










ASTRONOMY EDUCATION IN SERBIA 2020-2023

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Abstract. Within this contribution we aim to present a review of triennial activities in astronomy education in Serbia at all levels: the astronomy education at the universities in Serbia, especially the activities at the University of Belgrade - Faculty of Mathematics, Department of Astronomy; the astronomy education within secondary schools and the activities of the Society of Astronomers of Serbia in astronomy education, such as the teacher's training, organized by the IAU NAEC Serbia.

1. INTRODUCTION

In this paper we give a brief overview of the activities in astronomy education in Serbia, that occurred in the period from November 2020 to November 2023. The previous periods were covered in triennial reviews of astronomy education in Serbia by Atanacković (2009, 2012, 2013, 2017, 2018), Atanacković and Arbutina (2021) and in the references therein (see also Arbutina and Atanacković 2019). We will outline main characteristics of the primary and secondary school education, as well as university education (Sections 2 and 3). Finally, we will present the activities of the Serbian National astronomical education coordinators - NAEC team¹ in more details in Section 4.

2. PRIMARY AND SECONDARY SCHOOL EDUCATION

Since the last report on astronomy education (Atanacković and Arbutina 2021), there have not been any changes in primary and secondary levels of education. In primary school, astronomy topics are mentioned in 4th grade, and in 5th grade, within the scope of Geography subject. In secondary school, astronomy topics are thought within the scope of subject of Physics, at 4th grade of Gymnasiums, and only 8 classes per year are devoted to astronomy. Only a few special schools in Serbia (e.g. Mathematical High School in Belgrade, "Jovan Jovanović Zmaj" in Novi

¹<https://astro.matf.bg.ac.rs/naec/>

Sad, "Svetozar Marković" in Niš and Zemun Gymnasium, which have specialized departments for pupils talented in physics) have astronomy as a separate subject in the 4th grade (two classes per week). In the previous period this subject named Basics of Astrophysics and Astronomy was taught in gymnasium "Jovan Jovanović Zmaj" by Tijana Prodanović and Marina Pavlović, and in the Zemun Gymnasium by personnel from Department of Astronomy, Faculty of Mathematics: Dragana Ilić, Stanislav Milošević, Milica Vučetić and Bojan Arbutina.

3. UNIVERSITY EDUCATION

Here we outline the astronomy education on the highest level. In subsection 3.1. we will focus on activities at the Department of Astronomy of the University of Belgrade - Faculty of Mathematics (further in the text denoted as MATF), subsection 3.2 is dedicated to the international joint study programme, whereas in subsection 3.3. we will briefly mention activities at other universities.

3. 1. UNIVERSITY OF BELGRADE

MATF is the only high-education institution in Serbia with the Department of Astronomy, where students start their education in astronomy from the first year of studies. Astronomy courses are also taught at other five state universities (University of Novi Sad, University of Kragujevac, University of Niš, University of Priština in Kosovska Mitrovica and State University of Novi Pazar), predominantly as optional courses.

The ongoing studies of astronomy and astrophysics at MATF were accredited in 2022, and its structure can be found at the Department's website <http://astro.math.rs>. The structure of the previously accredited study program at the Department of Astronomy (2014) is described in the paper by Atanacković (2018). In the past three years, 19 students graduated, 4 students received master degrees and 7 students received PhD degrees, which is an increase in the number of graduated students with respect to the previous triennial period (Atanacković and Arbutina 2021).

Three best students in their generation won the "Prof. Zaharije Brkić" award in the past three years: Milica Rakić (generation 2019/2020), Mara Čutura and Teodor Kostić (generation 2022/2023). Regular student trainings on optical telescopes ("Studentska Vidojevačka Astronomska Praksa – S VAP) have been organized. In the last period three trainings were organized, 10-13th SVAP. In 2021, due to the Covid-19 pandemic, training was held online (Figure 1), while 11th and 12th students' practices were held at the Astronomical Station Vidojevica (ASV). Students were trained to use the reflectors "Nedeljković" ($D = 60$ cm) and "Milanković" ($D = 140$ cm). After a two-year pause, Student Astronomy Workshop (SAW) - where student present their projects, and practise presentation skills, was held on 22nd of April, 2023, at the Astronomical Observatory of Belgrade (AOB). The SAW participants were students of MATF and Department of Physics from University of Novi Sad.

