

## SPECTROSCOPIC INVESTIGATIONS OF EXTRAGALACTIC OBJECTS AT THE ASTRONOMICAL OBSERVATORY IN BELGRADE (2008 – 2009)

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**Abstract.** In this paper we present the work and results of the project P146002 (Astrophysical spectroscopy of extragalactic objects) during two-year period (2008-2009). The work on this project is financed by the Ministry of science and technological development of the Republic of Serbia. Here we describe the scientific activities and give a list of published papers in this period.

### 1. INTRODUCTION

This paper follows two previous reviews (Popović and Ilić, 2006; Popović, Kovačević, Ilić, 2008) where we have reported all activities on the project Astrophysical spectroscopy of extragalactic objects in the period from 2002 to 2007. Astrophysical spectroscopy gives powerful tools for investigation of the emission of extragalactic objects, from which we can learn about the nature and evolution of these objects, and also about the evolution of the Universe. In the period 2008-2009 we have continued the spectroscopic investigation of extragalactic objects started in 2001 at the Astronomical Observatory in Belgrade. These investigations were done in three basic directions: 1. Spectroscopy of active galactic nuclei - AGN; 2. Spectroscopy of quasar gravitational lenses, or the influence of gravitational lenses on quasar spectra; 3. Investigations of the gamma-ray bursts phenomenon.

The most important results from these investigations are: contribution to the research of physical and kinematical properties of central emission regions in AGN, as well as to determining the influence of microlensing effect on quasar spectra (with the aim to scan the inner structure of quasars and lens-galaxy). Also, a model of shock waves for the gamma-ray bursts is developed.

Apart from the scientific research, the project was a base for the education of young researchers (work on several doctoral and master thesis), but also for the

development of wide and successful international collaboration.

In further text we will shortly present the work on this project during 2008 and 2009. We should note here that the participants on this project are closely collaborating with the project led by M. S. Dimitrijević, therefore these two projects (together with the project *Serbian virtual observatory*, led by Darko Jevremović) form an informal group called *Group for astrophysical spectroscopy (GAS)*. Therefore, some activities presented here are actually the activities of the Group for astrophysical spectroscopy.

## 2. RESEARCHERS ON THE PROJECT

In the period from 2008 to 2009, nine researchers were working on this project from three institutions: Astronomical Observatory in Belgrade (AOB), Faculty of Mathematics in Belgrade (FMB) and Faculty of Sciences in Kragujevac (FSK). The project leader was L. Č. Popović, and the researchers were:

1. Edi Bon (born 1970), PhD student from AOB, total 24 Research Months (RM), category A2 (Note here, that Ministry of Science of Serbia invited a categorization due to score of published papers for each researcher. The categories are A1, A2, A3, B1, B2, B3, where the best scientists, around 10% of all, are in A1, and B1 is basic category.)
2. Miodrag Dačić (born 1946), research associate professor from AOB, total 4 RM, category A1
3. Nataša Gavrilović (born 1979), Msc student (PhD student from 2009) from AOB, total 24 RM, category A1
4. Dragana Ilić (born 1978), teaching assistant (assistant professor from 2009) from FMB, total 16 RM, category A1
5. Jelena Kovačević (born 1981), MSc student (PhD student from 2009) from AOB, total 20 RM, category A1
6. Predrag Jovanović (born 1968), assistant research professor from AOB, total 24 RM, category A1
7. Luka Č. Popović (born 1964), research professor from AOB, total 24 RM, category A1
8. Saša Simić (born 1971), teaching assistant from FSK, total 16 RM, category B1
9. Marko Stalevski (born 1982), PhD student granted for a young research position from the Ministry

## 3. SCIENTIFIC AND OTHER ACTIVITIES

The main investigations on the project were related to the activities of galaxies, first of all of to active galactic nuclei (AGNs). These objects are the most powerful sources in the Universe, and they emit energy in a broad range of wavelengths (from gamma to radio emission). The spectroscopy of these objects can give us a lot of information about the innermost part of AGNs, as e.g. mechanisms for

producing the energy in the black hole vicinity, the behaviour of plasma in the strong gravitational field, etc. On the other hand, since these objects are the most powerful sources, we can detect them at large cosmological distances, thus they represent objects that carry information important for cosmological investigations. In the mentioned period the investigations were done in the following subjects:

