

## PROJECT OF FIRST URBAN ASTRONOMICAL OBSERVATORY IN KRUŠEVAC

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**Abstract.** Since 2010, the astronomical society "Eureka" has been actively working on the promotion of astronomy in Kruševac and Serbia. It carries out numerous activities, among which, in addition to citizen science projects and lectures, are astronomical observations. In 2022, the society managed to accomplish the most important project since its founding, which is the construction of the "Šarengrad" astronomical observatory in the area of the "Šarengrad" amusement park. An year of work has passed since its opening, which is an excellent opportunity for analysis and further improvement of the work. In this paper, we shall present the results of our work in the past year including the citizen science projects and promotion of astronomy in general, along with the brief description of the project that led to the build-up of the first urban observatory in Kruševac with its implementation.

### 1. INTRODUCTION

Astronomical Society (AS) "Eureka" was founded in 2010 with the aim of promoting astronomy and related sciences in Kruševac. Over time, the activities of the association expanded, and in addition to the organization of public lectures and observations, the association began to organize workshops and projects supported by a large number of organizations. One of the most successful activities of the association is certainly the organization of the astronomy camp on Jastrebac, which was held for the seventh time in 2023. This camp was supported years ago by the city of Kruševac, Mensa Serbia, and the Tourist Organization of the city of Kruševac and the Center for Professional Development that helped in its implementation. The goal of the camp is to gather astronomy lovers from Kruševac, but also beyond, and to provide an opportunity for a better understanding of astronomy in one place, through the realization of an interesting program consisting of lectures not limited to astronomy, but also in other areas such as entrepreneurship, artificial intelligence and informatics. The camp is organized in August around the peak of the Perseid meteor shower [6].

During the 2020 corona pandemic, the association organized a series of interesting lectures via the Skype application called "Online Interesting Astronomy" and public observations that were broadcast live via the Facebook and Instagram page. This activity attracted the attention of a large number of astronomy lovers not only from Kruševac, but throughout Serbia and beyond its borders. Therefore, in 2021, the association applied for a project called "Interesting Astronomy Online" where, in the period from 2021 to 2022, an online lecture and observation for astronomy lovers was organized on average twice a month. Lectures and observations were broadcast through the association's YouTube channel, and the promotion and announcements

were made through social networks. In the following year, funds were obtained to continue the project, where the association bought additional equipment (a CCD camera, a computerized telescope, and a DSLR camera), where, in addition to the aforementioned activities, lectures were held on the topic of astrophotography and how to photograph celestial objects using various techniques and equipment that are available to amateurs [1] [6].

In order to achieve its goal in the promotion of astronomy, the association began to actively engage in social networks. We worked on the development of our Instagram page, which today has over 22 thousand followers [8], and the YouTube channel that has over 2690 followers [6]. In this way, we try to inform the astronomical community not only about the events and activities of the association, but also about important astronomical events and activities in the whole world. Thanks to this, the association has successfully implemented an international asteroid search campaign called the “All Serbian Asteroid Search Campaign”, and has started implementing projects that are important for the further development of the association and the promotion of astronomy, among which is the construction of the first urban astronomical observatory in Kruševac. In this paper, we will present the realization of the “Šarengrad Astronomical Observatory” project and the implementation of the “All Serbian Asteroid Search Campaign”.

## 2. ASTRONOMICAL OBSERVATORY “ŠARENGRAD

The idea of building an astronomical observatory in Kruševac has started to take shape in 2010, when the society was founded. Then, in 2013, the society in cooperation with ZGR “Vlasinac IGDA”, made a conceptual solution for the construction of an observatory on Bagdala with a separate classroom. As the city expanded and developed, the observing conditions at Bagdala became bad, which led to the stopping the building of an observatory at that location. After two years of successful cooperation with the Center for the Promotion of Science in 2022, the Society envisioned the idea of building an astronomical observatory in the “Šarengrad” amusement park in cooperation with the Tourist Organization of the city of Kruševac. Due to the amount of budget funds that were approved, the project was designed to build an observatory building made of wood with a movable roof, modeled after the models offered abroad. The surface on which the telescope is located is 2x2m with a raised floor in order to create the conditions for the telescope to see as much of the horizon as possible. The project was approved by the Center for the Promotion of Science in June 2022, and work formally began in August, when the foundation stone was laid. The observatory is prefabricated and is mounted on a foundation that has been installed. Observations are made with one Newtonian 150/750 and the other Maksutov 150/1250 telescopes. The tubes are installed on the NEQ5 assembly, which was purchased along with two CCD cameras during the implementation of the “Sky is the limit” project in 2017, when funds were obtained from the Erste Bank [1][2][3][4].

