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THE BELISSIMA PROJECT

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Abstract. We discuss the goals and achievements of BELISSIMA (BELgrade Initiative for Space Science, Instrumentation and Modelling in Astrophysics), the most ambitious infrastructural project currently active at the Astronomical Observatory of Belgrade (AOB). The FP7 REGPOT project BELISSIMA started in July 2010 and is extended to July 2015. The most important goals include the reinforcement of the AOB, purchase and installation of the 1.50 m-class telescope, training of the AOB staff, public outreach, dissemination and promotional activities. The activities and results of the local project ON176021 (Visible and Invisible Matter in Nearby Galaxies: Theory and Observations) are also briefly discussed.

1. INTRODUCTION

BELISSIMA is the FP7 (Seventh Framework Programme) project (call FP7-REGPOT-2010-5; funding scheme is "CSA Coordination and support action") started its activities in July 2010. The initially planned duration was three years, but due to the various circumstances beyond the control of the management of BELISSIMA, in June 2013 the BELISSIMA project was extended by the European Commission to June 30, 2015.

The project is coordinated by the Astronomical Observatory of Belgrade (AOB) and is the most ambitious infrastructural project undertaken recently by AOB. The BELISSIMA project was evaluated very favorably by the European Commission and obtained 14.50 out of 15.00 points. Its "scientific and/or technological excellence" brought the projects maximal 5.00 points and he approval of the project was thus explained: "The BELISSIMA is an excellent project which is perfectly targeted and very clearly described. (...) The proposal to upgrade the research capacity of the AOB is based on the excellent competence and research activities which are on the cutting-edge of astrophysics and astronomy".

The project has been described previously in English in Samurović (2012a, 2013a, 2013b), Samurović & Knežević (2013) and in Serbian in Samurović (2010, 2012b). For the sake of completeness, some details presented there were included in the present contribution and the updates were added wherever necessary.

2. WORK PACKAGES

The BELISSIMA project consists of five work packages (WPs), which are listed below with their leaders.

- WP1: Preparations and reinforcement of the AOB (leader: Dr. Zoran Knežević)
- WP2: Purchase, installation and testing of optical equipment (leader: Dr. Ištvan Vince)
- WP3: Human potential, training and public outreach (leader from March 2011: Dr. Miroslav Mićić; until March 2011 the leader was Dr. Luka Č. Popović)
- WP4: Dissemination and promotional activities (leader: Dr. Milan Ćirković)
- WP5: Project management (leader: Dr. Srdjan Samurović)

The coordinator of BELISSIMA is Dr. Srdjan Samurović, and the Management board of BELISSIMA consists of the leaders of WPs.

Below, we briefly describe the accomplishments of each WP and their importance for the AOB and astronomy in Serbia.

2. 1. WP1. PREPARATIONS AND REINFORCEMENT OF THE AOB

The very beginning of the BELISSIMA project was marked with the improving of human resources of the AOB. As soon as the positive outcome of the proposal was announced (the beginning of 2010), the Management board intensified the contacts with candidates for a total of 72 months of engagement intended for recruited researchers coming from abroad. This task was successfully handled by Director of the AOB, Dr. Zoran Knežević, the head of WP1.

The first researcher, Dr. Milan Bogosavljević was hired on July 15th, 2010. Dr. Milan Bogosavljević was born in Niš in 1977. He graduated from the University of Belgrade, Faculty of Mathematics, Serbia and obtained his PhD from California Institute of Technology (CalTech). He is an expert in observational astronomy with a significant experience with observations with the world's largest telescopes (such as Keck). Immediately after his hiring Dr. Bogosavljević was appointed technical director of the Vidojevica Astronomical Station (VAS) and initiated his numerous activities related to the design and construction of the planned telescope "Milanković" to be mounted at the VAS. He made numerous trips around Europe within the scope of the BELISSIMA project for the purpose of establishing the optimal design of the planned 1.50 m-class telescope and the construction of the dome where the telescope will be mounted; he visited the VAS on numerous occasions and participated in performing final activities regarding the mounting of the 60 cm telescope purchased by the AOB using the funds from Ministry of Science and Technological Development of Republic of Serbia and mounted at the VAS; he worked with young researchers at the AOB providing help with various aspects of observational activities and reductions of observations. At the time of this writing (November 2014) he is in charge of the supervision of the construction of the 1.40 m telescope currently being manufactured (see below).

