

ASTRONOMY EDUCATION IN SERBIA 2017-2020

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Abstract. A review of triennial activities in astronomy education in Serbia at all levels is given with an emphasis put on considerable changes introduced within the reform of the primary and secondary school education, especially regarding the representation of Astronomy within Physics in high school teaching. The nomination and participation of Serbian NAEC team within the IAU Office of Astronomy for Education is described. Astronomy education at the universities in Serbia, and the numerous activities of the Department of Astronomy are considered as well.

1. INTRODUCTION

In this paper we give a brief overview of the news and changes in astronomy education in Serbia that occurred in the period from 1 November 2017 to 1 November 2020. The previous period was covered in triennial reviews of astronomy education in Serbia by Atanacković (2009, 2012, 2013, 2017, 2018), Arbutina and Atanacković (2019), Atanacković-Vukmanović (2006a,b) and Milogradov-Turin (2003), and in the references therein.

Some recent news concerning the founding of the International Astronomical Union (IAU) Office of Astronomy for Education (OAE) and the participation of the Serbian team will be described in Section 2. Sections 3 to 5 are devoted to the primary, secondary and university education, respectively. Public outreach is very briefly reviewed in Section 6.

2. THE OAE AND THE SERBIAN NAEC TEAM

Apart from three offices that already exist within the IAU Commission C1 on Astronomy Education and Development: Office for Young Astronomers (OYA, ISYA), Office for Astronomy Development (OAD) and Office for Astronomy Outreach (OAO), the fourth one - Office of Astronomy for Education (OAE) was founded in January 2020 with the aim to promote astronomy in education at school level all over the world. The OAE established a network of NAECs (National Astronomy Education Coordinators). The National Committee for Astronomy of Serbia nominated Serbian NAEC team: O. Atanacković (chair), D. Ilić (contact person), J. Kovačević-Dojčinović and B. Arbutina. So far 251 individual NAECs from 80 countries have been confirmed.

NAECs have submitted a brief review representing the structure of education in their country with the focus on Astronomy in the curriculum and Astronomy education outside the classroom.

From 6 to 9 October 2020 the OAE organized the IAU 2nd Shaw Workshop on Astronomy Education that was held online due to SARS-CoV-2 pandemic. The document "Big Ideas in Astronomy" was offered as a framework on what should any (18 years old) citizen of planet Earth know about Astronomy. The goal is that everyone should be astronomically literate. This framework is supposed to be further developed with the help of NAECs. All of the material created: textbooks, glossary, diagrams, images (a kind of astroEDU data base) will be available under the licence that allows it to be used universally in teaching.

Serbian NAEC team took part in The Astronomy Day in Schools¹, which in 2020 was on the day of the Total Solar Eclipse of December 14. Any amateur or professional astronomer, scientist or teacher was invited to participate. Although this event was visible only on the southern hemisphere, marking and following this event was a unique opportunity for students around the world to participate together in this beautiful natural phenomenon on that specific day as well as to learn something more about the eclipses. Elementary and high-school teachers in Serbia were invited to work with their students on the topics of Solar eclipse. The materials in Serbian were provided: a short video/lecture about eclipse events "Šta su pomračenja?" posted online at <https://youtu.be/OOnST-49tZs>, and a little game to illustrate the moon phases that can be used in the future. The information on the Great conjunction of Jupiter and Saturn on December 28 was shared as well.

3. PRIMARY SCHOOL EDUCATION

In the primary school curricula astronomy topics are mostly taught as part of the Geography course (5th grade). The pupils learn about the Milky Way, stars, the Sun and Solar system, Earth's rotation and revolution and the consequences, the Moon and lunar phases, Earth's atmosphere and climate changes. Additional topics are taught in astronomy clubs organized by the enthusiastic teachers of physics, mathematics or geography.