The observatory has a stable power supply and is positioned in a part of the park where one has excellent conditions to observe the eastern, southern and southwestern sky. Light pollution is not a big problem because objects such as M31, M57 have been successfully observed through the activities. The observatory officially started work in September 2022, when it was officially opened. Live observations of objects such as the Sun, Moon, and planets are organized, but also online observations that are

transmitted via the-association’s YouTube channel. Over 10,000 visitors visited the observatory in the first year and had the opportunity to observe some of the objects through the telescope. The working hours of the observatory are not fixed, but there is an agreement to announce important events that visitors to the park will be able to watch, and during the month it is opened to the public at least twice, depending on the obligations of the association members. In order to solve this problem, the association opened a call for volunteers at the observatory at the end of 2023 [1].



Figure 1: Astronomical observatory “Šarengrad”.

The work on the building was carried out by the company ZGR “Vlasinac IGDA” with the aim that this facility can be offered to the wider market and commercialized. This is the first object of this type that was made for the needs of a public observatory, which is why the model itself was called the first urban astronomical observatory. Of course, it won’t stop there. Work on the improvement of the building itself will continue so during the year the “Tourist Organization of the city of Kruševac” designed the outer wall and the observatory has got a nicer look. The following activities are planned in the future: arranging the equipment, acquiring a solar telescope in order to enrich the program for monitoring solar activities, and a weather station, but also creating conditions for remote telescope management. These are the goals that the association has set for itself in order to make this observatory even more attractive for visitors both live from the park and in the virtual segment.

### 3. ALL SERBIAN ASTEROID SEARCH CAMPAIGN

“All Serbian Asteroid Search Campaign“ is part of the international asteroid search campaign that has been successfully implemented in Serbia for almost 8 years. AS “Eureka” is the coordinator of this activity for Serbia and so far it is one of the most successful citizen science projects. The campaign is carried out 6 times in a year,

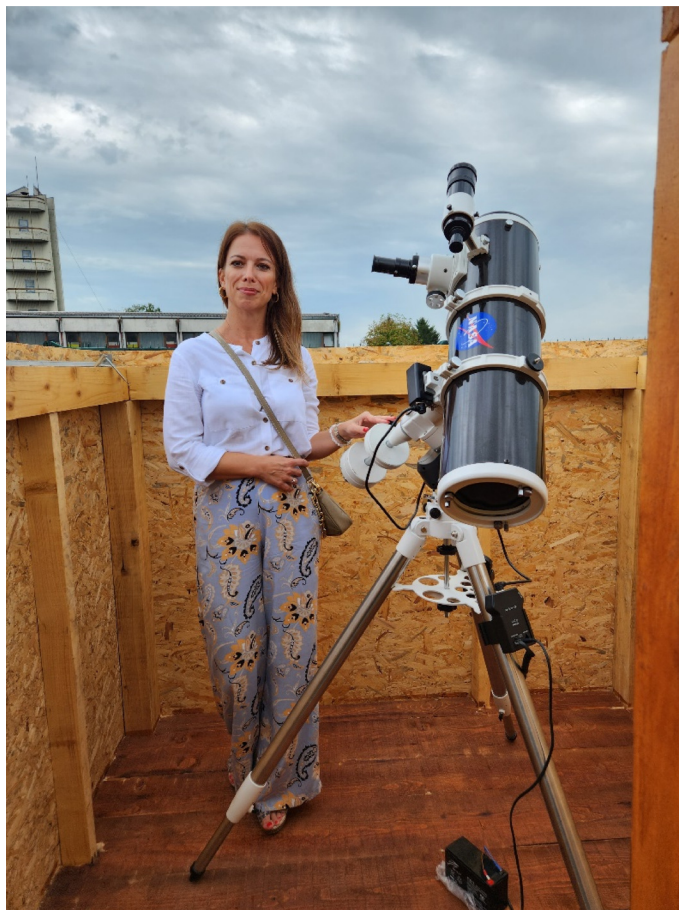


Figure 2: Jelena Gajic with telescope in observatory during opening ceremony.

