

II WORKSHOP ON ASTROPHYSICAL SPECTROSCOPY

Vrujci, Serbia, October 9-13, 2013

BOOK OF ABSTRACTS

Edited by Milan S. Dimitrijević and Zoran Simić



Society of Astronomers of Serbia

Belgrade, 2014

II Workshop on Astrophysical Spectroscopy Vrujci, Serbia, October 9-13, 2013

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Organized by:

Serbian Astronomical Society (<http://www.das.org.rs/>) and

Group for Astrophysical Spectroscopy, Astronomical Observatory, Belgrade

Scientific rationale

Spectroscopy is a power tool for the analysis of radiation from different plasmas in astronomy, laboratory, fusion research and industry. The investigation of nature of the emitting ionized gas in galactic nuclei is one of important subjects in astrophysics today. Investigating the processes in the central parts of these objects, we can learn about the innermost parts of other 'normal' galaxies. Moreover, AGN are the most powerful sources, located at different cosmological time-scales, and their investigation is cosmologically important. Additionally, a part of emission from these objects (e.g. in the X-rays) has its origin very close to a massive black hole, and investigation of this emission can help us understand the physical processes in a strong gravitational field.

On the other side, a number of AGN are affected by gravitational lensing effect. Studies aimed at determining the influence of microlensing on spectra of lensed quasars (hereafter QSOs) ought to account for the complex structure of the QSO central emitting region. Since the sizes of the emitting regions are wavelength-dependent, microlensing by stars in a lens galaxy will lead to a wavelength-dependent magnification.

Efficace theoretical analysis, synthesis and modelling of stellar spectra as well as the spectra from other plasma sources, depends on atomic data and their sources. In particular for the modeling of stellar atmospheres and opacity calculations a large number of atomic data is needed, since we do not know a priori the chemical composition of a stellar atmosphere. Consequently the development of databases with atomic data and astroinformatics is important for stellar spectroscopy.

Investigation of spectral line profiles is of significance for various research fields not only in astrophysics, where, for example, by analysis of stellar line profiles we can obtain effective temperature, chemical composition, surface gravity and other data on the investigated star, but also for a number of topics in physics and technology

The workshop is planned as an opportunity to consider above mentioned aspects of spectroscopic research on plenary sessions and then to work on the special mini-projects, which will result in common papers to be published in international astronomical journals.

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Abstracts

INVITED LECTURES

**LONG TERM MONITORING OF AGN SPECTRA AND DETECTION OF
SUPERMASSIVE BINARY BLACK HOLES**

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Luka Č. Popović¹, Nataša Bon¹**

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Active galactic nuclei (AGN) are the most luminous objects in the Universe. There are many scenarios that can explain how AGN are triggered. One of the most intriguing involves the existence of a supermassive binary black hole system in their cores. AGN monitoring spectra can reveal such systems by analysing their emission line shapes and continuum flux variation.

Using very long AGN monitoring data and a method typically used for spectroscopic binary stars, we reveal several candidates. We obtained radial velocity curves from which we calculated orbital elements and made estimates about black hole masses. Given the large observational effort needed to reveal this spectroscopically resolved binary orbital motion, we suggest that many such systems may exist in similar objects even if they are hard to find. Detecting more of them will provide us with insight into the supermassive black hole mass growth process.

DIAGNOSTICS FOR COMPOSITE GALACTIC SPECTRA IN HII GALAXIES

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Galactic spectra are often compared to Single Stellar Populations (SSPs) to determine 'characteristic' ages and metallicities, therefore to be called SSP-equivalents age or metallicity. This is in particular often the case when line-strength indices, like those of the Lick system, are used to analyse them. In fact, both physical arguments and detailed analysis of spectra plead for an extended star formation history, and in general SSP-equivalent ages younger than several Gyr are interpreted as evidence for the 'presence of a young population'.

In this note we search the purely observational indices indicating that a medium-resolution optical range galactic spectrum is not well modelled with a SSP. To address this question, we select a sample of (non-AGN) emission line galaxies, we analyse their spectra using full spectrum fitting and we identify the main misfits.

**ON THE EDUCATION OF NATURAL SCIENCES AND PARTICULARLY OF
ASTROINFORMATICS**

Magdalena Christova

*Department of Applied Physics, Technical University – Sofia, 8 Blvd Kl. Ohridski,
1000 Sofia, Bulgaria*

The quality of teaching is of major interest for academic educational institutions. For the new astro-sciences as astroinformatics, astrostatistics, astrochemistry, astrobiology etc., the new way of teaching have to be applied, may be. The modern sources of information and communications define different point of view for young people. The classical and traditional teaching methods are not so adequate and effective even more for new and rapidly developing sciences as astroinformatics. It implies the question on the quality of education in natural science (the programs, the training and learning forms, permanent control of knowledge, examinations, etc.) to attract the scholars to discover the beauty of science and universe. As a educators of the next generation of researchers, scientist and inventors we a responsible for their scientific training.

