part in the Festivals of adult education with several lectures held in Planetarium.

In 2002 the AS "Ruđer Bošković" celebrated the fiftieth anniversary of its non-profit astronomical review "Vasiona" ("Universe"). 15 issues of "Vasiona" were published in the period concerned.

On the occasion of the 70th anniversary of the Society "The 4th Serbian-Bulgarian Astronomical Conference" and the Conference "Development of Serbian Astronomy III" were held in April 2004, organized together with the Belgrade Astronomical Observatory.

(2) The Astronomical Group of the "Vladimir Mandić-Manda" Organization of Young Researchers in Valjevo (founded in 1973) has advanced its work. Every year (from September to June next year) they organized courses of astronomy with one lecture per week. About 100 listeners attended three courses held in the period 2003-2005.

In addition to the theoretical education, the Astronomical Group organized two camps every year (in spring and autumn) lasting several days. In the three-years period about 130 participants of these camps had a chance to be acquainted with the astronomical instrumentation and the methods of observation through practical work.

Several public debates and round-table discussions have been organized during the Valjevo Astronomical Meetings, enabling the general public to be acquainted with the recent astronomical discoveries. All the activities of the Astronomical Group as well as the most important astronomical news are published on its web site.

From October 2003 to August 2005 the Astronomical Group organized 14 obser-

vational camps, each lasting 3-5 days and including about 25 participants. Meteor showers, variable stars, solar activity etc. have been observed. The Astronomical Group proceeded ethnoastronomical investigations. The results of the activities are published annually in the Proceedings of the Society of Researchers as well as in other journals and magazines (*Publ. Obs. Astron. Belgrade, Vasiona, Astronomija, Petničke sveske, Astronomical magazine*, etc.).

During the last three years the Astronomical Group had a very successful cooperation with other astronomical organizations in our country and in the south-eastern Europe. In December 2003 the Astronomical Group celebrated its 30th anniversary.

(3) The AS "Novi Sad" (ADNOS), founded in 1974, has about 150 active members.

The planetarium (ZKP-1 of Carl Zeiss, Jena), situated within the Petrovaradin fortress in 2001, is used for lectures to secondary school students and general public. In the last three years about 20000 visitors and some 350 groups from elementary and secondary schools visited Planetarium. Projections and lectures are organized in the Planetarium for the high school students of Novi Sad and for the university students of astronomy, physics and geography. Regular projections on Saturdays are followed by some selected popular lectures in astronomy. The visitors can use telescopes of the Observatory that makes the whole with the Planetarium in all activities of ADNOS. All major astronomical events have been observed. In the period concerned two seminars were organized for the collaborators of the Observatory and for the demonstrators of the planetarium projector. Popular lectures on Mars, potentially dangerous asteroids and meteors were presented as well as oral presentations of the seminars of the students of astronomy. The equipment of the Society is used for the training of the students of astronomy and astrophysics. The Planetarium was also used for art happenings (EXIT, picture exhibition and multimedia performance).

The members of ADNOS participated in the Astronomical Camp in Vršac, and every year they participate in the Messier marathon and Letenka Summer Camp. The AS "Novi Sad" (ADNOS) organized "The First Summer Astronomical Meeting" on 21 June 2002 in Bački Petrovac. The topic was "The use of web camera for the photographing of Moon and planets". The Society takes part in the popularization of astronomy through local TV and radio programmes.

(4) The AS "Belerofont" ("Bellerophon") was founded in August 1995 in Kragujevac. The Society mainly used the telescope and premises of the Faculty of Sciences of Kragujevac. According to the opinion of the members of the Belerofont Observatory, the year 2004 was the most successful, due to the activities and the investments in the instrumentation. Thanks to the management of the Faculty, new telescope and the web camera are bought. The montage of the telescope is constructed by the members of the Observatory and the web camera is redesigned to work as a telescope CCD camera. The web site of the Observatory is designed by its members – students of the Institute of Physics.

Many people visited the Observatory within the period concerned. In August 2003, during 2-days excursion in Šumarice, more than 800 citizens of Kragujevac observed the great opposition of Mars. Also outdoor expeditions were organized for getting photographs of the solar and lunar eclipses in 2003. The Society got new permanent members, meritorious for a great part of the above activities.