In the last triennial report (Atanacković, 2018) we wrote about an initiative and the first activities undertaken by the Department of Astronomy to introduce Astronomy as a separate elective course in primary schools. However, according to the most recent reform there will be no more elective courses in primary schools.

4. SECONDARY SCHOOL EDUCATION

As of recently, according to the decision of the National Education Council and Minister of Education, the number of hours of Physics has been reduced from 5 to 3+1 per week². Accordingly, the number of hours of Astronomy within Physics has also been drastically reduced from 32 to 6+2 per year.

¹The Astronomy Day in Schools initiative is an IAU100 Global Project with the vision of mobilising the astronomical community to organise activities in schools. This is a special opportunity for students to directly interact and engage with astronomers in their communities, and to learn about the significant role that astronomy plays in our lives.

²3 hours of lectures + 1 hour of laboratory exercise.

In 1990, astronomy topics were incorporated in the 4th year Physics course with 32 class hours per year (one hour per week)³. Students were taught about gravity, coordinate systems in astronomy, time, distances to celestial bodies, physical processes, radiation, astronomical instruments, Sun and Solar system, stars, galaxies and cosmology. Today, only a few special schools in Serbia (e.g. Mathematical High School in Belgrade, "Jovan Jovanović Zmaj" in Novi Sad, "Svetozar Marković" in Niš) have astronomy as a separate subject. Despite many attempts made by the Serbian astronomical community to reintroduce Astronomy as a separate and compulsory course in all grammar schools, Astronomy is still taught within Physics. To make things even worse, by the decision of the National Education Council, the number of hours of Astronomy within Physics is reduced. The program is now as follows:

- Introduction to astronomy and its basic terms (2)
- Gravitational effects (1)
- Electromagnetic radiation of celestial bodies and astronomical instruments (1)
- Stars and galaxies (1+1)
- The Sun and the Solar system (1+1)

4. 1. TEACHER TRAINING

The Serbian Physical Society organizes annual meetings of physics and astronomy teachers where teachers are acquainted with the latest discoveries and news in astronomy.⁴ International seminars for physics teachers have been organized since 2012 as well. A regular session dedicated to astronomy education is included in the program of triennial Serbian Astronomical Conferences (see, e.g. Stojičić 2021). The Commission for astronomy education within the Society of Astronomers of Serbia intends to apply for the organization of seminars in astronomy to help physics teachers to teach astronomy topics. The call of the Institute for the Advancement of Education and Upbringing is expected to be announced in 2021.

4. 2. PETNICA SCIENCE CENTER (PSC)

Petnica Science Center (founded in 1982) has a very important role in extracurricular (informal) astronomy education of the gifted secondary-school students. The program of astronomy in PSC includes 6-7 seminars per year. The main concept of PSC is learning through research. Research projects realized by the participants in the most advanced group are presented at the annual conferences "A Step into Science" and regularly published in "Petnica Notebooks". The activities of PSC in the past three years are described in more detail in the paper by Vukadinović et al. (2021). Let us mention here only two summer schools for students ("Petnica Summer Institute" - PSI) that were held in the past three years: the 6th Summer School on High Energy Physics (12-21 July 2018) and the 7th Summer School on Astrophysics (25 July - 3 August 2019). In 2020 the 8th Summer School was not organized due to SARS-CoV-2 pandemic.

³For 25 years (from 1969 to 1994) astronomy was taught in the 4th year of grammar schools as a separate course with one class hour per week.

⁴A comprehensive review on astronomy in seminars for teachers in Serbia (independent astronomical seminars and astronomy at seminars for physics teachers) in the period 1964-1997 is given by Milogradov-Turin (1997).

4. 3. INTERNATIONAL ASTRONOMY OLYMPIAD

Since 2002 Serbian teams have participated with success in the following International Astronomical Olympiads⁵:

- since 2002 at IAO (International Astronomy Olympiad, founded in Russia in 1996),
- since 2009 at IOAA (International Olympiad on Astronomy and Astrophysics, founded on the initiative of Thailand, Indonesia, Iran, China and Poland in 2007),
- since 2013 in the Saint-Petersburg Astronomical Olympiad, which represents the correspondence type competition.