**ASTROPHYSICAL SPECTROSCOPY:
RESEARCH ON SPECTRAL LINE SHAPES**

Milan S. Dimitrijević

Astronomical Observatory, Volgina 7, 11060 Belgrade, Serbia

Data on spectral line shapes are of importance for a number of problems concerned to research and modelling of various astrophysical and laboratory plasmas, as well as for inertial fusion, laser produced and technological plasmas investigations, modelling and the corresponding spectrum synthesis and analysis. Also, such data are of interest for designing of laser equipment. For example in astrophysics, data on the broadened spectral lines are needed for radiative transfer investigations, analysis and synthesis of spectra of astrophysical plasmas and modelling, spectroscopic diagnostics and determination of optical characteristics of stellar atmospheres and envelopes, as well as for determination of the temperature in particular atmospheric layers, the chemical composition of stellar plasma, surface gravity, spectral type and effective temperature.

We will review here the needs for line broadening data, with an accent on astrophysical applications and the line broadening due to the influence of collisions with charged particles on emitting/absorbing atoms and ions, so called Stark broadening. We will also review the recent work in this research field on Belgrade astronomical observatory and inclusion of such data in STARK-B database (<http://stark-b.obspm.fr/>), Virtual Atomic and Molecular Data Center (VAMDC - <http://www.vamdc.org/>) and Serbian Virtual Observatory (SerVO - <http://servo.aob.rs/>).

SERBIAN INVOLVMENT IN LSST

Darko Jevremović

Astronomical Observatory, Volgina 7, 11060 Belgrade, Serbia

In this contribution we give a brief overview of the Large Synoptic Survey Telescope (LSST) project. Recent developments, as well as comparisons to other future projects are discussed. We also summarize Serbian interest in the LSST which is mainly in the fields of astroinformatics, variable objects (AGN's, stars etc.) and solar system objects. Our current and future involvement with the project opens many oportunities to work in the top level science.

**SUPER-MASSIVE BLACK HOLE ESTIMATE USING SPECTO-POLAROMETRIC
OBSERVATIONS**

Luka Č. Popović

Astronomical Observatory, Volgina 7, 11060 Belgrade, Serbia

Here we discuss a method for super-massive black hole estimates using spectro-polarometric observations. Using the fact that the polarization angle in the case of equatorial polarization depends only on the velocity field in the region around a super-massive black hole, we find that this can be used for confirmation of Keplerian emission gas motion, and consequently for the super-black hole mass estimate."

LONG TERM MONITORING ON BROAD LINE AGN

Alla I. Shapovalova

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Active galactic nuclei (AGNs) - are among the most luminous long-lived objects in the universe, which emit a wide range of the electromagnetic spectrum from radio waves to gamma rays. The standard model of AGN assumes that at the centers of galaxies (harboring active nuclei) is a supermassive black hole, which mass-magnitude spanning the range between 10^6 and 10^9 mass of the sun, surrounded by a bright accretion disk. The radiation of the accretion disk ionizes and heats the surrounding gas, producing broad spectral lines. This region is known as broad-line emission region or BLR-region.

We present the program and results of ground-based long-term monitoring of AGNs, conducted by Special Astrophysical Observatory (Russia), Guillermo Haro Observatory (Mexico) and Astronomical Observatory Belgrade (Serbia). The principal aim of this program is to search for changes in the BLR on a dynamical timescale that might be tracked in changes in the emission lines response time or in the emission-line profiles. This program also provides continuum observations, which may provide keys about the origin and variability of the continuum.

ON THE STARK BROADENING IN STELLAR ATMOSPHERES

Zoran Simić

Astronomical observatory, Volgina 7, 11060 Belgrade, Serbia

Stellar spectroscopy needs atomic and line-broadening parameters for a very extensive list of line transitions for various elements in neutral and ionized states. In several works we investigated Stark broadening mechanism in atmospheres of A type stars and DB and DA white dwarfs. Here, we present a review of our work on the importance of Stark broadening data for stellar atmospheres plasma research on the basis of our results for spectral line widths for Cr II, Mn II, Au II, Cu III, Zn III and Se III transitions, obtained within the modified semiempirical approach and semiclassical perturbation method. Also, Stark broadening of rare earth ions (La II, La III, Eu II and Eu III) was considered in chemically peculiar Ap stars.

**THE QUASI-MOLECULAR ABSORPTION BANDS IN UV AND EUV REGION
CAUSED BY THE NON-SYMMETRIC ION-ATOM PROCESSES IN THE HELIUM
RICH WHITE DWARF ATMOSPHERES**

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The processes of the ion HeH^+ photo-dissociation together with the process of the absorption charge-exchange and photo-association in the $\text{He}+\text{H}^+$ collisions can significantly influence on the opacity of the atmospheres of some helium rich white dwarfs in far UV and EUV regions. It is shown that the examined processes generate rather wide quasi-molecular absorption bands in the considered spectral regions even in the cases of the atmospheres of the white dwarfs with $\text{H}:\text{He} = 10^{-5}$. It is established that in the cases of the white dwarfs with $\text{H}:\text{He}$ larger or approximately equal to 10^{-4} , particularly when $\text{H}:\text{He}$ is approximately 10^{-3} , these processes have to be included *ab initio* in the corresponding models of their atmospheres since in far UV and EUV region they became dominant in respect to the known symmetric ion-atom absorption processes.