where 15 teams of astronomy enthusiasts are involved in the activities. One campaign lasts about 20 days, where the teams receive sets of images made at the PanStarrs observatories. Using a free *ASTROMETRICA* program, they analyze images and help professional astronomers search for asteroids. At the end of each campaign, participants receive certificates as a confirmation of their participation in the same campaign, and during the period of the discoveries they have made, they go through the phases of verification of the potential, preliminary and subsequent discovery of a new asteroid. At the beginning of the campaign, the association organizes training for the participants on how to approach the work and program of *Astrometrica*. The essence of this program is to detect asteroids using the visual method, i.e. objects that are moving and in accordance with the given parameters determine whether they are potential asteroids or not. During detection, a search through the database of Near Earth Objects (NEO) objects determines whether it is present or not. It is important to note that there are three segments that give the participants an indication of the

Noise to signal ratio, which must be greater than 3, the appearance of Gaussian brightness distribution curves, and the visual shape of the body, which should be spherical in shape [7].

In the images below, you can see an example of a certificate that is awarded and a table with preliminary asteroid discoveries after the completion of one of the monthly campaigns. So far, over 1,000 young astronomy enthusiasts from all over Serbia have gone through one of the campaigns and we are proud to have 6 of the same teams participating in research all the time. This campaign is one of the important activities that encouraged the association to think about the project of building a new astronomical observatory in Kruševac, which will be discussed further below.



Figure 3: Certificate for participation in All Serbian Asteroid Search Campaign.

#### 4. NEW ASTRONOMICAL OBSERVATORY PLANS

Based on the experience of the construction of the first urban astronomical observatory and the implementation of citizen science projects, the idea to build a new astronomical observatory was created. The location for the new observatory is planned in Lukavac, where light pollution is minimal. It is located 9 km from the city of Kruševac. The project idea called "Armchair astronomy 2.0" was developed together with the Faculty of Science and Mathematics in Niš. The project idea was submitted to the competition of the Center for the Promotion of Science and was evaluated with an average grade of 3.25/5.00. The goal of the project is to build an automated observatory to create conditions for physics students and astronomy enthusiasts to engage in astronomy and astrophotography more simply and cheaply. The equipment would also be used for research projects, including tracking asteroids and deepening