- Physical and kinematical properties of central emission regions in AGN (in different spectral bands, from x-ray to optical emission, as well as the connections between the emissions from these different spectral bands).
- Spectroscopy of quasar gravitational lenses and the influence of gravitational lenses on quasar spectra.
- Connection between the stellar population and the activity in galaxies.
- Gamma ray bursts as the most violent processes in the Universe, i.e. the nature of this phenomenon.



**Figure 1.** The Local Organizing Committee of the SPIG 2008 (Novi Sad, Serbia, 25.-29. 08. 2008.). From the left to the right: Jelena Kovačević, Nataša Gavrilović, Marko Stalevski, Tanja Milovanov, Edi Bon, Anđelka Kovačević, Branimir Acković, Dragana Ilić, Darko Jevremović, Predrag Jovanović, Nenad Milovanović, Milan Dimitrijević, Zoran Simić i Luka Popović.

In the frame of the listed subjects, the activities of the project participants were the following:

1. Theoretical and experimental investigations, where special attention was given to trainings of young researchers, there were conducted in three directions: a) investigations of physics and kinematics of AGN using the spectral lines shapes and intensities; b) investigations of the influence of gravitational lenses

on the quasar's continuum and spectral lines; c) modelling and explaining the origin of gamma-ray bursts taking into account shock waves;

2. Observations with different telescopes;
3. Research visits to various collaborating institutes and attending scientific conferences interesting to the project;
4. Popularization of science, especially astronomy in the form of giving lectures or organizing exhibition dedicated to astronomy. We should note here that all project participants were actively involved in projects related to the International year of astronomy 2009;
5. Developing of international collaboration through exchange visits of project participants and colleagues from abroad, as well as writing common (bilateral) proposals;
6. Organizing conferences and publishing Proceedings;
7. Systematization and publishing of fulfilled results.

The results that are achieved in the period 2008/2009 are (see Appendix for more detailed description of the achieved results):

- More than 101 bibliography units published, out of which 20 papers in international journals from SSCI list (see the list of references). If we compare the result from this period to the period 2006-2007, we have published two more papers in journals from SSCI list;
- Two PhD theses and two Master theses defended;
- Performed optical observations of gravitational lenses using 6m telescope of Special astrophysical observatory (Caucasus, Russia);
- Became members of the COST action M0905 “Black holes in violent Universe”. We should note that this is the first COST action in astronomy. It involves 17 European countries;
- Participated in 14 international and domestic conferences;
- Project participants did 15 research visits to foreign institutes;
- Organized (or participated in organization) six scientific meetings (see Appendix);
- Large international collaboration (Bulgaria, Russia, Germany, Spain, Italy, Mexico, France, Greece, USA). In the frame of this wide collaboration we formed a new Erasmus Mundus master programme in astrophysics “AstroMundus”, where participants are four European universities (Innsbruck – Austria, Goettingen – Germany, Padua and Rome – Italy, and Belgrade – Serbia). In this programme three project participants are involved as lecturers, and Dragana Ilić is member of the Consortium Board (deputy L. Č. Popović), and Luka Č. Popović is a member of the Selection Committee for selection of students and scholars (deputy Dragana Ilić).

#### 4. FINANCING OF THE PROJECT

As we have reported in previous papers (Popović, Ilić 2006, Popović, Kovačević, Ilić 2008) the project was mainly financed by the Ministry of science of the republic of Serbia. The Ministry has financed the salaries of the researchers, administrative expenses (run by the Institute) and other expenses (which cover travels, materials, equipment, etc.). In the considered period, the Ministry have allocated to the project in total 22,076,716 RSD (for 2008, in total 9,907,390 RSD and for 2009, in total 12.169.326 RSD), or approx. 220,000 EUR.

