

ASTRONOMY EDUCATION IN SERBIA 2005-2008

O. ATANACKOVIĆ

*Department of Astronomy, Faculty of Mathematics, University of Belgrade,
Studentski Trg 16, 11000 Belgrade, P.O.Box 550, Serbia
E-mail: olga@matf.bg.ac.yu*

Abstract. This paper is a review of triennial activities in astronomy education in Serbia at all levels. Special attention is paid to the reform of university education and the new European Credit Transfer System (ECTS), now implemented at all universities in Serbia. The re-introduction of astronomy as a compulsory course in secondary school curricula is announced. Due attention is given to the activities of numerous amateur astronomical societies in public astronomy education, as well as to the increasing success of Serbian team at the International Astronomy Olympiad over the past three years.

1. GENERAL INFORMATION

Astronomy is a part of the primary and secondary school curricula but neither as a separate nor as a compulsory subject. Astronomy is being taught as a separate course only at the Belgrade Mathematical High School and at seven high schools throughout Serbia.

However, within the current reform of primary and secondary school education, two important changes have been made. First, two astronomy lectures have been introduced as extra topics in the 7th year physics course curriculum. Second, after 17 years, astronomy is to be reintroduced in the 4th year of secondary schools as a separate and compulsory one hour per week course.

According to the act passed in September 2005 the new European Credit Transfer System (ECTS) is introduced at all universities in Serbia. At the University of Belgrade new study programs of Astronomy and Astrophysics were introduced starting from the 2006/2007 academic year. The model 4+1 for the bachelor and master degrees was accepted. Since 2002 the University of Novi Sad has introduced an astronomy study group simultaneously with a new "credit" system and the model 3+2. At the Universities of Niš, Kragujevac and Priština (in Kosovska Mitrovica), the fundamentals of astronomy and astrophysics are still being taught as a one-semester compulsory course for students of physics.

There is also an increased interest for astronomy among the general public. Four new amateur astronomical societies have been founded during the last three years, whereas one was closed. There are currently 17 amateur astronomical societies in Serbia.

This paper is a review of the present state of astronomy education in Serbia, with a special emphasis on the changes introduced from September 1, 2005 to November 1, 2008. The previous period was covered in papers by Atanacković-Vukmanović (2006a, 2006b) and by Milogradov-Turin (2002) and references therein.

2. PRIMARY SCHOOLS

Astronomy topics in primary schools are taught as topics in the courses of Natural History, Geography and Physics.

Within the current reform of primary school education, the following two astronomy topics have been introduced as the additional topics in the 7th year physics course: "Interesting things in astronomy" and "Kepler's laws and the Solar System".

3. SECONDARY SCHOOLS

From 1969 to 1990 astronomy in secondary schools was taught as a fourth year one hour per week course. After 1990 astronomy topics became incorporated with topics of fourth year physics courses. The only remaining schools where astronomy was taught as a separate fourth year course were the Belgrade Mathematical High School and seven other high schools throughout Serbia.

During the last three years many attempts have been made to reintroduce astronomy as a separate and compulsory subject. Within the current reform of secondary school education, it is proposed that astronomy should be reintroduced in the 4th year of secondary schools as a separate and compulsory one hour per week course.

At three regular annual meetings of physics and astronomy teachers within the last period three lectures (Ilić 2006, Urošević 2007, Kovačević 2008) and two poster presentations (Miler 2006, Vidojević and Šurlan 2006) on topics related to astronomy were given.

3. 1. INTERNATIONAL ASTRONOMY OLYMPIAD (IAO)

In 2002 Professor J. Milogradov-Turin (Milogradov-Turin 2003), then the president of the Society of Astronomers of Serbia (SAS), initiated the participation of Serbia and Montenegro in the International Astronomical Olympiad (IAO).

Members of the National Astronomical Olympic Committee (NAOC) did the training, testing and selection of the participants.