The second researcher, Dr. Miroslav Mićić was hired on March 16th, 2011. Dr. Miroslav Mićić was born in Belgrade in 1977. He graduated from the University of

Belgrade, Faculty of Mathematics, Serbia and obtained his PhD from the Pennsylvania State University. He joined the BELISSIMA project coming from the University of Sydney where he had been working. He is an expert in astrophysical simulations, astronomical data processing and visualization of astronomical data. The activities of Dr. Mićić include: he initiated the collaboration with young researchers at the AOB regarding start of various research projects with numerical astrophysical simulations; he was appointed leader of WP3 of the BELISSIMA project; he joined the work of Dr. Srdjan Samurović, Dr. Milan Ćirković, Dr. Milan Bogosavljević, the AOB librarian Ms. Vesna Mijatović and designer of the publication Ms. Ivana Horvat and helped in the final stages of the production of the bi-lingual brochure dedicated to the AOB and BELISSIMA; he presented opportunities for the future research on supercomputers in Serbia with the talk on "Supermassive Black Holes" in the amphitheater of the Department of Natural Science and Mathematics, Niš University; he featured as guest at the astronomy seminar in the Research Center in Petnica.

The third candidate, Dr. Milica Mićić was hired on November 1, 2012. She was born in Kruševac in 1984, graduated from the Department of Mathematics at the University of Belgrade in June 2008 and later, in December 2008, also obtained the masters degree there. She obtained her PhD at the Institute for Theoretical Astrophysics at the University of Heidelberg (Germany). Dr. Milica Mićić is an expert in numerical astrophysical simulations in the field of massive star and molecular cloud formation, focusing on the influence of chemical processes on the gas dynamics; she is also an expert in astronomical data processing and visualization of astronomical data.

All three recruited researchers continued to work at the AOB after the expiration of the period of 72 person-months dedicated to this task. The Ministry of Education, Science and Technological Development of the Republic of Serbia (MESTDRS) continues to support the researchers and they all work as members of the AOB staff. They all perform various research activities through project ON176021 funded by MESTDRS as research associates (see below).

2. 2. WP2. PURCHASE, INSTALLATION AND TESTING OF OPTICAL EQUIPMENT

From the very beginning of BELISSIMA the Management board of the project began to work on the selection of the optimal configuration of the 1.50 m-class telescope to be purchased and mounted at the top of Vidojevica. The telescope will be named "Milanković" after the famous Serbian astronomer. Several manufacturers of telescopes were contacted and they provided their estimates of prices. The Management board of BELISSIMA applied to Ministry of Science and Technological Development of the Republic of Serbia (now MESTDRS) for additional funds needed for a purchase of a high quality 1.50 m-class telescope. We have asked for additional funds through a national project ON176021, "Visible and Invisible Matter in Nearby Galaxies: Theory and Observations" (see below for more details) that gathered 26 researchers from leading research institutions of Serbia, which would make it possible to purchase a telescope with targeted performances. The funds were granted and the contract for the purchase of the 1.40 m telescope was signed in March 2014 and, according to it, the telescope is expected to be mounted at the VAS by June 2015. All the foreseen tests are expected to be finished by that date.

2. 3. WP3. HUMAN POTENTIAL, TRAINING AND PUBLIC OUTREACH

In the first year of activity of the BELISSIMA project, numerous activities pertaining to human potential, training and public outreach were performed and below only the brief list is given. The reader is referred to the BELISSIMA Web site (see below) for the detailed information.

At the beginning of the project two events were organized. On September, 6th 2010 at the AOB the meeting of the Serbian astronomical community was organized and 40 colleagues from the AOB, Department of Astronomy (Belgrade University), Institute of Physics (Belgrade) and People's Observatory from Beograd took part in the discussions related to the needs of the community regarding the new telescope. Three weeks later, the executive meeting of the BELISSIMA project took place in Prokuplje, from 27th to 28th September 2010. The meeting "Network of Telescopes in the Western Balkans Region" gathered 30 participants, of which 13 were foreign experts from several European countries.