We should note that approx. 40% of total funds were spent on researcher's salaries, a significant amount was directed to administrative expenses, while for travels, materials, supplies and equipment, only 2,800,000 RSD (around 28000 eur) were spent in two years. These funds were used for renewing the computer equipment, as well as for financing travels (to meetings), observational missions, etc. Apart from this financial support, some additional fund were obtained from the Alexander von Humboldt Foundation, which is financing a project of collaboration between the Group for astrophysical spectroscopy from the Astronomical observatory and the Group for investigation of active galactic nuclei (led by professor Wolfram Kollatschny) from Institute for astrophysics of the University of Goettingen (Germany). Project is awarded a 40,300 EUR for three years, and in 2009 research visits were done and 6,500 EUR were spent from approved funds.

#### 5. CONCLUSIONS

As in the previous period, we can be satisfied with the achieved results in the period 2008-2009. For sure we will try to work harder and give better results in forthcoming period. When comparing the results from 2001-2005, 2006-2007 and 2008-2009, there is an impression that the last period was slightly more successful than the previous two. Also, we should note that the financial support was larger in the last period.

Finally, we have to mention that in July 2010, new project proposal for 2011-2014 was submitted, under the same title and containing the research subjects mentioned above. Apart from this project, researcher Predrag Jovanović has submitted a new project proposal that will deal in more details and depth the investigations of gravitational lenses phenomenon and its applications in the cosmological research. Considering that this project is a product of spectroscopic investigations of extragalactic objects, this could be treated as another great result of this project.

## APPENDIX

### A1. Research visits (observational missions)

- Nataša Gavrilović, 3-months visits each year to CRAL – L'Observatoire de Lyon, Lyon, France
- Luka Č. Popović, Special Astrophysical Observatory, Nizhniy Arkhiz, Russia (2008 observation with the 6m telescope and collaboration, 2009. 10-day visit)
- Luka Č. Popović, University of Padua (May 2008, gave a course to PhD students)
- Luka Č. Popović, Academy of Science of Finland (May 2008, participating in the Pannel for evaluation of project proposals in astronomy that are supposed to be financed by the Academy of Science of Finland)
- Luka Č. Popović, Institute for astrophysics, Canary Islands, Spain (December 2009)
- Luka Č. Popović, University of Gent, Belgium (February 2009)
- Luka Č. Popović, Special Astrophysical Observatory (August 2009, collaboration with the Laboratory for extragalactic astrophysical spectroscopy)
- Luka Č. Popović, Institute for astrophysics, University of Goettingen (one-month visits in November 2008 and in the period 15. 11. – 15. 12. 2009.)
- Luka Č. Popović, Max Planck Institute for Radioastronomy, Bonn (February 2008. Visit financed from the special program of the Alexander von Humboldt Foundation)
- Dragana Ilić, Max Planck Institute for Radioastronomy, Bonn (January - February 2008. Visit financed from the special program of the Alexander von Humboldt Foundation)
- Dragana Ilić, University of Padua (one-week visits in May 2008, gave an Invited lecture, and September 2008, collaboration)
- Dragana Ilić and Jelena Kovačević, Special Astrophysical Observatory, Nizhniy Arkhiz, Russia (November 2008, observation with the 6m telescope and collaboration, two-week visit)
- Dragana Ilić and Jelena Kovačević, Institute for astrophysics, University of Goettingne (one-month visit in the period 15. 11. – 15. 12. 2009. Visit financed from the special program of the Alexander von Humboldt Foundation)
- Marko Stalevski, The Astronomical Observatory of the University of Ghent, Belgium (February 2 – December 16 2009, collaboration in the frame of the program Erasmus Mundus External Cooperation Window, BASILEUS)

### A2. Conferences

#### A2.1 Organized conferences

1. 7<sup>th</sup> Serbian Conference of Spectral Line Shapes in Astrophysics, Zrenjanin, 15-19. June 2009 (Co-chairman Luka Č. Popović, everyone from the project were in the Local Organizing Committee)

