

# Astrophysical Spectroscopy of Extragalactic Objects. Research at the Belgrade Astronomical Observatory

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**Abstract.** We present here activities on the project “Astrophysical Spectroscopy of Extragalactic Objects” financed by the Ministry of Science of Serbia within 2002-2005 period.

## 1 Introduction

The scientific research at the Astronomical Observatory has been variously organized in the different time periods. It was mainly done in the scientific groups that were working on one specific subject. In the nineties of the previous century, there was only one project that covered all the research that was performed at Belgrade Astronomical Observatory (AOB). However, after 2001. the Ministry of Science of the Republic of Serbia has made a call for proposals, where it has put in favor small and well defined projects. In that way, conditions were made to propose several projects from the AOB (9 projects were performed and all 9 were accepted). One of these project is “Astrophysical Spectroscopy of Extragalactic Objects” which will be discussed further in the following text.

We would like to point out here our reasons for making this report:

1. The project has lasted from 2002. to 2004., and it was extended to 2005. In the 2006. new 4-year projects have started, therefore this an excellent opportunity to make a retrospective of this project;
2. Even though yearly reports were sent regularly to the Ministry, a complete summary of the project activities have not been made;
3. From the historical point of view many activities, if not recorded somewhere, are forgotten after some period of time, therefore this text should be some sort of reminder to all the participants in this project. On the other hand, we would like to make this report in order to easily compare future with previous results, as well as for the other to compare their achievements with ours and viceversa.

Also, we would like to emphasize that researches that were done through this project have never been done before in Serbia, therefore with this project another important and up to date subject was started in Serbia.

## **2 Researchers on the Project**

In the period from 2002 to 2005, 12 researchers were working on this project. The coordinator of the project was L. Č Popović, and the researchers are:

1. Edi Bon (born 1970, AOB) 2002-2005, total 42 Research Months (RM)
2. Nataša Gavrilović (born 1979, AOB) started in 2005, total 3 RM
3. Milan S. Dimitrijević (born 1947, AOB) 2002-2005, total 8 RM
4. Dragana Ilić (born 1978, MFB) 2002-2005, total 32 RM
5. Katarina Kovač (born 1976, MFB) only in 2002, total 8 RM
6. Predrag Jovanović (born 1968, AOB) 2002-2005, total 18 RM
7. Luka Č. Popović (born 1964, AOB) 2002-2005, total 40 RM
8. Srdjan Samurović (born 1967, AOB) 2002-2004, total 36 RM
9. Saša Simić (born 1971, FFK) 2002-2005, total 32 RM
10. Nataša Stanić (born 1967, AOB) 2002-2004, total 29 RM
11. Dejan Urošević (born 1970, MFB) 2002-2004, total 6 RM
12. Milan Ćirković (born 1971, AOB) 2002-2004, total 12 RM

It is interesting to make a small statistical analysis of the participants in this project. For the total of 4 years, 12 researchers worked for 226 research months, thus 22.2 years. Mainly young researchers were engaged, therefore the average age was around 34 years (or year of birth 1970). For all the duration of the project the following researchers were engaged: Edi Bon, Milan Dimitrijević, Dragana Ilić, Predrag Jovanović, Luka Popović and Saša Simić.

## **3 Activities**

With the aim to achieve the project objectives, in the period from 2002 to 2005, the following activities were performed:

1. Scientific theoretical and experimental research, together with the education of young researcher, in three fields:

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- (a) investigation of the kinematical and physical properties of active galactic nuclei and stellar systems in other galaxies;
  - (b) b) investigation of the influence of the microlensing effect on the spectra of quasars;
  - (c) c) explaining (modeling) phenomena of the gamma ray burst;
2. Performing observations;
  3. Research visits to international institutions and participation in international Conferences;
  4. Popularization of science (through seminars and public lectures);
  5. International cooperation - visits to AOB of foreign scientists and viceversa, planning and writing proposals for future bilateral and multilateral projects;
  6. Organizing Conferences;
  7. Systematizing and publishing research results (see references in Appendix).