Within WP3, numerous visits to various European observatories and institutes were organized: Orliakas Astronomy Station (Greece) in August 2010; meeting "Big Science With Small Telescopes" held in Dornburg, near Jena, Germany, from October, 19th to 22nd 2010; observations at the Baja Observatory, Hungary (February 2011), visit to the telescopes at Tenerife and La Palma (February/March 2011); "Second Workshop on Robotic Autonomous Observatories" held in Malaga, Spain from 5th to 10th June 2011; "Hands-on Strong Gravitational Lensing School" held at Excellence Cluster Universe, Garching, Germany from 14th to 17th June 2011; summer school "Opto-Mechanical Design in Astronom", which was held at the Astrophysical Institute of Potsdam (AIP) in Potsdam, Germany from June 20th to 23rd, 2011; the observing NEON school held at Molutai Astronomical Observatory (Lithuania) from July 14th to 27th, 2011.

It is important to mention here two three-months visits of the participants of the BELISSIMA project and members of the AOB staff, Ms. Monika Jurković and Ms. Milena Jovanović, to the Leibniz Institute for Astrophysics (AIP) at Potsdam within the scope of the WP3. Since the AIP is one of the leading institutes in Europe for the development of the astronomical instrumentation, their training is important for the AOB and the work with the new robotic telescope "Milanković". Their host at the AIP was Dr. Michael Weber who collaborated with the BELISSIMA project. Ms. Monika Jurković, a research assistant from the AOB, visited AIP in the period from April to June 2012. During her three month visit she was involved in the calibration of the PARSES, parameter search package of the STELLA's echelle spectrographs. STELLA is a project of the AIP done in collaboration with the Instituto de Astrofisica de Canarias (IAC) and is located at the Teide Observatory on the Canarian island of Tenerife, Spain (see more details below). P.I. of the project is Dr. Klaus G. Strassmeier. The facility, the telescopes and the spectrographs are running automatically and autonomously. Ms. Milena Jovanović, a research assistant from the AOB visited the AIP from June to August 2012. The purpose of her visit is the training on the procedures of automated reduction of stellar spectra used in robotic observatories. At AIP she joined the Stellar Activity group and in particular the part of it connected to the STELLA project. STELLA is an observatory hosting two robotic telescopes (STELLA-I and STELLA-II) that operate in fully unattended mode. STELLA-I will host an optical CCD imager and photometer (WIFSIP) and

an AO testbed, while STELLA-II fiberfeeds the STELLA echelle spectrograph. Both STELLA-I and STELLA-II are 1.2 meter telescopes. Ms. Jovanović visited again the AIP from July to August 2014 for the purpose of completing her work started there in 2012.

Also, foreign researchers came to the AOB after the invitation of the BELISSIMA project: Dr. Zach Ioannou came from Thessaloniki to Belgrade where he stayed from March 28th to April 2nd 2011. Dr. Ioannou is one of the creators of the Astronomical Station Orliakas. He came for two reasons: to help with the writing of the technical documentation regarding the construction and purchasing of the telescope "Milanković" (see above) and scientific collaboration with the AOB. Although his suggestions were mostly technical ones (parameters of the various parts of the telescope, details of the construction etc.) he also provided the participants of BELISSIMA numerous administrative details regarding European tenders which is very important for BELISSIMA and the AOB since this is the first time that such an international activity takes place at the AOB.

For the purpose of training of the AOB staff various activities were performed, such as: training at the VAS, training course related to photometry and spectroscopy held at the AOB in May 2011 by Dr. Ištvan Vince and training of data reduction at the AOB.