2. 25<sup>st</sup> Symposium and Summer School on Physics of Ionized Gases (SPIG), August 25-29, 2008. (Co-chairmans of the Local Organizing Committee: Milan S. Dimitrijević and Luka Č. Popović, everyone from the project were in the Local Organizing Committee)
3. 6<sup>th</sup> Bulgarian-Serbian Conference on Astronomy and Space Science, Belgrade 7 - 11 May 2008 (organized together with Bulgarian colleagues)
4. XV National Conferences of Astronomers of Serbia, Belgrade 2-5. October, 2008 (Dragana Ilić, chairperson of the Local Organizing Committee)
5. Conference dedicated to the IYA 2009: „Како разумјети Универзум: допринос астрономских и физичких истраживања“ (How to understand the Universe: Contribution of investigation in Astronomy and Physics), Banja Luka, 28-29. May 2009. (Luka Č. Popović co-chairman of the Scientific committee)
6. 1<sup>st</sup> Workshop on astrophysical winds and disks, Platamonas, Greece, September 3-8, 2009. (vice-chairmans: Luka Č. Popović and Milan S. Dimitrijević)

## A2.2 Participations in conferences

1. 6th Serbian-Bulgarian regional astronomical meeting, Belgrade, Serbia, June 2008 (participants: everyone from the project).
2. 24th Summer School and International Symposium on the Physics of Ionized Gases, August 2008, Novi Sad, Serbia (participants: everyone from the project)
3. School and Workshop on Space Plasma Physics, September 2008, Sozopol, Bulgaria (participants: L. Č. Popović, D. Ilić, N. Gavrilović, J. Kovačević)
4. XV National Conferences of Astronomers of Serbia, October 2008, Београд, Serbia (participants: everyone from the project)
5. 7th Serbian Conference on Spectral line shapes in Astrophysics, June 2009, Zrenjanin, Serbia (participants: everyone from the project)
6. 1st International Workshop: "Astrophysical winds and disks - Similar phenomena in stars and quasars", September 2009, Platamonas, Greece (participants: everyone from the project)
7. Quantum of Quasars, December 2009, Grenoble, France (participants: Nataša Gavrilović)
8. Развој астрономије код Срба V (development of Astronomy among Serbs V), 18.04 - 22. 04.2008, Belgrade, Serbia (participants: Miodrag Dačić, Luka Č. Popović, Dragana Ilić, Edi Bon)
9. Conference dedicated to the IYA 2009: „Како разумјети Универзум: допринос астрономских и физичких истраживања“ (How to understand the Universe: Contribution of investigations in Astronomy and Physics), Banja Luka, 28-29. May 2009 (participants: Luka Č. Popović, Dragana Ilić)

10. The Fifth RadioNet Science Workshop "The Central Kiloparsec: Active Galactic Nuclei and Their Hosts", June 4-6, 2008, Crete, Greece (participants: Dragana Ilić)
11. „Accretion and Ejection in AGN: a global view“, June 21-27, 2009, Como, Italy (participants: Dragana Ilić)
12. XXVII<sup>th</sup> General Assembly of the IAU, IAU Symposium 267 on “Evolution of Galaxies and Black Holes: Feeding and Feedback”, August 2009, Rio de Janeiro, Brasil (participants: Dragana Ilić)
13. 1st School on Multiwavelength Astronomy”, Paris, France, 29. June-10 July, 2009 (participants: Marko Stalevski).
14. XXI Canary Island Winter School on Astrophysics”, Puerto de La Cruz, Tenerife, Spain, 2-13 November 2009 (participants: Marko Stalevski).

### A3. Publications

#### A3.1 Chapters in international books

1. Jovanović, P., Popović, L.Č., 2009., *X-ray Emission From Accretion Disks of AGN: Signatures of Supermassive Black Holes*, chapter in the book "*Black Holes and Galaxy Formation*", Eds. A. D. Wachter and R. J. Propst, Nova Science Publishers, Inc, Hauppauge NY, USA, ISBN: 978-1-60741-703-3 (62 page)