In 2006 Serbia participated at the XI IAO with a team consisting of two senior and three junior members winning two gold and two bronze medals as well as a special prize. Next year the team consisted of four senior and three junior members and each participant won a medal for a total of two gold, two silver and three bronze medals. Finally, in 2008, the team consisted of five senior and three junior members and won two silver and three bronze medals.

4. UNIVERSITY EDUCATION

Astronomy topics are taught at five state universities in Serbia (University of Belgrade, University of Novi Sad, University of Niš, University of Kragujevac and University of Priština in Kosovska Mitrovica).

In 2009 the Serbian university education in astronomy celebrates its 125 anniversary (in 1884 Milan Nedeljković was elected to be suplent for the courses of astronomy and meteorology of the Grand School).

(1) The University of Belgrade is still the only university with the Department of Astronomy (as part of the Faculty of Mathematics). Students can choose to major in Astronomy or in Astrophysics starting with the first study year. So far 240 students have graduated from the Department of Astronomy at the University of Belgrade, 66 students received MSc degrees and 31 students received PhD degrees. Out of all graduated students 44.6% are women. Within the last three years, 20 students graduated in Astrophysics and 3 in Astronomy (61% of the graduated students in the last three years are women). Two postgraduate students received their master degree, 10 students acquired MSc degrees and four students completed their PhD degrees. Each year in November the best student of the generation receives the "Prof. Zaharije Brkić" award.

At the Faculty of Mathematics of the University of Belgrade new study programs for Astronomy and Astrophysics that include the ECTS were introduced starting from the 2006/2007 academic year. The model 4+1 for the first two degrees (bachelor and master) is accepted. The PhD degree consists of compulsory and optional courses taken during the first two years of the PhD program and PhD thesis work starting in the third year.

Astronomy courses are also taught as: (1) a compulsory one-semester course "Fundamentals of Astrophysics" for the third-year students of the Faculty of Physics (physics teachers division), (2) a compulsory course "Geodetic Astronomy" (4th study year) at the Faculty of Civil Engineering and (3) a one-semester optional course "Fundamentals of Astronomy" for the fourth-year students of mathematics at the Faculty of Mathematics.

The Department of Astronomy continues to organize regular seminars on different topics in astronomy on every second Tuesday during the academic year. Seminars are also held on Wednesdays at the Astronomical Observatory in Belgrade.

(2) The Department of Physics of the Faculty of Natural Sciences at the University of Novi Sad founded an astronomy study group in the 2002/2003 academic year, introducing also the new European Credit Transfer System (ECTS). The model 3+1+1 was accepted. After 3 years of study students can get the diploma "Teacher of physics and astronomy", after 4 study years (240 ECTS) they receive the diploma of "Physicist - astronomer", whereas after 5 study years (300 ECTS) they receive the status of a "Graduated physicist - Master of physics and astronomy". So far 6 students have graduated from the Department of Physics at the University of Novi Sad - three students with the diploma "Teacher of physics and astronomy" and three with the diploma "Physicist - astronomer" (Prodanović 2008). New accredited studies have adopted the model 3+2 (180+120 ECTS).

(3) At the Institute of Physics at the Faculty of Natural Sciences of the University of Kragujevac there is a one-semester compulsory course, "Astrophysics and Astron-

omy”, for the third-year students of physics. These students use equipment (a Carl Zeiss Telescope 150/2250 and a 200/1000 Newton telescope) of the Astronomical Observatory that belongs to the Faculty. The Observatory is also open to the students of primary and secondary schools and interested citizens (Simić 2008).

(4) At the Department of Physics at the Faculty of Natural Sciences of the University of Niš there is a one-semester compulsory course, ”Fundamentals of Astrophysics”, at the third study year. According to new study programs at the undergraduate level of the ”General Physics” study group, a compulsory 2-hour per week course ”Fundamentals of Astrophysics” is to be taught during the fourth semester. At the PhD level, a 5-hour per week course ”Cosmic plasma” is anticipated. The Department of Physics also offers a laboratory in meteorology, astronomy and solar energetics. This department has a small 60mm refractor and a MEADE LX200 telescope, bought with funds from a project financed by the WUS Austria foundation in 2007.