2. 4. WP4. DISSEMINATION AND PROMOTIONAL ACTIVITIES

We here list only a few dissemination and promotional activities (the reader is referred to the BELISSIMA Web site for a full list): the all-sky camera at the VAS recorded on November 12th, 2010 is (to the best of our knowledge) the only image of the meteor entering the atmosphere above Serbia and numerous media published it, thus promoting the BELISSIMA project, the VAS and the AOB in public; the AOB had the honor on November, 8th 2010 to host Prof. Sir Arnold Wolfendale, FRS, 14th Astronomer Royal and the participants of the BELISSIMA project discussed with him numerous astronomical issues; BELISSIMA has participated in the 4th Festival of Science held in Belgrade in December 2010; an article that describes the BELISSIMA project and telescope "Milanković" was published in "Danica 2011" (Samurović 2010); several BELISSIMA participants took part in various radio and TV programmes; the cooperation with Amateur Astronomers Association of Serbia has started from the very beginning of the work of the BELISSIMA project; the BELISSIMA project collaborated with the researchers from Serbian town of Niš through various initiatives – we mention here only one: Dr. Goran Sv. Djordjević who leads Southeastern European Network in Mathematical and Theoretical Physics organized a seminar "Trends in Modern Physics" for the elementary and high school teachers from Balkan countries and neighboring regions, held in August, 2011 in Niš and in agreement with the BELISSIMA project the teachers were taken to the VAS and the first TV material related to BELISSIMA was shot there; several BELISSIMA participants took part in the activities of the Research Center in Petnica. The AOB brochure mentioned above was printed in Serbian and in English: this is a booklet dedicated to the AOB, its history, its present activity and its future, which will be without doubt marked by the "Milanković" telescope. The publication presents in an accessible language the active projects, their leaders and participants and the BELISSIMA project is also covered in detail. The first BELISSIMA Workshop, "Science with 1.5

m telescopes", was organized from 13 to 14 October 2011, after the 16th National Conference of Astronomers of Serbia: it gathered approximately 50 participants out of which 21 were foreign experts who discussed with the BELISSIMA participants various aspects of observations possible with 1.50 m-class telescope. The CDROM with the presentations from the Workshop (together with some additional material) was pressed and distributed afterwards. From 18-21 September 2012, the large international BELISSIMA conference "Future Science With Meter-Class Telescopes" with approximately 100 participants was held in Belgrade. The presentations are available at the BELISSIMA Web site and the book of Proceedings was printed in December 2013 in the series of the Publications of the AOB (no. 92)[1]; the Proceedings were widely distributed and the copies are available at the AOB. The multimedia BELISSIMA DVD was printed in October 2013 and it includes various material describing the progress of BELISSIMA and its activities. The disk was widely distributed and is also available at the AOB.

Finally, within the WP4 of the BELISSIMA project four episodes of the BELISSIMA TV programme have been realized (until November 2014): the first episode presents the VAS, the second episode is dedicated to the 125 years of the AOB and shows its past, present and future and the importance of BELISSIMA for its activities, the third and fourth episodes were shot in September 2012 during the international BELISSIMA conference held in Belgrade and present the work of the world's leading researchers who participated in the work of the conference (these two episodes were subtitled in Serbian and in English as they are of interest to a wider astronomical community that can thus learn about the plans for the future of Serbian astronomy). All four episodes of the BELISSIMA TV programme are included in the BELISSIMA multimedia DVD and are available from the BELISSIMA Web site.

2. 5. WP5. PROJECT MANAGEMENT

The project management of the BELISSIMA project was done by the Management board of the project and coordinated by Dr. Srdjan Samurović. The Management board includes all the leaders of WPs and had meetings on a regular basis when the activities of the project were discussed and the tasks for a future work were created. The main remaining activity of the Management board is a successful manufacturing of the 1.40 m telescope and its mounting at the top of the VAS by June 2015. At the time of this writing (November 2014) the contacts with the MESTDRS have been intensified in order to secure a pavilion with a high-quality dome where the instrument will be mounted.

3. BELISSIMA AT THE HORIZON 2020 WEB SITE

The importance of BELISSIMA for astronomy for Serbia and the Western Balkans region was recognized by the European Commission (EC) and the project was presented within the section "Success Stories" at the EC Web site with the text "Serbia is a rising star in astronomical research". The story was first published on the FP7

[1]As all AOB Publications, the BELISSIMA Proceedings were indexed at the NASA Astrophysics Data System (ADS) (`http://adsabs.harvard.edu`).

Web pages[2] and was later also put on the Horizon 2020[3] (the biggest EU Research and Innovation programme and successor of the FP7) Web page[4].

4. PROJECT ON176021

The activities of the BELISSIMA project are closely related to the work of the local, Serbian, project ON176021 ("Visible and Invisible Matter in Nearby Galaxies: Theory and Observations") funded by the MESTDRS. The duration of the project is 5 years, from 2011 to 2015, and the leader is Dr. S. Samurović.