#### A3.2 Papers in international journals from SSCI list

1. Shapovalova, A. I.; Popović, L. Č.; Collin, S.; Burenkov, A. N.; Chavushyan, V. H.; Bochkarev, N. G.; Benítez, E.; Dultzin, D.; Kovačević, A.; Borisov, N.; Carrasco, L.; León-Tavares, J.; Mercado, A.; Valdes, J. R.; Vlasuyk, V. V.; Zhdanova, V. E., 2008, *Long-term variability of the optical spectra of ngc 4151. I. Light curves and flux correlations*, *Astronomy and Astrophysics*, Volume 486, Issue 1, pp.99-111
2. Hamdi, R.; Ben Nessib, N.; Milovanović, N.; Popović, L. Č.; Dimitrijević, M. S.; Sahal-Bréchet, S., 2008, *Atomic data and electron-impact broadening effect in do white dwarf atmospheres: Si VI*, *Monthly Notices of the Royal Astronomical Society*, Volume 387, Issue 2, pp. 871-882
3. Jovanović, P.; Zakharov, A. F.; Popović, L. Č.; Petrović, T., 2008, *Microlensing of the X-ray, UV and optical emission regions of quasars: simulations of the time-scales and amplitude variations of microlensing events*, *Monthly Notices of the Royal Astronomical Society*, Volume 386, Issue 1, pp. 397-406.
4. Popović, L. Č.; Shapovalova, A. I.; Chavushyan, V.m H.; Ilić, D.; Burenkov, A. N.; Mercado, A.; Bochkarev, N. G., 2008, *Probing the Physical Properties of the NGC 5548 Broad Line Region Using Balmer Lines*, *Publications of the Astronomical Society of Japan*, Vol.60, No.1, pp.1-9



5. Popović, L. Č.; Dimitrijević, M. S.; Simić, Z.; Dačić, M.; Kovačević, A.; Sahal-Bréchet, S., 2008, *Stark broadening and hfs of Mn II*, New Astronomy, Volume 13, Issue 2, p. 85-92.
6. P. Jovanović, L. Č. Popović, *Observational effects of strong gravity in vicinity of supermassive black holes*, Fortschritte der Physik, Volume 56, Issue 4-5, Date: April 2008, Pages: 456-461
7. Simić, S.; Popović, L. Č., 2008, *Investigation of Element Abundances in the Surroundings of GRB Afterglows*, International Journal of Modern Physics D, Volume 17, Issue 09, pp. 1377-1382 (2008).
8. Bon, E., Popović, L.Č., Gavrilović, N., La Mura, G., Mediavilla, E., 2009, Contribution of a disc component to single-peaked broad lines of active galactic nuclei. Monthly Notices of the Royal Astronomical Society 400, 924-936.
9. La Mura, G., Di Mille, F., Ciroi, S., Popović, L.Č., Rafanelli, P., 2009., Balmer Emission Line Profiles and Complex Properties of Broad-Line Regions in Active Galactic Nuclei, Astrophysical Journal 693, 1437-1448.
10. Popović, L.Č., Smirnova, A. A., Kovačević, J., Moiseev, A.V., Afanasiev, V.L. 2009. Three-Dimensional Spectroscopic Study of the Line-Emitting Regions of Mrk 493., Astronomical Journal 137, 3548-3557.
11. Ilić, D. 2009., Plasma Diagnostics in the Broad Line Region of Active Galactic Nuclei Using Emission Lines, Publications of the Astronomical Society of the Pacific, Volume 121, issue 886, pp.1440-1441
12. Urošević, D., Vukotić, B., Arbutina, B., Ilić, D., Filipović, M., Bojičić, I.; Segan, S.; Vidojević, S. 2009. The sigma-D relation for planetary nebulae, Astronomy and Astrophysics, Volume 495, Issue 2, 2009, pp.537-546.
13. Jevremović, D., and 14 colleagues 2009., The project of Serbian Virtual Observatory and data for stellar atmosphere modeling. New Astronomy Review 53, 222-226.
14. Danezis, E., Lyratzi E., Popović, L.Č., Dimitrijević, M.S., Antoniou, A., 2009, Interpreting the complex line profiles in the stellar spectra, New Astronomy Review 53, 214-221.
15. Shapovalova, A.I., Popović, L.Č., Bochkarev, N.G., Burenkov, A.N., Chavushyan, V.H., Collin, S., Doroshenko, V.T., Ilić, D., Kovačević, A., 2009, Long-term variability of the Broad Emission Line profiles in AGN, New Astronomy Review 53, 191-197.
16. Lyratzi, E. Popović, L.Č., Danezis, E., Dimitrijević, M.S., Antoniou, A., 2009, Kinematics of the broad absorption line region in QSOs: Rotation and random motion, New Astronomy Review 53, 179-185.
17. La Mura, G., di Mille, F., Popović, L.Č., Ciroi, S., Rafanelli, P., Ilić, D., 2009, Hydrogen Balmer emission lines and the complex broad line region structure, New Astronomy Review 53, 162-168.
18. Jovanović P., Popović, L.Č., Simić, S., 2009, Influence of gravitational microlensing on broad absorption lines of QSOs: The case of the Fe K $\alpha$  line, New Astronomy Review 53, 156-161.