(5) The AS "Alpha" in Niš has permanent activities since April 1996. It has more than 150 members, mainly high-school and university students. The members of the

Society participated in many TV and radio programmes on the occasion of important astronomical events. The activities of this society contributed to an increased interest in astronomy in the south of Serbia. This intensified the work and helped the foundation of amateur astronomical societies in Knjaževac, Prokuplje, Leskovac, etc. In March 2002 the Society initiated the foundation of a small observatory with a planetarium within the fortress of Niš. The project was supported by the Faculty of Natural Sciences, the Commission for the revitalization of the Niš fortress, and by the assembly of the town Niš, but it is still not realized.

During the last three years the AS "Alpha" organized about 20 lectures (each with 50–250 listeners), public observations (with a few hundred people) of all major events, 3-days seminar "A little night astronomy" in July 2003 dedicated to telescopes, astrology and the Solar system, and "Spring astronomical workshop" in 2004.

(6) The AS "Milutin Milanković", founded in 1996 in Zrenjanin, was active in public astronomical education. It has about 100 members. A series of lectures was organized during 2004 and 2005. The Society organized the observations of the transit of Mercury in May 2003 and of Venus in June 2004. The members of the Society regularly participate in the Messier marathon and in Astronomical camps on Fruška Gora mountain.

(7) The AS "Lira" ("Lyra") in Novi Sad edits Internet magazine "Astronomical magazine" (www.astronomija.co.yu) since 1998, the largest astronomical web site in the country. Since 2003 the AS "Lira" publishes paper magazine "Astronomija" in cooperation with the Graphic studio "Spremo" from Novi Sad. Fifteen issues have been published up to November 2005.

Every year the AS "Lira" organizes observation competition in the Messier marathon with 15-20 participants. From 2002 to 2005 the Society organized 4 astronomical camps (on Fruška Gora mountain), lasting 3 days. 50 to 100 participants have come from Serbia, Macedonia, Bosnia and Herzegovina and Croatia. During each camp five to ten lectures were given, the observation competition and exhibition of telescopes were organized and films on astronomy were shown.

The members of the AS "Lira" gave about 12 lectures in Novi Sad, Niš, Zrenjanin, Valjevo, Subotica and Vršac.

(8) Astronomical group within the Natural History Society "Gea", founded in 1999 in Vršac, kept on organizing the Astronomical Meetings of Vršac (AMV) every year. They organized the 2nd AMV in 2002. The 3rd AMV (held in 2003) was dedicated to the partial solar eclipse of May 31 and the 4th AMV (in 2004) was dedicated to the transit of Venus. Astronomical observations have been performed by means of the telescope CELESTRON 8, bought in 2003. In 2004 the members of the Astronomical group within "Gea" gave several lectures in Vršac and Niš. The Society "Gea" published annual bulletins. Seventeen contributions in the last three numbers were dedicated to astronomy.

(9) The Society for Radio Astronomy Research "Aurora", founded in December 2000 in Bor, observed radio reflections from meteor showers. They possess the antenna system working at 144MHz. The building of the new antenna system for higher frequencies and the providing of the equipment for registration of meteors at lower frequencies (50MHz) are under way.

(10) The AS "Magelanov oblak" ("Magellanic Cloud") was founded in May 2001 in Prokuplje. It has about 80 members. The chief aim is to gather and to educate

amateur astronomers of the Toplica district. The Society possesses a 23 cm f/8 Newtonian reflector. It organized three seminars (in January 2002, April 2004 and May 2005), with several lectures and the Assembly of the Society. In this 3-years period the main activities of the Society were connected with the building of a new Astronomical Observatory on Vidojevica mountain near Prokuplje.

(11) The Astronomical Society "Loznica" was founded in 2002 in Loznica. The principal aim is public education (through local radio programmes "Astronomical magazine" lasting one hour per week, lectures in the secondary schools, web presentation regularly updated, etc.). The members of the AS "Loznica" possess several small telescopes - reflectors (150mm in diameter) or refractors (D=75-100mm) and organize public observations of various celestial bodies.