The goal of the project is the study of the visible (stars, gas, dust) and invisible (hypothetical, dark) matter in nearby galaxies of various morphological types. One of the main goals is the creation of a sample which includes both early and late-type galaxies that is studied using their photometric and spectroscopic data coming from large available catalogs and databases. Their kinematics and dynamics are thoroughly studied and the anisotropies in the stellar motions are examined. The decomposition of their photometric profiles is performed for the purpose of discovering various structures (such as inner disks). Dark matter is studied in detail in nearby elliptical galaxies using various observational techniques and theoretical approaches. The studies of the Milky Way is used for the comparison with other galaxies. Also, within ON176021, the features of the Galactic habitable zone related to the kinematics and dynamics of the Milky Way and nearby spiral galaxies are studied. For some important recent results related to nearby galaxies obtained within ON176021, the reader is referred to the contributions by Vudragović et al., Jovanović et al. and Samurović in the present volume.[5]

Within project ON176021, through its main subproject (leader: Dr. M. Bogosavljević), we make preparatory studies, design and build of a robotic telescope "Milanković"; through the same subproject, the additional funds for the purchase of the telescope were asked from the MESTDRS and granted. Also, through the same subproject, the funds for the pavilion and dome are expected to be secured in 2015. Since March 2014, within ON176021 another subproject, "Investigation of Blazars", has been initiated; the leader is Dr. Oliver Vince who established a collaboration with colleagues who study blazars through several European projects. The future telescope "Milanković" will be also used for the study of blazars, using both photometry and spectroscopy.

5. CONCLUSIONS

The BELISSIMA project is of an immense significance for Serbian science. It created favorable conditions for the return of Serbian scientists working abroad and the three researchers that were recruited by BELISSIMA are now members of the AOB staff. By constructing the "Milanković" telescope Serbia is opening doors to the new technologies in the field of optics, astronomy, informatics, and electronics. The BELISSIMA

[2] http://ec.europa.eu/research/regions/index_en.cfm?pg=success_stories&lg=en&id=5

[3] https://ec.europa.eu/programmes/horizon2020/en/what-horizon-2020

[4] https://ec.europa.eu/programmes/horizon2020/en/news/serbia-rising-star-astronomical-research

[5] All contributions in these Proceedings made within project ON176021 can be traced through the acknowledgment sections present at the end of each paper printed in this volume.

project will play an important role in improving scientific literacy in Serbia. BELISSIMA will strengthen and establish new regional collaboration with partners from the Western Balkans and with the leading European scientific institutions. In this contribution, the activities of the project from the beginning in July 2010 to November 2014 were presented. The BELISSIMA WWW site is: `http://belissima.aob.rs` and it contains various information and news related to the project.

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References

Samurović, S.: 2010, "Telescope 'Milanković"' in "Danica 2011", Serbian illustrated almanac (in Serbian), Vuk Karadžić Foundation, vol. 18, pp. 440-442.

Samurović, S.: 2012a, "The BELISSIMA Project", in the Publications of the Astronomical Observatory of Belgrade, vol. 91, pp. 71-76.

Samurović, S.: 2012b, "125 Years of the Astronomical Observatory of Belgrade"' in "Danica 2013", Serbian illustrated almanac (in Serbian), Vuk Karadžić Foundation, vol. 20, pp. 537-542.

Samurović, S.: 2013a, "The BELISSIMA Project", in the Publications of the Astronomical Observatory of Belgrade, vol. 92, pp. 11-16.

Samurović, S.: 2013b, "The BELISSIMA Project" in the Proceedings from the BELISSIMA Workshop held in Belgrade 13-14 October 2011, Editors: S. Samurović, N. Martinović and B. Vukotić, CDROM.

Samurović, S. and Knežević, Z.: 2013, "Astronomical Observatory of Belgrade: Individual and Institutional Cooperation with Italy" in the Proceedings of the Workshop "Serbia-Italia: Status and Perspectives of Scientific and Technological Bilateral Cooperation", edited by P. Battinelli and M. Ivetić, Belgrade 25-26 June, 2012, pp. 69-78.