A new optional course ”Fundamentals of astrophysics with astrobiology” (2+0+1) has been introduced at the third semester of undergraduate studies at the Department of Biology. There is a great interest among biology students for this subject. At the Department of Geography an optional 5-hour per week (3+2) course ”Astronomy” is offered to the second semester undergraduate students. Another compulsory course ”Mathematical Geography” contains a number of astronomical topics (Gajić 2008a).

(5) At the University of Priština in Kosovska Mitrovica a one-semester 2-hour per week course, ”Fundamentals of Astronomy and Astrophysics”, is taught to the second year students of physics.

In 2007 a university textbook ”Theoretical Bases of Radio-astronomy” by Dejan Urošević and Jelena Milogradov-Turin was published (Urošević and Milogradov-Turin 2007).

5. PUBLIC EDUCATION

Public astronomy education in Serbia is realized through various lectures, radio and TV programmes, popular journals and books, lectures in two Planetaria (Belgrade and Novi Sad), in public observatories, and by means of various activities (public observations of all major events, courses, conferences, schools and camps) of 17 amateur astronomical societies.

Within the last three years, four amateur societies were founded (”Univerzum” in Bačka Palanka, ”Orion” in Ivanjica, ”Milutin Milanković” in Pančevo and ”Aristarh” in Kragujevac), whereas the AS ”Belerofont” (”Bellerophon”), which was founded in August 1995 in Kragujevac, was closed.

5. 1. AMATEUR ASTRONOMICAL SOCIETIES

(1) The Astronomical Society (AS) ”Rudjer Bošković”, founded in 1934 in Belgrade, has about 700 members. The Society has seven types of activities: education, astronomical observations (amateur observations and work with public), publishing (astronomical review ”Vasiona” (”Universe”), proceedings of the conferences organized by the Society, posters, booklets), library (about 3500 books and journals), work with the Society’s members, information in media on various astronomical events and participation in special events (The Night of Museums, at national and international conferences, Book Fair, Festival of Science, International Year of Astronomy etc.). In

the last 3-years about 300000 people interested in astronomy participated in these programs (Stanić 2008).

The Society organizes "Astronomy courses for beginners" each autumn and spring (with 23-25 lectures per course). It organizes the Belgrade Astronomical Weekend (BAW) every June, covering various astronomical topics. It also organized a special topics meeting titled "Summer Astronomical Meetings" held at the end of August/beginning of September.

The Society organizes the Summer Schools of Astronomy, lasting 7 to 8 days. In 2006 and 2007 the Summer Schools of Astronomy were held on the mountain Golija ("Odvraćenica") and in 2008 on the mountain Kopaonik.

Associates of the AS "Ruđer Bošković" observed various celestial objects (Solar System bodies, stars, star clusters and nebulae). They also gave many lectures in Belgrade and other towns throughout Serbia.

The Society made regular announcements regarding important astronomical events via radio (Radio Belgrade), TV programs (TV Metropolis, Studio B) and newspapers ("Politika", "Novosti", etc.). In December 2007 Radio Belgrade became the main media sponsor of all activities concerning the organization of the International Year of Astronomy (IYA2009). The Society has an important role in several global projects related to the IYA2009. The web site of the Society is <http://www.adrb.org>.

(2) The Astronomical Group of the Organization of Young Researchers "Vladimir Mandić-Manda" from Valjevo (founded in 1973) has increased scope of its work (Milošević 2008, Božić 2008b). Every year they organized courses of astronomy for new members. Many lectures on the most recent events in astronomy were also given.

In 2007 members of the Astronomical Group completed two new projects: Summer and Winter astronomical activities aimed at direct popularization of astronomy. During 10 days in July, they organized observations of the Sun, Moon and Jupiter in the center of the city. Winter astronomical activities were organized as a School of Astronomy with one lecture per week running from December till March. These activities were mainly for the last-year primary-school students.