All Serbia Asteroid Search Campaign  
September 23 - October 28, 2019

Provisional #	Object	Students	School	Location	Status	Date	Linked
Total	81						
F2018AH	A. Subasić-Koprić, N. Džukić, M. Duganović, Dina Džepić, I. Tržajk		Astronomical Society Orion Sarajevo	Bošnja and Herzegovina	Preliminary	09/24/19	AD0005
F2018AZ	A. Subasić-Koprić, N. Džukić, M. Duganović, Dina Džepić, I. Tržajk		Astronomical Society Orion Sarajevo	Bošnja and Herzegovina	Preliminary	09/24/19	AD0005
F2018AL	H. Brzozić, D. Agapović, L. Jurić, N. Džikić, A. Štanić		Astronomical Society Orion Sarajevo	Bošnja and Herzegovina	Preliminary	09/24/19	AD0006
F2018AP	A. Subasić-Koprić, M. Duganović, I. Tržajk, D. Džepić, M. Spjanić		Astronomical Society Orion Sarajevo	Bošnja and Herzegovina	Preliminary	09/24/19	AD0006
F2018AR	H. Brzozić, T. Colicinić, D. Agapović, L. Jurić, A. Štanić		Astronomical Society Orion Sarajevo	Bošnja and Herzegovina	Preliminary	09/24/19	AD0005
F2018AV	H. Brzozić, T. Colicinić, D. Agapović, L. Jurić, A. Štanić		Astronomical Society Orion Sarajevo	Bošnja and Herzegovina	Preliminary	09/24/19	AD0006
F2018AG	H. Brzozić, N. Džikić, A. Štanić, T. Colicinić, L. Jurić		Astronomical Society Orion Sarajevo	Bošnja and Herzegovina	Preliminary	09/24/19	AD0005
F2018AJ	H. Brzozić, T. Colicinić, D. Agapović, N. Džikić, L. Jurić		Astronomical Society Orion Sarajevo	Bošnja and Herzegovina	Preliminary	09/24/19	AD0006
F2018AK	H. Brzozić, N. Džikić, A. Štanić, T. Colicinić, L. Jurić		Astronomical Society Orion Sarajevo	Bošnja and Herzegovina	Preliminary	09/24/19	AD0005
F2018AA	A. Subasić-Koprić, M. Duganović, I. Tržajk, D. Džepić, M. Spjanić		Astronomical Society Orion Sarajevo	Bošnja and Herzegovina	Preliminary	09/24/19	AD0005
F2018AC	A. Subasić-Koprić, M. Duganović, I. Tržajk, D. Džepić, M. Spjanić		Astronomical Society Orion Sarajevo	Bošnja and Herzegovina	Preliminary	09/24/19	AD0007
F2018AD	A. Subasić-Koprić, M. Duganović, I. Tržajk, D. Džepić, M. Spjanić		Astronomical Society Orion Sarajevo	Bošnja and Herzegovina	Preliminary	09/24/19	AD0006
F2018AE	H. Brzozić, N. Džikić, A. Štanić, D. Agapović, T. Colicinić		Astronomical Society Orion Sarajevo	Bošnja and Herzegovina	Preliminary	09/24/19	AD0006
F2018AF	H. Brzozić, N. Džikić, A. Štanić, D. Agapović, T. Colicinić		Astronomical Society Orion Sarajevo	Bošnja and Herzegovina	Preliminary	09/24/19	AD0005
F2018AG	H. Brzozić, T. Colicinić, D. Agapović, N. Džikić, L. Jurić		Astronomical Society Orion Sarajevo	Bošnja and Herzegovina	Preliminary	09/24/19	AD0005
F2018AH	A. Subasić-Koprić, M. Duganović, I. Tržajk, D. Džepić, M. Spjanić		Astronomical Society Orion Sarajevo	Bošnja and Herzegovina	Preliminary	09/24/19	AD0006
F2018AI	A. Subasić-Koprić, M. Duganović, I. Tržajk, D. Džepić, M. Spjanić		Astronomical Society Orion Sarajevo	Bošnja and Herzegovina	Preliminary	09/24/19	AD0006
F2018AJ	A. Subasić-Koprić, M. Duganović, I. Tržajk, D. Džepić, M. Spjanić		Astronomical Society Orion Sarajevo	Bošnja and Herzegovina	Preliminary	09/24/19	AD0006
F2018AK	A. Subasić-Koprić, M. Duganović, I. Tržajk, D. Džepić, M. Spjanić		Astronomical Society Orion Sarajevo	Bošnja and Herzegovina	Preliminary	09/24/19	AD0006
F2018AL	M. Bognarović Perić, M. Džurđević, S. Vukobratović, V. Braon, N. Radujković, O. Brijunić, M. Radulović, M. Mrganović, D. Ristanović, S. Radenković & S. Manić		Asteroid	Serbia	Preliminary	09/24/19	AD0005
F2018AM	M. Bognarović Perić, M. Džurđević, S. Vukobratović, V. Braon, N. Radujković, O. Brijunić, M. Radulović, M. Mrganović, D. Ristanović, S. Radenković & S. Manić		Asteroid	Serbia	Preliminary	09/24/19	AD0006
F2018AN	S. Kavezić & S. Mitrović		Orion	Serbia	Preliminary	09/24/19	AD0006
F2018AO	J. Kubiak, A. Kubiak, J. Mladenić, A. Kubiak, S. Vukobratović, K. Gavrilović, M. Štanić, V. Stojković, S. Kostić & M. Plićević		OS Savi Sava	Serbia	Preliminary	09/24/19	AD0006
F2018AP	J. Kubiak, A. Kubiak, J. Mladenić, A. Kubiak, S. Vukobratović, K. Gavrilović, M. Štanić, V. Stojković, S. Kostić & M. Plićević		OS Savi Sava	Serbia	Preliminary	09/24/19	AD0004