19. Ilić, D., Kovačević, J., Popović, L.Č., 2009, The line parameters and ratios as the physical probe of the line emitting regions in AGN, *New Astronomy Review* 53, 149-155.
20. Bon, E., Gavrilović, N., La Mura, G., Popović, L.Č., 2009, Complex broad emission line profiles of AGN: Geometry of the broad line region, *New Astronomy Review* 53, 121-127.

### **A3.3 Paperes in domestic refereed journals**

1. Bon, E., 2009, The Disk Emission in Single Peaked Lines for 12 AGNs, *Serbian Astronomical Journal*, vol. 177, pp. 9- 13
2. D. Jevremović, M. S. Dimitrijević, L. Č. Popović, M. Dačić, V. Protić Benišek, E. Bon, V. Benišek, D. Ilić, A. Kovačević, M. Malović: 2009, *SERBIAN VIRTUAL OBSERVATORY, Pregled NCD*, 15, 52-58.
3. Arbutina, B., Ilić, D., Stavrev, K., Urošević, D., Vukotić, B., Onić, D. 2009, Optical Observations of M81 Galaxy Group in Narrow Band [SII] and Halpha Filters: Holmberg IX, *Serbian Astronomical Journal*, 179, 87-94

### **A3.4 Invited lectures on international conferences published in the Proceedings**

1. A. Antoniou, E. Danezis, E. Lyratzi, L. Č. Popović, M. S. Dimitrijević: 2008, *KINEMATICAL PARAMETERS IN THE CORONAL AND POST-CORONAL REGIONS OF THE Oe STARS*, 24th Summer School and International Symposium on the Physics of Ionized Gases, *Journal of Physics: Conference Series* 133, 012028 (1-8).
2. Vauglin, I.; Gavrilović, N.; Prugniel, P., *Thermal InfraRed surveys from Antarctica for extragalactic astronomy*, *EAS Publications Series*, Volume 33, 2008, pp.293-295
3. Simić, Saša; Popović, Luka Č., *Variability of GRB light curve: Shock wave model modification*, *Journal of Physics: Conference Series*, Volume 133, Issue 1, pp. 012030 (2008)

### **A3.5 Papers in non-international journals**

1. Z. Simić, M. S. Dimitrijević, L. Č. Popović, M. Dačić, A. Kovačević, S. Sahal-Bréchet: *ON STARK BROADENING OF Mn II LINES IN Ap-STAR CONDITIONS*, *Contributions to the Astronomical Observatory Skalnaté Pleso* 38, (2008), 451-452.
2. M. S. Dimitrijević, Z. Simić, A. Kovačević, M. Dačić, S. Sahal-Bréchet: *ON STARK BROADENING OF Te I SPECTRAL LINES FOR CP STAR PLASMA ANALYSIS*, *Contributions to the Astronomical Observatory Skalnaté Pleso* 38, (2008), 403-404.

3. M. S. Dimitrijević, T. Ryabchikova, Z. Simić, L. Č. Popović, M. Dačić: *ELECTRON-IMPACT BROADENING OF IONIZED CHROMIUM LINES FOR Ap STAR ATMOSPHERES ANALYSIS*, Contributions to the Astronomical Observatory Skalnaté Pleso 38, (2008), 401-402.