The Astronomical Group has only one ($F=700\text{mm}$) reflector that was used to observe all the important astronomical events: the partial solar eclipse on October 3, 2005; the total solar eclipse on March 29, 2006; the partial lunar eclipse on September 7, 2006; the occultation of Venus on June 18, 2007; the eruption on the comet 17P/Holmes on November 3, 2007 and the total lunar eclipse on February 21, 2008. The largest activity undertaken was a nine-member group expedition to Anthalya from 27 March until 2 April 2006 when they worked on the determination of contacts, changes in local magnetic field, atmospheric changes and astrophotography.

The members of the Group organized visual observations of meteor showers (Lirids (2007, 2008), Perseids (2005, 2006, 2007), Orionids (2006), Leonids(2006)) that lasted 3-7 days. The results of these observations have been sent to the International Meteor Organization.

During the last three years, the Astronomical Group cooperated successfully with other astronomical organizations in our country and from countries of south-eastern Europe. Since 2006 astronomers from Valjevo have become regular participants of the Letenka camp and BAV. For more details see the web site: <http://www.istrzivaci.org.yu>.

(3) The AS "Novi Sad" (ADNOS), founded in 1974, has about 200 members. Their planetarium (ZKP-1 of Carl Zeiss, Jena), is situated within the Petrovaradin fortress since 2001. It is used for lectures to secondary school students and the general public. In the last three years about 150 groups from primary and secondary schools and about 10000 people visited the Planetarium. Shows and lectures are organized in Planetarium for high school students from Novi Sad and for the university students of astronomy, physics and geography. During the last year a Thursday evening School of Astronomy (including lectures, projections and observations) was held for visitors. Visitors could use telescopes belonging to the Observatory. All major astronomical events were observed. The most recent equipment acquired consists of two reflectors (Meade LXD75 6" and LXD75 10"), and a Meade DeepSky CCD Imager. This equipment will be used by students and for research projects (Marjanović 2008).

The members of ADNOS participated regularly in the Astronomical Camp in Vršac, in the Messier marathon and Letenka Summer Camp, and in the Belgrade Astronomical Weekends. The Society took part in the popularization of astronomy through local TV and radio programs, newspapers and web portals. The web site of the Society is <http://www.adnos.org>.

(4) The AS "Alpha" in Niš (<http://alfa.org.rs>) has been active since April 1996. It has more than 150 members, mainly high-school and university students. During the last three years the AS "Alpha" organized about 15 lectures and public observations of major astronomical events (solar and lunar eclipses, etc.). Within the Project for the popularization of physics and natural sciences in the south and south-east Serbia" (the project leaders are: the Department of Physics at the Faculty of Natural Sciences, the Society of physicists of Serbia (the Department in Niš) and the AS "Alpha") since 2005 about twenty lectures have been given, half of which were dedicated to astronomy and astrophysics. In addition to that, lectures were presented in several other Serbian towns (Gajić 2008b).

(5) The AS "Milutin Milanković", founded in 1996 in Zrenjanin, has about 100 members. The members of the Society regularly participate in the Messier marathon and in the Astronomical camps on Fruška Gora mountain. The Society was also active in public astronomical education.

(6) The AS "Lira" ("Lyra") in Novi Sad has edited Internet magazine "Astronomical magazine" (<http://www.astronomija.co.rs>) since 1998. This is the largest astronomical web site in the country. Since 2003 the AS "Lira" also publishes the printed magazine "Astronomija" in cooperation with the Graphic studio "Spremo" from Novi Sad. So far 34 issues have been published.

Every year the AS "Lira" organizes the observation competition in the Messier marathon. The Society organizes astronomical camps "Letenka" (on Fruška Gora mountain) lasting three days. Participants come from Serbia, Macedonia, Bosnia and Herzegovina and Croatia. During each camp lectures were given, the observation competition was held and an exhibition of telescopes was organized, and astronomy related documentaries were shown.