F2018AQ	J. Kubiak, A. Kubiak, J. Mladenić, A. Kubiak, S. Vukobratović, K. Gavrilović, M. Štanić, V. Stojković, S. Kostić & M. Plićević		OS Savi Sava	Serbia	Preliminary	09/24/19	AD0005
F2018AR	N. Subarićević		Selječko Jastrebo	Serbia	Preliminary	09/24/19	AD0005
F2018AS	K. Dragović		Selječko Jastrebo	Serbia	Preliminary	09/24/19	AD0005
F2018AT	K. Dragović		Serbian Team 2	Serbia	Preliminary	09/24/19	AD0005
F2018AU	K. Dragović		Serbian Team 2	Serbia	Preliminary	09/24/19	AD0005
F2018AV	K. Dragović		Serbian Team 2	Serbia	Preliminary	09/24/19	AD0005
F2018AW	A. Vasić		Serbia	Serbia	Preliminary	09/24/19	AD0005
F2018AX	A. Vasić		Serbia	Serbia	Preliminary	09/24/19	AD0005
F2018AY	A. Vasić		Serbia	Serbia	Preliminary	09/24/19	AD0005
F2018AZ	A. Vasić		Serbia	Serbia	Preliminary	09/24/19	AD0006
F2018BA	G. Brijunić, M. Radulović, D. Džukić, T. Džikić, V. Braon, D. Ristanović, M. Mrganović, M. Čurčić, S. Kamburović, A. Vukobratović, B. T. Željak		Traci Kamen of Mladost	Serbia	Preliminary	09/24/19	AD0002
F2018BB	G. Brijunić, M. Radulović, D. Džukić, T. Džikić, V. Braon, D. Ristanović, M. Mrganović, M. Čurčić, S. Kamburović, A. Vukobratović, B. T. Željak		Traci Kamen of Mladost	Serbia	Preliminary	09/24/19	AD0003
F2018BC	H. Brzozić, N. Džikić, A. Štanić, D. Agapović, L. Jurić		Astronomical Society Orion Sarajevo	Bošnja and Herzegovina	Preliminary	09/25/19	AD0002
F2018BD	A. Subasić-Koprić, N. Džukić, M. Duganović, D. Džepić, M. Spjanić		Astronomical Society Orion Sarajevo	Bošnja and Herzegovina	Preliminary	09/25/19	AD0002
F2018BE	H. Brzozić, D. Agapović, L. Jurić, T. Colicinić, N. Džikić		Astronomical Society Orion Sarajevo	Bošnja and Herzegovina	Preliminary	09/25/19	AD0002
F2018BF	A. Subasić-Koprić, M. Duganović, I. Tržajk, N. Džikić, M. Spjanić		Astronomical Society Orion Sarajevo	Bošnja and Herzegovina	Preliminary	09/25/19	AD0009
F2018BG	A. Subasić-Koprić, N. Džukić, D. Džepić, M. Spjanić		Astronomical Society Orion Sarajevo	Bošnja and Herzegovina	Preliminary	09/25/19	AD0002
F2018BH	H. Brzozić, T. Colicinić, D. Agapović, L. Jurić, A. Štanić		Astronomical Society Orion Sarajevo	Bošnja and Herzegovina	Preliminary	09/25/19	AD0002
F2018BI	A. Subasić-Koprić, M. Duganović, I. Tržajk, N. Džikić, D. Džepić		Astronomical Society Orion Sarajevo	Bošnja and Herzegovina	Preliminary	09/25/19	AD0004

Figure 4: List of preliminary discoveries of asteroids in one campaign.

cooperation on the international asteroid search project. This project idea will be realized in the future and thus Kruševac will be additionally enriched with content important not only for the promotion of astronomy, but also for the practice of astronomy as a science. In the Figures 5 and 6, the location of the future observatory is given along with an automated observatory dome.



Figure 5: Location of future astronomical observatory.

### 5. CONCLUSION

Since its establishment, the astronomical society "Eureka" has implemented a large number of activities in the field of promotion and popularization of astronomy. An important segment of the work of every astronomical society is the existence of a base in the form of an astronomical observatory. AS "Eureka" managed to realize this goal in 2022, when the first urban astronomical observatory was opened in Kruševac. It



Figure 6: Automated observatory dome.

is located within the "Šarengrad" park, where over 10,000 visitors visited the observatory and attended the activities in the first year. In addition to activities on the site, online activities were also successfully implemented, as well as the citizen science project "All Serbian Asteroid Search Campaign". Encouraged by these results, the association plans to build a new observatory in the coming period in cooperation with the Faculty of Science and Mathematics in Niš for the needs of students, as well as the realization of research projects in astronomy and further promotion and popularization of science.

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