In 2020 GeCAA (Global e-Competition on Astronomy and Astrophysics), an on-line astronomy and astrophysics competition was held instead of the IOAA due to SARS-CoV-2 pandemic.

So far Serbian teams have won 78 medals and 21 recognitions in total, out of which 12 medals and 5 recognitions in the past three years. The success of Serbian team in the period 2017-2020 is described in more detail in the paper by Vidojević et al. (2021).

Main coordinators and leaders of Serbian teams in the past years are Dr. Sonja Vidojević and Prof. Slobodan Ninković.

A new book "Astronomski zabavnik: zadaci i vežbe iz astronomije i astrofizike" has been published (Vidojević, 2019). It is a translation by Sonja Vidojević of the Russian book "Astronomicheskij divertisment. Zadachi i uprazhnenija po astronomii i astrofizike".

At the assembly held on 16 April 2019 the Society of Astronomers of Serbia decided by a majority vote to withdraw its candidacy for the organizer of the International Astronomical Olympics 2021 in Serbia, due to the financial difficulties and uncertain funding.⁶ The withdrawal was sent to the International Olympic Committee (see Vidojević et al., 2021).

5. UNIVERSITY EDUCATION

Astronomy courses are taught at six state universities (University of Belgrade, University of Novi Sad, University of Niš, University of Kragujevac, University of Priština in Kosovska Mitrovica and State University of Novi Pazar).

The University of Belgrade is the only one with the Department of Astronomy (at the Faculty of Mathematics, MATF) where students can major in astronomy from the first study year. The structure of the last accredited study program at the Department of Astronomy (2014) is described in the paper by Atanacković (2018), along with all the courses in astronomy taught at the Faculty of Mathematics for the students of mathematics and informatics and at other faculties within the University of Belgrade (Faculty of Physics, Faculty of Civil Engineering, Faculty of Geography). Previous study programs (in Serbian) at the Department of Astronomy can be found at the Department's website <http://astro.math.rs>.

⁵Prof. Jelena Milogradov Turin (1935-2011) initiated in 2002 the participation of Serbian team at the IAOs. In 2011 "Jelena Milogradov-Turin" award is introduced.

⁶In 2013, at the 7th IOAA, Serbia was nominated as the host for 15th IOAA in 2021 (see Atanacković, 2018; Vidojević et al., 2018).

So far 307 students have graduated from the Department of Astronomy at the University of Belgrade (since 1936), 45 students received Master degree (since 2007), 69 students received MSc degree (1968-2010), and 61 students - PhD degree (since 1958). In the past three years, 10 students graduated, 9 students received master degrees and 5 students received PhD degrees, which is much fewer than in the previous triennial period (Atanacković, 2018).

The best students in their generation won the "Prof. Zaharije Brkić" award: Ivana Bešlić (2016/2017), Andrija Kostić (2017/2018) and Milica Rakić (2019/2020).

AstroMundus, a 2-year European Erasmus Mundus Joint Master program in astronomy and astrophysics between 5 European universities, formally ended in January 2020 (Ilić, 2020). AstroMundus program is described in more detail in the paper by Atanacković (2018).

The students had summer practice - training in observations and data reduction at the Ondřejov Observatory in 2018 (Nikolina Milanović and Marija Obućina), and in 2019 (Sara Savić and Lazar Živadinović). They worked under the supervision of Czech colleagues (Marčeta, 2020).

Three summer students' practices lasting 3 days have been organized at the Astronomical Station Vidojevica (ASV): in April 2018 (3 students), in April 2019 (9 students) and in May 2020 (10 students). The last one was organized completely virtually. Students were trained to use the reflectors "Nedeljković" ($D = 60$ cm) and "Milanković" ($D = 140$ cm).