(7) The Astronomical group within the Natural History Society "Gea", founded in 1999 in Vršac, organized the Astronomical Meetings of Vršac (AMV) every year from 2005 to 2008. These were the 5th, 6th, 7th and 8th AMV. Astronomical observations were performed by means of a CELESTRON 8 telescope. The Society "Gea" published annual bulletins (No.5 (2005), No.6 (2006) and No.7 (2007)). Thirty six

contributions (twenty four articles and twelve short reports/announcements) in the last three numbers were dedicated to astronomy (Lazarević 2008).

(8) The Society for Radio Astronomy Research "Aurora" was founded in December 2000 in Bor. Members of the Society observed radio reflections from meteor showers: Lirids, Perseids, Draconids, Taurids, Leonids, Geminids, delta Aurigids, Quadrantids (Disterlo 2008).

(9) The AS "Magelanov oblak" ("Magellanic Cloud") was founded in May 2001 in Prokuplje. It has about 80 members. Their main aim is to gather and educate amateur astronomers of the Toplica district. The Society possesses a 23 cm f/8 Newtonian reflector. The Society organized several seminars with lectures and the Assembly of the Society. The activities of the Society were also closely connected to the building of a new Astronomical Observatory on Vidojevica mountain near Prokuplje. For more details see the paper by Mijajlović et al. (2009) as well as the web site: <http://www.dorado.org.yu>.

(10) The Astronomical Society "Loznica" was founded in 2002 in Loznica. Their principal aim is public education (through local radio programs, lectures in secondary schools, regularly updated web presentation (<http://www.ad-loznica.org.yu>), etc.). The members of the AS "Loznica" possess several small telescopes - reflectors (150 mm in diameter) or refractors (D=75-100mm) and organize public observations of celestial objects and events.

(11) The AS "Andromeda" in Knjaževac was founded in December 2003. It has about 350 members. They have two telescopes with 60 mm and 200 mm mirrors. The Society organizes Autumn and Spring Schools of Astronomy at regular intervals. The 2nd Autumn School, dedicated to the Year of Physics, was held in November and December 2005. The 2nd Spring School (March - May 2006) was dedicated to the 150th anniversary of Nikola Tesla. Within this School an inter-regional quiz "Think like Tesla" was held in May 2006. Also organized were the 3rd Autumn school (October- November 2006), the 3rd Spring School (March - May 2007), the 4th Autumn School (October-December 2007), the 4th Spring School (April - May 2008) and the 5th Autumn School (October - November 2008) dedicated to the Solar System (Srejić 2008). The members of the Society "Andromeda" participated at the Summer schools of astronomy on Golija in 2006 and 2007 and on Kopaonik in 2008 (organized by the AS "Rudjer Boskovic", Belgrade). More details on the activities of the AS "Andromeda" can be found at: <http://www.andromeda.rs>.

(12) The AS "Novi Pazar" was founded in April 2004 in Novi Pazar. It has about 15 members. They have a TAL 200K telescope, ETX 60 Meade refractor and a 150mm-Newton reflector.

(13) The Center for Radio Astronomy "Tesla" was founded in November 2004 in Belgrade. It has about 15 members. The Center possesses three receivers, at 406.7 MHz, 1420 MHz and 40kHz that measure the solar radio flux.

(14) The AS "Univerzum" in Bačka Palanka was founded in 2006. It has about 20 members. Its goal is to establish astronomy clubs in primary and secondary schools. The members of the Society participated in the astronomical "Letenka" camps, the Belgrade Astronomy Weekends, the Astro-weekends in Vršac and Pančevo, Messier marathon, Star party and the ATM school in Croatia. In 2007 they won the Messier marathon as well as the Višnjani marathon competition in Croatia. "Univerzum" was the only astronomical society from Serbia that took part in the international

Sidewalk Astronomers events (in honour of John Dobson) in 2007 and 2008. They cooperate with the Astronomical magazine and the journal "Astronomy". Their website www.ad-univerzum.org.yu is under construction. The Society still has no equipment but uses personally owned equipment (300 mm f5 and 250 mm f3 hand made Newtonian telescopes, a Celestron ED 80 and EQ6 sky scan pro mount, a Skywatcher 150/750 on eq3 and a binocular TS 25x100). They have plans to mount a Newtonian telescope (402 mm in diameter) in their 3.5m dome by the end of 2008 (Mravik 2008).