The main results of all these activities in the period 2002-2005 are:

- Defended two PhD thesis (see references Samurović 2004, Jovanović 2005);
- Defended two Master thesis (see references Stanić 2002, Ilić 2005);
- Defended one Diploma thesis at the University of Padova, Italy (see references La Mura 2005);
- Published 128 bibliographic papers;
- Performed radio observation of the active galaxy Akn 120 with European VLBI network (data reduction is in progress);
- Performed spectroscopical observation (in optical band) with the Isaac Newton telescope (Canary Islands, Spain) and 2m telescope at Rozhen Observatory (Bulgaria);
- International project “Virtual Observatory for investigation of the galaxy origin” between Serbia and France, Program “Pavle Savić”, approved for the period 2006-2007;
- Participation to 16 international and national conferences and workshops;
- 3 Research visits (more then 15 days);

- Organization of the 4th and 5th Serbian Conference on Spectral Line Shapes in Astrophysics (Arandjelovac 2003, Vršac 2005);
- Visits of 9 foreign scientist (collaborators on project);
- Established wide international cooperation (Bulgaria, Russia, Germany, Spain, Italy, France, USA).

#### **4 Financing the Project**

As it was mentioned previously this project was approved by the Ministry of Science of the Republic of Serbia, therefore it was financed by that institution. The detailed financial structure of this project is given in the Table 1.

Table 1. Financial structure of the project 1196.

2005.	
Honoraria for the researchers	1,995,940 DIN
Expenses for travels, materials, equipment...	517,000 DIN
Expenses of the institution	830,352 DIN
<b>SUB-TOTAL</b>	<b>3,343,292 DIN</b>
2004.	
Honoraria for the researchers and expenses of the institution	3,183,174 DIN
Expenses for travels, materials, equipment...	88,709 DIN
<b>SUB-TOTAL</b>	<b>3,271,883 DIN</b>
2002-2003.	
Honoraria for the researchers and expenses of the institution	5,657,485 DIN
Expenses for travels, materials, equipment...	282,875 DIN
<b>SUB-TOTAL</b>	<b>5,940,360 DIN</b>
<b>TOTAL 2002-2005.</b>	<b>12,555,535 DIN</b> (~170,000 EUR)

As it can be seen from Table 1. almost all financial support from the Ministry was spent on the researcher's salaries, 40 % were spent on administrative expenses, and only a small part was spent on travels, materials, supplies and equipment.

#### **5 Conclusions**

We are going to use statistic again to present our work on this project. As we already mention, the average age of the researcher was 34 year, that is a usual age for a post-doc. If we take that for 22.2 years of work, the Ministry has supported the project with 170,000 EUR, which is approx. 8,000 EUR per year

per a researcher. In the same time, the same researcher in the European Union would have yearly incomes of around 30,000 EUR, therefore it is pretty clear in what position are researchers in Serbia. On the other hand, that researcher is published 6 bibliographic papers per year, that is comparable with the results of his colleagues from the European Institutes. The conclusion is left for the readers to make.

## Appendix

### Defended dissertations

1. Jovanović, P. 2005, "The influence of gravitational microlensing on the X-ray radiation of the accretion disk in active galaxies", PhD thesis, Faculty of Mathematics, University of Belgrade.
2. Ilić, D. 2005, "Kinematical and physical properties of the active galaxy Mrk 817", Master thesis, Faculty of Mathematics, University of Belgrade.
3. La Mura, G. 2005, "Balmer Lines Intensities as an Indicator of Physical Processes in the BLR", Diploma thesis at Università degli Studi di Padova, Facoltà di Scienze, Padova.
4. Samurović, S. 2004, "Dark Matter in Early-Type Galaxies With X-Ray Haloes. A Spectroscopic Study of Dynamics and Abundance Indices", Department of Physics, University of Trieste (supervisors John Danziger and Francesca Matteucci).
5. Stanić, N. 2002, "The variability of the  $H\beta$  emission line profile and structure of the emission region of the galaxy Akn 120", Master thesis, Faculty of Mathematics, University of Belgrade.