Two Student Astronomy Workshops (SAW) were held in the past three years: the 10th SAW on 18 November 2017 in Novi Sad (37 students) and the 11th SAW on 2 November 2019 in Belgrade (38 students).

The first students' practice at the Rozhen Observatory was held from 27 February to 4 March 2020. This student training was conducted within the project SUPERAST (Supercomputing astronomy) led by Andjelka Kovačević (2019-2020). Coordinators of the practice were Nikola Petrov (deputy-director of NAO Rozhen), Bojan Arbutina, Dragana Ilić, Dejan Urošević and Stanislav Milošević (MATF). The students (Sara Savić, Nikolina Milanović, Jana Marković, Isidora Jankov and Teodora Žižak) observed emission nebulae.

In the past three years 33 seminars on different topics in astronomy were held on every second Tuesday throughout the academic year at the Department of Astronomy, whereas 33 seminars were held at the Astronomical Observatory in Belgrade.

In this triennial period two new university textbooks were published: "Evolution of supernova remnants" by Bojan Arbutina and "Odabrani tekstovi iz astronomije" ("Selected texts in astronomy") by Mihailo Martinović and Stevo Šegan (Arbutina, 2017; Martinović and Šegan, 2018).

The activities of the Department of Astronomy at the Faculty of Mathematics in Belgrade in the period 1999-2020 are described in the paper by Arbutina et al. (2021).

At the Department of Physics of the Faculty of Natural Sciences (FNS) at the University of Novi Sad eighteen students enrolled in the bachelor programme in Astronomy and astrophysics in 2017/2018, 8 out of which are still studying astronomy. Two students received the Master degree in 2018.

New accredited studies at this department started in 2018/2019. Eleven optional courses in astronomy and astrophysics are offered at the undergraduate studies in

Physics. "Fundamentals of the Solar System" in the 1st study year was elected by 13 students in 2018/2019, by 10 students in 2019/2020 and 12 students in 2020/2021. Two students in 2019/20 and two students in 2020/21 chose "General astronomy" in the 2nd year, whereas one student of the 3rd year chose "General astrophysics" (Prodanović, 2020).

Master studies have also been newly accredited and are focused on High energy astrophysics.

Astro CEEPUS (Central European Exchange Program for University Studies) program, which initiated basically from the University of Novi Sad resulted in international astronomy student conference. The participants of the first regional students workshop "Multi-messenger Astrophysics in Central Europe (ASTRO.CE)", held in Nova Gorica from 13 to 15 May 2019 were from the universities of Banja Luka, Belgrade, Novi Sad, Rijeka and Skopje. The participants from Serbia were Tijana Prodanović, Dragana Ilić, Dejan Urošević, Dušan Onić, Stanislav Milošević, as well as students from Belgrade (Nikolina Milanović, Debora Pavela, Miljan Kolčić, Damnjan Milić, Milica Rakić, Teodora Žižak, Jana Marković, Milana Vuković) and Novi Sad (Marina Pavlović, Isidora Jankov, Nikola Radulović). All the participants gave lectures.

At the University of Niš astronomy, astrophysics and cosmology are taught at the Department of Physics. "Fundamentals of Astrophysics" is the compulsory course for the students of General Physics (2nd year) and elective for the students of Physics - Informatics (1st year). "Introduction to Cosmology" is elective at the 3rd study year, and "Cosmic plasma" and "Fundamentals of cosmology" are elective at the PhD studies. Astronomy is also taught at the master studies at the Department of Biology ("Fundamentals of astrophysics with astrobiology", elective, 1st year) and at the Department of Geography ("Astronomy", elective, 1st year). Several changes are foreseen in the curricula starting from 2021/2022 (Gajić, 2020).