In the period that we are covering, Department of Astronomy and AOB organized summer internship for students of third and fourth year of studies. Coordinators of these internships were prof. Dragana Ilić (MATF) and dr Marko Stalevski (AOB). Internship is intended to be in the form of research project, lasting for 3 to 6 weeks over summer, and in the new accreditation, it will be mandatory and part of curriculum for master students and students of last year of bachelor studies.

As part of extracurricular activities at the Department of Astronomy, observations of partial solar eclipse on 25th of October 2022 were organized from Observatory of Astronomical Society Rudjer Bošković at Kalemegdan fortress.

3. 2. ERASMUS+ MASTER PROGRAM

Since 2022, the Erasmus Mundus Joint Master program in Astrophysics and Space Science - MASS² is jointly delivered by a Consortium of four Universities: University of Rome "Tor Vergata", Italy, University of Belgrade, University of Bremen, Germany, and University of Côte d'Azur, France. It is funded by European Union (EU) and its granting authority European Education and Culture Executive Agency (EACEA) for the period 2022 – 2027, supporting the first 4 editions of students. MASS will aim to secure funding beyond the EU support. The coordinator of MASS project is prof. dr Nicola Vittorio, the University of Rome "Tor Vergata", and the local project coordinator for the University of Belgrade is prof. dr Dragana Ilić.

MASS is an intersectoral, research-oriented Master program, covering state-of-the-art research in six main pillars: Gravitation and Cosmology, Stellar Astrophysics, Exoplanets, Astrophysical Techniques, Astrostatistics and Big Data, and Space Science. MASS allows its students to move among the four Consortium Universities to be exposed to different aspects of modern astrophysics. Within the first edition University of Belgrade was attended by 10 out of 13 enrolled students.

3. 3. OTHER STATE UNIVERSITIES AND FACULTIES

At the University of Belgrade - Faculty of Physics, we have an optional course in Astrophysics (2+2) in the first year of theoretical physics, and in the Master studies in general physics. At the Institute of Physics of the Faculty of Natural Sciences, University of Kragujevac, astronomy is thought as one-semester (2+2) course "Astrophysics and Astronomy". This course is part of Master studies and it became a compulsory course for the module A1 (General physics) according to the new accreditation, while it remained optional for other modules. At the University of Priština in Kosovska Mitrovica a one-semester (2+2) optional course "Fundamentals of astronomy and astrophysics" is taught to the students of physics. At University of Novi Sad astronomy is thought among several optional courses. At the University of Niš astronomy, astrophysics and cosmology are taught at the Department of Physics. "Introduction to Cosmology" is elective course at bachelor studies. At Master studies "Astrophysics" is compulsory course for future professors of physics, while "Stars and stellar systems" and "Basics of Astrophysics" are elective courses. "Cosmology" and "Numerical cosmology" are elective at the PhD level. From this year, Department of Biology at University of Belgrade has a module Astrobiology at master studies.

4. ACTIVITIES OF NAEC SERBIA

NAEC teams provide a link between their national astronomy education community, the Office of Astronomy for Education (OAE) and the International Astronomical Union (IAU). OAE gathers (so far) 397 NAECs, representing 112 countries and territories. Members of NEAC team Serbia are dr Dragana Ilić (Chair of NAEC team),

²<https://www.master-mass.eu>

dr Milica Vučetić, dr Bojan Arbutina, dr Marina Pavlović, and dr Jelena Kovačević-Dojčinović. NAEC team is also a part of the Committee for education of the Society of Astronomers of Serbia. Other members of Committee for education are dr Stanislav Milošević, dr Zorica Cvetković, dr Tijana Prodanović and Biljana Stojčić.