SHORT TALKS

THE CORRELATIONS BETWEEN UV AND OPTICAL SPECTRAL PROPERTIES

Jelena Kovačević and Luka Č. Popović

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We assume that the correlations between different spectral features reflect the kinematical and physical properties of the emission regions. In order to investigate the different emission regions of the Active Galactic Nuclei (AGN), we investigate the correlations between UV and optical spectral properties in the large sample of AGN spectra (293) obtained from Sloan Digital Sky Survey (SDSS). In order to analyze the emission lines, the first step was to subtract the UV pseudocontinuum. The new model of UV pseudocontinuum is presented which enable calculation of the Balmer continuum intensity using the strong Balmer lines. The obtained line and continuum parameters are analyzed and several interesting correlations are found, which need physical explanation in farther investigation. Also, we found kinematical connection between the optical and UV Fe II lines with cores of the Balmer lines and Mg II.

Program

Wednesday 09.10.2013

10:00-11:30 Arrival and registration

11:30-12:00 Opening ceremony

Chairman: **Luka Č. Popović**

12:00-12:40 Invited lecture **Milan S. Dimitrijević**: ASTROPHYSICAL SPECTROSCOPY: RESEARCH ON SPECTRAL LINE SHAPES

12:40-13:20 Invited lecture **Alla Shapovalova**: LONG TERM MONITORING ON BROAD LINE AGN

13:30-15:00 Lunch

15:00-18:00 Work in Sections 1-4 on Mini-projects

19:00 Dinner

Thursday 10.10.2013

Chairperson: **Alla Shapovalova**

10:30-11:10 Invited lecture **Vladimir Srećković**, A. A. Mihajlov, Lj. M. Ignjatović, M. S. Dimitrijević: THE QUASI-MOLECULAR ABSORPTION BANDS IN UV AND EUV REGION CAUSED BY THE NON-SYMMETRIC ION-ATOM PROCESSES IN THE HELIUM RICH WHITE DWARF ATMOSPHERES

11:10-11:50 Invited lecture **Zoran Simić**: ON THE STARK BROADENING IN STELLAR ATMOSPHERES

12:00-14:00 Lunch

14:00-18:00 Work in Sections 1-4 on Mini-projects

Friday 11.10.2013

09:00-16:00 Excursion: Monastery Ćelije (<http://tov.rs/?p=1138>) and Brankovina (<http://tov.rs/?p=1145>)

17:00-19:00 Work in Sections 1-4 on Mini-projects

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Saturday 12.10.2013

Chairperson: **Vladimir Srećković**

11:00-11:40 Invited lecture **Darko Jevremović**: SERBIAN INVOLVMENT IN LSST

11:40-12:20 Invited lecture **Magdalena Christova**: ON THE EDUCATION OF NATURAL SCIENCES AND PARTICULARLY OF ASTROINFORMATICS

12:20-12:50 Invited lecture **Nataša Bon**: DIAGNOSTIC FOR COMPOSITE GALACTIC SPECTRA IN HII GALAXIES

12:50-13:05 Short talk **Jelena Kovačević**: THE CORRELATIONS BETWEEN UV AND OPTICAL SPECTRAL PROPERTIES

13:30-15:00 Lunch

15:00-18:00 Work in Sections 1-4 on Mini-projects

20:00 Conference Dinner

Sunday 13.10.2013

Chairman **Darko Jevremović**

11:00-11:40 Invited lecture **Luka Č. Popović**: ESTIMATION OF THE SUPERMASSIVE BLACK HOLE MASS USING SPECTRO-POLARIMETRIC OBSERVATIONS IN THE BROAD LINES

11:40-12:20 Invited lecture **Edi Bon**, P. Jovanović, P. Marziani, A. I. Shapovalova, L. Č. Popović, N. Bon: LONG TERM MONITORING OF AGN SPECTRA AND DETECTION OF SUPERMASSIVE BINARY BLACK HOLES

12:20 Closing ceremony

12:30-14:00 Lunch

14:30 Departure

SECTIONS

S1 Spectroscopy of Active galactic nuclei (Coordinator Luka Č. Popović)

S2 Astrophysical plasmas (Coordinator Anatolij Mihajlov)

S3 Astroinformatics and spectroscopic research (Coordinators Darko Jevremović and Milan S. Dimitrijević)

S4 Spectral line profiles in stellar and laboratory plasmas (Coordinator Milan S. Dimitrijević)

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