(12) The AS "Andromeda" in Knjaževac was founded in December 2003. It has about 350 members. They have two telescopes with mirrors of 60mm and 200mm. In June 2004 the gymnasium of Knjaževac and gymnasium "Hristo Botev" from Belogradčik organized the International Camp on Old Mountain. Together with the AS "Rudjer Bošković" the Society organized the Summer school of astronomy on Old Mountain in August 2004. The Autumn School of Astronomy was held from October to December 2004 and the CD with the lectures was compiled. From March to May 2005 the Society organized the Spring School of Astronomy dedicated to the Solar system. The school of photography and astro-photography was organized from 10 September to 20 October 2005. The 2nd Autumn School dedicated to the Year of Physics is to be held in November and December 2005. The members of the Society participated several times in local radio and TV programmes dedicated to solar eclipses, transit of Venus, planets, etc.

(13) The AS "Novi Pazar" was founded in April 2004 in Novi Pazar. It has about 15 members. They have telescope TAL 200K, refractor ETX 60 Meade and 150mm-Newton reflector. They observed meteor showers, transit of Venus and other astronomical events.

(14) The Montenegro Astronomical Society was founded in April 2004 in Podgorica. The chief aim is popularization and public education in astronomy. They have the telescope Celestron of 11 inches and two small telescopes (5 and 6 inches). The members participate in one-hour local radio-programme on astronomy on Saturday night.

(15) The Center for Radio Astronomy "Tesla" was founded in November 2004 in Belgrade. It has 15 members, mainly students of astronomy and astrophysics. The Center possesses three receivers, at 406.7 MHz, 1420 MHz and 40kHz. They measure the solar radio flux with the aim to examine the solar activity in the radio domain.

Many of the amateur astronomical societies have their web sites and all can be contacted by e-mail. More details about their activities can be found in the papers published in *Visiona*, *Astronomija*, *Astronomical magazine*, *Gea*, etc.

Despite high enthusiasm and activity of their members and great interest among general public, the common problem of all of the amateur societies is a lack of adequate space, equipment and financial support. Very often they succeed to survive thanks to enormous enthusiasm and a hard work of only a few people. So, due to a lack of such "critical mass", two astronomical societies: the AS "Kraljevo", founded in June 2001 and the AS "Vlašići" ("Pleiades") in Leskovac, not officially registered, ceased to exist during the last three years.

Special emphasis should be put on the activities of the Petnica Science Center (PSC), center for talented pupils interested in science. It organizes 7 seminars per year, lasting 7-8 days on the average with about 20 participants. Starting from 2003 only the participants of the seminars belonging to the oldest group did the research projects independently. The best research works were presented at the Conferences of research projects of the PSC participants (organized since 2002).

The PSC published three issues of "Petničke sveske" ("Petnica notebooks") within the period concerned with 12 papers related to astronomy (see the references).

The PSC organized the observations of all major events. In the last three year Petnica meteor group organized about 20 camps and various observational activities.

In May 2004 a 7-days seminar was organized at the PSC for the third-year students of astronomy and astrophysics, concerning the exercises within the courses 'Practical Astronomy' and 'Practical Astrophysics'.

Astronomy has also been popularized by the "Mladi fizičar" ("Young Physicist"), a quarterly magazine for the elementary and secondary school students.

After years of rather successful work, the organization "Nauku mladima" has stopped the competitions in astronomy for the academic year 2001/2002. The participants with works in astronomy were directed to the competition in physics.

International Astronomy Olympiad (IAO)

In 2002 prof. J. Milogradov-Turin, then the president of the Society of Astronomers of Serbia (SAS), initiated the participation of Serbia and Montenegro in the International Astronomical Olympiad (IAO). The training, testing and selection of the participants was made with a help of the Department of Astronomy of the University of Belgrade, the Astronomical Observatory of Belgrade, the AS "Rudjer Boškovic" and the Petnica Science Center. The both members of the senior team in 2002 won the third prizes (bronze medals) on the VII IAO. In 2004 Serbia and Montenegro participated in the IX International Astronomy Olympiad. Two members of the senior team won the second and the third prize.

In 2005 Serbia and Montenegro participated in the IAO for the first time with the junior team also. Three-member junior team and two-member senior team participated in October 2005 in the X IAO. Two juniors won bronze medals.

Acknowledgements. I would like to thank prof. Jelena Milogradov-Turin for useful comments that helped improve the manuscript. Also my thanks are due to Milan Jeličić for his valuable remarks.

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