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3. Popović, L. Č., Dimitrijević, M. S., Mediavilla, E., Danezis, E., Lyratzi, E., Bon, E., Ilić, D., Jovanović, P., Theodosiou, E., Dačić, M. 2004, Some Spectroscopical Methods for Astrophysical Plasma Research, 22th SPIG (eds. Lj. Hadzievski, T. Grozdanov, N. Bibić), AIP Conf. Proc. 740, pp.497-508
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#### Conferences

1. XIV NATIONAL CONFERENCE OF ASTRONOMERS OF SERBIA AND MONTENEGRO, October 12 - 15, 2005, Belgrade, Serbia and Montenegro
2. European and National Astronomical Meeting JENAM 2005, DISTANT WORLDS, 4-7 July 2005, Liege, Belgium



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3. ASTROPHYSICAL SOURCES OF HIGH ENERGY PARTICLES AND RADIATION, June 20 - 24, 2005, Torun, Poland
4. 5th Serbian Conference on Spectral Line Shapes in Astrophysics. Vršac, June 6-10, 2005 (Local Organizing Committee)
5. Workshop - Multiband Approach to AGN, September 30 - October 02 2004, Bonn, Germany
6. IAU Symposium 225 - IMPACT OF GRAVITATIONAL LENSING ON COSMOLOGY, 19-23 July 2004, Lausanne, Switzerland
7. 17th International Conference on Spectroscopic Line Shapes, June 21-25 2004, Paris, France
8. 4th Serbian-Bulgarian Astronomical Conference (IV SBGAC), 21-24 April 2004, Belgrade, Serbia (Local Organizing Committee)
9. CONFERENCE DEVELOPMENT OF ASTRONOMY AMONG SERBS III, April 25-28, 2004, Belgrade, Serbia
10. 22nd Summer School and International Symposium on the Physics of Ionized Gases, 23 - 27 August 2004, National Park Tara, Serbia and Montenegro
11. Vseruska Astronomicheskaya Konferentsiya (VAK-2004), 3 - 10 June 2004, Moscow, Russia
12. European and National Astronomical Meeting JENAM 2003, NEW DEAL IN EUROPEAN ASTRONOMY: Trends and Perspectives, in connection with the 12th European Meeting for Astronomy and Astrophysics, 25 - 30 August 2003, Budapest, Hungary
13. IV Serbian Conference on Spectral Line shapes, 10 - 15 October 2003, Arandjelovac, Serbia (Local Organizing Committee)
14. Third Bulgarian-Serbian Astronomical Meeting, May 13-15, 2002, Gjolechitsa, Bulgaria
15. XIII National Conference of Yugoslav Astronomers, 17 - 20 October 2002, Belgrade, Serbia (Local Organizing Committee)
16. 21st Summer School and International Symposium on the Physics of Ionized Gases, Sokobanja, Yugoslavia, August 26-30, 2002

### Other activities

Luka Č. Popović:

- Editor of two Proceedings: 1. Publications of the Astronomical Society "Rudjer Boskovic" Proceedings of the 4th Serbian-Bulgarian Astronomical Conference 2. Proceedings of 5th Serbian Conference on Spectral Line Shapes in Astrophysics, published in Vol. 7 of *Memorie della Societa Astronomica Italiana Supplement* (<http://sait.oat.ts.astro.it/MSAIS/7/index.html>)
- Supervisor one 1 PhD thesis, two Master thesis and one Diploma thesis on the University of Padova.

*Astrophysical Spectroscopy of Extragalactic Objects. Research at AOB*

- PI (Principal Investigator) in the observation of the active galaxy Akn 120 with European VLBI network (in the project, besides AOB, participate scientist of the Max-Planck Institute for Radio astronomy in Bonn).

Dejan Urošević:

- Editor of the international journal “Serbian Astronomical Journal” (since 2002).
- Supervisor of two Master thesis.

Predrag Jovanović

- Ivanov, G., Dimitrijević, M. S., Jovanović, P. 2002, Proceedings of the Third Bulgarian-Serbian Astronomical Meeting, May 13-15, 2002, Gjolechitsa, Bulgaria, Publ. Astron. Obs. Belgrade, 73