(15) The AS "Orion" in Ivanjica was founded in 2007 and has 19 members. They took part in the Summer School of astronomy "Odvraćenica" in 2007. The society's emphasize is on educating the young members of the Society as well as the planning of practical research activities. The Society possesses one electronic and one manual 10-inch Dobsonian telescope. They plan to purchase a wood built house as their observatory, which will be located on a hill near the mountain Mucanj (Stojić 2008).

(16) The Astronomical Society "Milutin Milanković" in Pančevo was founded in 2007. It has 15 members. They have a Dobsonian telescope Sky Watcher (D=305 mm, F=1500 mm). The members participated in the astronomical "Letenka" camps, Messier marathons and Summer schools on the mountains Golija and Kopaonik. Several lectures in the organization of the AS "Milutin Milanković" were held in 2007 (Važić 2008). More about the Society can be found on the web site:

<http://ljevazic.googlepages.com>.

(17) The AS "Aristarh" in Kragujevac was founded in 2005. They have 5 active members. From their founding the Society had a Newtonian reflector with a Dobson mount (250 mm, f/5), a UHC-S Baader filter, a Philips ToU Pro II web camera and a notebook computer. Their usual observation site is 55 km from Kragujevac on the slopes of the Gledičke planine (850 m of altitude). In October 2006 the Society bought a 80 mm triplet APO refractor. Recently the Society obtained a Losmandy GM8 mount as well as an Orion (UK) photo-Newton 150/600 mm F4 with a coma corrector.

The common problem of all amateur societies is lack of adequate space, equipment and financial support. They usually succeed to survive thanks to enormous enthusiasm and the hard work of their members, often consisting of only a few people.

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

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

5. 2. PETNICA SCIENCE CENTER

Special emphasis should be put on the activities of the Petnica Science Center (PSC) for talented students interested in science (<http://www.psc.ac.yu>, www.ispast.net, <http://pi.petnica.rs>). The PSC organizes two cycles of seminars in astronomy: "Astronomy 1" and "Astronomy 2" (Božić 2008a). Each cycle consists of 4 seminars (winter, spring, summer and autumn) per year, lasting on average 7-8 days with about 25 participants. The cycle "Astronomy 1" is of educational character as it is intended for the participants attending the PSC astronomy seminar for the first time. The students learn about various astronomy related topics, observational techniques and methods in research, data analysis, the use of astronomical instruments

and data presentation. Participants of the second cycle "Astronomy 2" who have already took part in some of the PSC programs complete their independent observational/research projects. The seminars within the second cycle are intended to support their work. The best research projects are presented at the Conferences of the PSC participants "A step into science" (organized since 2002) each December and published in "Petničke sveske" ("Petnica notebooks"). Within the last three years the PSC published three issues of "Petničke sveske" with 12 papers related to astronomy (Jelisavčić 2006, Šišariva 2006, Darijević et al. 2007, Kološnjaji 2007, Obuljen and Knežević 2007, Ranković 2007, Tomić and Bobić 2007, Kološnjaji 2008, Cvijović and Radaković 2008, Radojević 2008, Savić 2008, Tomić and Jovanović 2008).

In November the PSC organizes a one-day seminars for primary school students from Valjevo. The PSC is also very active in the training of the Serbian team for the International Astronomy Olympiad, where it is responsible for the practical part of all training activities.

The participants and young collaborators of the PSC attend the International Meteor Conferences, Summer Schools of Astronomy in Višnjan (Croatia), Summer Schools "X Lab" in Germany, Weizmann Institute in Israel, etc.

The PSC organized observations of major astronomical events. In the last three years the Petnica meteor group organized about 15 camps and various observational activities. During 2007 the Astronomy program in the PSC acquired several new pieces of equipment: a telescope mounting "Paramount ME Robotic Telescope System", and two cameras for video observations of meteors.

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