### **A3.6 Papers presented on international conferences published in the Proceedings**

1. M. S. Dimitrijević, A. Kovačević, Z. Simić, M. Dačić: 2008, *STARK BROADENING OF O V 1371 A LINE IN STELLAR ATMOSPHERES*, in “Exploring the Solar System and the Universe”, Eds. V. Mioc, C. Dumitrache, N. Popescu, American Institute of Physics Conference Proceedings 1043, 410-411.
2. Lyratzi, E. Danezis, L. Č. Popović, M. S. Dimitrijević, A. Antoniou: 2008, *A.DACs AND SACs IN THE UV SPECTRUM OF THE QUASAR PG 0946+301*, in Spectral Line Shapes 15, 19<sup>th</sup> International Conference on Spectral Line Shapes, AIP Conference Proceedings 1058, 323-325.
3. E. Lyratzi, E. Danezis, L. Č. Popović, M. S. Dimitrijević, A. Antoniou: 2008, *A.KINEMATICS OF BROAD ABSORPTION LINE REGIONS OF PG 1254+047*, in Spectral Line Shapes 15, 19<sup>th</sup> International Conference on Spectral Line Shapes, AIP Conference Proceedings 1058, 320-322.
4. A. Antoniou, E. Danezis, E. Lyratzi, L. Č. Popović, M. S. Dimitrijević, E. Theodosiou, G. Katsavrias: 2008, *A STUDY OF THE STRUCTURE OF DIFFERENT IONIZATION POTENTIAL REGIONS IN THE ATMOSPHERE OF AX MON (HD 45910)*, in Spectral Line Shapes 15, 19<sup>th</sup> International Conference on Spectral Line Shapes, AIP Conference Proceedings 1058, 317-319.
5. A. Antoniou, E. Danezis, E. Lyratzi, L. Č. Popović, M. S. Dimitrijević, E. Theodosiou, D. Stathopoulos: 2008, *AX Mon (HD 45910) KINEMATICAL PARAMETERS IN THE Fe II SPECTRAL LINES AS A FUNCTION OF THE EXCITATION POTENTIAL*, in Spectral Line Shapes 15, 19<sup>th</sup> International Conference on Spectral Line Shapes, AIP Conference Proceedings **1058**, 314-316.
6. E. Danezis, E. Lyratzi, L.Č. Popović, M.S. Dimitrijević, A. Antoniou:2008, *A.SIMILARITY BETWEEN DACs/SACs PHENOMENA IN HOT EMISSION STARS AND QUASARS ABSORPTION LINES*, in Spectral Line Shapes 15, 19<sup>th</sup> International Conference on Spectral Line Shapes, AIP Conference Proceedings 1058, 305-307.
7. A. Antoniou, E. Danezis, E. Lyratzi, L. Č. Popović, M. S. Dimitrijević, E. Theodosiou, D. Stathopoulos: 2008, *A STUDY OF AX Mon (HD 45910) KINEMATICAL PARAMERERS OF THE Fe II DENSITY REGIONS*, 24<sup>th</sup> Summer School and International Symposium on the Physics of Ionized Gases, SPIG 2008, Contributed papers & abstracts of invited lectures, topical invited lectures and progress reports, eds. G. Malović, L. Č. Popović, M. S. Dimitrijević, Publications of the Astronomical Observatory of Belgrade 84, 455-458.

8. E. Danezis, E. Lyratzi, L. Č. Popović, A. Antoniou, M. S. Dimitrijević: 2008, *THE VERY BROAD LINES IN THE UV SPECTRA OF HOT EMISSION STARS - A POSSIBLE EXPLANATION*, 24<sup>th</sup> Summer School and International Symposium on the Physics of Ionized Gases, SPIG 2008, Contributed papers & abstracts of invited lectures, topical invited lectures and progress reports, eds. G. Malović, L. Č. Popović, M. S. Dimitrijević, Publications of the Astronomical Observatory of Belgrade 84, 463-466.
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