At the Institute of Physics of the Faculty of Natural Sciences of the University of Kragujevac one-semester (2+2) course "Astrophysics and Astronomy" for the 5th-year (master) students, so far optional, became a compulsory course for the module A1 (General physics) according to the new accreditation, while it remained optional for other modules. Prof. Saša Simić is leading the project "Digitalization of Astronomy Teaching" supported by the Ministry for Education of the Republic of Serbia and intended for the development of university education (Simić, 2020).

At the University of Priština in Kosovska Mitrovica a one-semester (2+0) compulsory course, "Fundamentals of astronomy and astrophysics", is taught in the 3rd semester to the students of physics. According to the new accreditation foreseen to start in October 2021, this course will be optional and it will be taught in the 6th semester with 2+2 hours per week (Gulan, 2021). At the Department of Geography at the FNS in Kosovska Mitrovica, a course "Mathematical geography" (2+2) included a lot of astronomical topics (Valjarević, 2021).

During the past five years a one-semester course in astronomy/astrophysics (2+2) was taught at the Department of Physics, Mathematics and Informatics at the State University of Novi Pazar. From 2014/15 to 2016/17 this course was taught to the third year undergraduate students (Mijajlović, 2021), whereas from 2017/18 to 2018/19 this course was transferred to master degree and taught as "Introduction to Astronomy and Astrophysics" (Šegan, 2021).

6. PUBLIC OUTREACH

Public astronomy education in Serbia was realized through many lectures held in: Ilija Kolarac Foundation, Belgrade Youth Center, Students Cultural Center, Serbian Academy of Sciences and Arts, astronomy seminars in Belgrade and Novi Sad, lectures in Planetaria (Belgrade and Novi Sad) and in public observatories, online videos, podcasts, TV series "Svemir na Zemlji", lectures during special events (Festival of Science, Researchers' Night, International Day of Light, Night of Museums, Book Fair, etc.), on radio programmes, in popular journals and books. Public outreach is also realized through various activities of 24 amateur astronomical societies. A detailed review of their activities is given in the paper by Atanacković (2009). Many activities were organized in 2019 during the global celebration of 100 years of the IAU (IAU100), e.g. mini-exhibitions "Above and Beyond", in Belgrade within the Researchers' Night in September, and in Kruševac in November 2019, as well as the NameExoWorlds contest in which Serbia has voted to name the star WASP-60 Morava and its planet WASP-60b Vlasina.

Carpe Noctem association gathers astronomy, physics and geography students and researchers in a joint effort directed at preserving the night sky. Since 2019 Carpe Noctem has the ongoing project Ecological Supernova funded by the Center for the Promotion of Science with the goal of educating about the light pollution and as a part of that has organized many educational activities in astronomy under the open skies such as Astro Walks and Star Triahtlon. They also have very successful cooperation with and have been recognized by the International Dark-Sky Association (Prodanović, 2021).

In July 2020 Monika Jurković replaced Tijana Prodanović as the IAU OAO National Outreach Coordinator (NOC).

7. CONCLUSIONS

In this paper we gave a brief overview of triennial activities in astronomy education in Serbia at all levels, including also the public outreach. Future prospects and plans for the astronomy education in Serbia should include: a larger representation of astronomical content in other subjects such as physics, mathematics, geography, both in elementary and high school teaching, organization of seminars in astronomy for teachers, an agreement with the authorities on the reintroduction of Astronomy in the curricula as a separate subject, larger presence in media and better coverage of astronomical events.

References

- Arbutina, B.: 2017, *Evolution of supernova remnants, Publ. Astron. Obs. Belgrade*, **97**, 1–92.
- Arbutina, B., Atanacković, O.: 2019, Astronomy in Serbia and Serbia in the International Astronomical Union, *Proceedings of the International Astronomical Union*, **349**, 248.
- Arbutina, B., Atanacković, O., Kovačević, A.: 2021, Department of Astronomy at the Faculty of Mathematics University of Belgrade in the period 1999-2020, *Publ. Astron. Obs. Belgrade*, this volume.
- Atanacković-Vukmanović, O.: 2006a, Astronomy Education in Serbia and Montenegro 2002-2005, *Publ. Astron. Obs. Belgrade*, **80**, 275–283.