Main goals of NAEC team Serbia are cooperation with schools and professors interested in astronomy topics (mainly professors of physics, geography, etc), organization of teacher's trainings, exchange of information, materials and calls for projects through cooperation with OAE and other IAU offices. NAEC team also organises outreach activities.

4. 1. TEACHERS TRAINING 2021

This training was the first seminar on astronomical topics organized after more than 20 years. In previous period, astronomers took part in seminars organized by Society of physicists of Serbia. Seminar intended for teachers of physics, mathematics, geography and computer science, as well as all other interested teachers, was held on-line in December 2021. This seminar was approved by the National body for education³ as 8-hours webinar. Lecturers and topics which they presented on this training were:

- dr Zorica Cvetković "The celestial sphere, its elements and spherical coordinate systems",
- prof. dr Tijana Prodanović "The apparent motion of the Sun and the Moon, and their consequences",
- Stanislav Milošević "Gravity and motion of celestial bodies",
- prof. dr Olga Atanacković "Electromagnetic radiation of celestial bodies",
- prof. dr Luka Č. Popović "Astronomical instruments",
- prof. dr Bojan Arbutina "Stars and the Milky Way",
- dr Jelena Kovačević-Dojčinović "Extragalactic astronomy and cosmology",
- dr Bojan Novaković "Sun and Solar system".

Moderators of webinar were dr Milica Vučetić and dr Monika Jurković.

Training had 37 participants. They gave very positive feedback and were supportive for further trainings. Suggestions for further trainings were in favour of shorter, in-person meetings, with more practical, hands-on sessions.

4. 2. TEACHERS TRAINING 2022

This training was held in-person at the Faculty of Mathematics in Belgrade in October 2022. It was entitled "Modern methods of teaching astronomy"⁴, and was accredited as 5-hour professional meeting. The meeting had three 40-minute lectures, and two 1-hour workshops:

- dr Nataša Todorović "Solar sistem",
- dr Monika Jurković "Stellar Evolution",
- dr Ivan Milić "Black holes in the universe".
- dr Tijana Prodanović "Digital media in teaching",
- dr Marina Pavlović "Using Stellarium in teaching astronomy".

This meeting had 15 participants, which was twice less than for the previous webinar, but that was expected. Nevertheless, participants preferred in-person training, since it has elements of more direct discussion and exchange of experience with

³<https://zuov.gov.rs/>

⁴https://poincare.matf.bg.ac.rs/~mandjelic/naec/seminar_2022/index.html

colleagues and lecturers. Teachers emphasize that astronomy topics are extremely interesting for pupils and that it should be used for the development of the research spirit among pupils. For future meetings, their expectations were to get more precise information about the teaching materials, photos and videos in Serbian language, as well as interesting practical projects – such as those shown in Stellarium software.

4. 3. ASTROPHOTOGRAPHY CONTEST

NAEC Serbia organized very successful competition on Astrophotography with a mobile device for high-school and elementary-school students entitled "Take a photo of night sky"⁵. Competition had an aim to be inclusive, as everyone who have even a very modest smartphone could participate with provided training and knowledge, which was available to all. Competition gathered almost 200 registered teams, which consisted of in total almost 1400 pupils and around 150 school teachers. Announcement of winners and award ceremony, which was held at AOB in April 2023. Best three teams won telescopes for their schools. First 15 photos were presented at the exhibition opened in the hall of Great refractor of AOB. For more details, see Pavlović et al. (2024).

5. SUMMARY

In this paper we gave a brief overview of triennial activities in astronomy education in Serbia at all levels, including outreach activity in form of Astrophotography contest. Future plans for the astronomy education in Serbia are continuation of annual meetings for teachers, leading to a larger representation of astronomical content in subjects such as physics, mathematics, geography, both in elementary and high school teaching.

Acknowledgements

Authors acknowledge funding provided by the University of Belgrade – Faculty of Mathematics through the grant by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia (the contracts № 451-03-66/2024-03/200104, № 451-03-66/2024-03/200002 and № 451-03-66/2024-03).

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⁵<https://sites.google.com/view/uslikajnocnonebo/home>