- Atanacković-Vukmanović, O.: 2006b, Astronomy in Serbia and in Montenegro, in IAU Spec. Session No.5, Eds. J.B. Hearnshaw and P. Martinez.
- Atanacković, O.: 2009, Astronomy Education in Serbia 2005-2008, *Publ. Astron. Obs. Belgrade*, **86**, 231–240.
- Atanacković, O.: 2012, Astronomy Education in Serbia 2008-2011, *Publ. Astron. Obs. Belgrade*, **91**, 273–284.
- Atanacković, O.: 2013, Astronomy education and popularization in Serbia, *Publ. Astron. Obs. Belgrade*, **92**, 107–112.
- Atanacković, O.: 2017, Astronomy Education in Serbia 2011-2014, *Publ. Astron. Obs. Belgrade*, **96**, 397–405.
- Atanacković, O.: 2018, Astronomy Education in Serbia 2014-2017, *Publ. Astron. Obs. Belgrade*, **98**, 91–99.
- Gajić, D.: 2020, Report on Astronomy Education at the University of Niš.
- Gulan, Lj.: 2021, Report on Astronomy Education at the University of Priština in Kosovska Mitrovica.
- Ilić, D.: 2020, Report on students practices at AS Vidojevica, Student Astronomy Workshops (SAW) and master program Astromundus.
- Marčeta, D.: 2020, Report on students practices at Ondřejov Observatory.
- Martinović, M., Šegan, S.: 2018, *Odabrani tekstovi iz astronomije*, Faculty of Mathematics, Belgrade (ISBN 978-86-7589-128-4).
- Mijajlović, Ž.: 2021, Report on Astronomy Education at the State University of Novi Pazar.
- Milogradov-Turin, J.: 1997, Astronomija na seminarima za nastavnike u Srbiji, *Publ. Astron. Obs. Belgrade*, **56**, 229–247.
- Milogradov-Turin, J.: 2003, Astronomy education in FR Yugoslavia 1999-2002, *Publ. Astron. Obs. Belgrade*, **75**, 313–318.
- Prodanović, T.: 2020, Report on Astronomy Education at the University of Novi Sad.
- Simić, S.: 2020, Report on Astronomy Education at the University of Kragujevac.
- Šegan, S.: 2021, Report on Astronomy Education at the State University of Novi Pazar.
- Stojičić, B.: 2021, Zašto je važno izučavanje astronomije u toku srednjoškolskog obrazovanja?, *Publ. Astron. Obs. Belgrade*, this volume.
- Valjarević, A.: 2021, Report on Astronomy Education at the University of Priština in Kosovska Mitrovica.
- Vidojević, S., Ninković, S., Simonović B., Bešlić, I.: 2018, Astronomy Competitions and their Role in Astronomy Education in Serbia, *Publ. Astron. Obs. Belgrade*, **98**, 217.
- Vidojević, S.: 2019, *Astronomski zabavnik: zadaci i vežbe iz astronomije i astrofizike*, Beograd, Društvo astronomia Srbije, translation from Russian of the book "Astronomicheskij divertiment. Zadachi i uprazhnenija po astronomii i astrofizike" (Redaction: I. A. Utesheva . - Moskva : OOO "Sam Poligrafist", 2018. - pp. 154 ISBN 978-5-00077-697-1).
- Vidojević, S., Prokić, V., Ninković, S., Simonović, B.: 2021, Serbia in astronomical contests between 2017-2020, *Publ. Astron. Obs. Belgrade*, this volume.
- Vukadinović, D., Milanović, N., Milošević, S., Bošković, M., Božić, N.: 2021, Department of Astronomy at Petnica Science Center: 2018-2020, *Publ. Astron. Obs. Belgrade*, this volume.