XIII SERBIAN CONFERENCE ON SPECTRAL LINE SHAPES IN ASTROPHYSICS

BOOK OF ABSTRACTS

Eds. Anđelka Kovačević, Luka Č. Popović and Saša Simić

Astronomical Observatory, 2021

XIII SERBIAN CONFERENCE ON SPECTRAL LINE SHAPES IN ASTROPHYSICS

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Invited Lecture

AB INITIO AND SEMI-EMPIRICAL ATOMIC STRUCTURE CALCULATIONS. APPLICATIONS TO THE 5s-6p TRANSITIONS FOR THE Mo II ION

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In this work, we present two different methods for calculating atomic structure for atoms and ions.

The first one is the Hartree-Fock pseudo-Relativistic (HFR) method which can be *ab initio* where we calculate the atomic parameters theoretically by using for example the first three programs of the Cowan (CW) atomic structure code: RCN, RCN2 and RCG. We can also use it semi-empirically by using the forth CW program RCE and fitting the purely theoretical energy levels with experimental data taken for example from the NIST database.

The second one is the Thomas-Fermi-Dirac-Amaldi (TFDA) method which can be *ab initio* where we calculate the atomic parameters theoretically by using for example the SUPERSTUCTURE (SS) or the AUTOSTRUCTURE (AS) atomic structure codes. We can also use it semi-empirically by using the Term Energy Corrections (TEC) in SS or the Level Energy Corrections (LEC) in SS or AS atomic structure codes.

As an applications of using these methods, we calculate energy levels, oscillator strengths and transition probabilities for the 5s-6p transitions for the Mo II ion using *ab initio* and semi-empirical methods with the CW and AS atomic structure codes.

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Invited Lecture

A NEW METHOD FOR CALCULATING COLUMN DENSITIES USING GR MODEL. AN APPLICATION IN THE CASE OF C IV, N IV AND N V SPECTRAL LINES IN THE UV SPECTRUM OF THE O STAR HD 149757 (ζ Oph)

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In this work, we present a new method for calculating column densities of ionic transitions exhibited in the spectra of various astronomical objects. The method is based on the GR model and the A.S.T.A. software we have developed for analyzing broad and complex absorption and emission profiles of astronomical objects like hot stars and BAL quasars. As the model is able to decompose broad absorption and emission profiles to the uniquely determined number of components they consist of, we can measure not only the column density of the entire profile but the column density (N_{ion}) of each absorption component. Apart from column densities the model provides the radial (V_{rad}) and rotational (V_{rot}) velocities, optical depths at line centers (τ_0), FWHMs and EWs of individual absorption components. In this pilot study, we analyze the DAC complex profiles of C IV, N IV and N V of the O-star HD 149757 (ζ Oph). We utilize multi-epoch spectra, obtained 13 years apart, in order to probe the variability of each absorption component's column density, i.e., variations of the column density of each absorbing system in the line of sight. We find that the absorption profiles of C IV and N V resonance lines consist of two absorption components, while the N IV spectral line of one. Our findings show that C IV, N IV and N V DACs arise from the same clumpy gas clouds, which have similar locations, kinematics as well as structure and physical conditions. The column density variations exhibited by individual absorption components are due to changes in the ionizing state of the outflowing gas.

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Invited Lecture

EXPLORING THE ORIENTATION OF RADIO-LOUD AGN

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Inclination angles of active galactic nuclei (AGN) are hard to estimate. Here we explore the orientation of radio-loud ("jetted") AGN in an SDSS and FIRST cross-matched sample, using the broad emission line shapes of Balmer lines. We discuss implications of inclination measurements for virial black hole mass estimates.

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Invited Lecture

MONITORING OF SEYFERT 1 GALAXIES AT THE SPECIAL ASTROPHYSICAL OBSERVATORY OF THE RUSSIAN ACADEMY OF SCIENCE

A. N. Burenkov[1], D. Ilić[2,3], V. H. Chavushyan[4], L. Č. Popović[2,5,6] and A. B. Kovačević[2,6]

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We present a development of the long-term monitoring of type 1 active galactic nuclei (AGNs) at the Special Astrophysical Observatory of the Russian Academy of Science, which was initiated by Alla Ivanovna Shapovalova back in the eighties of the last century. Setting up and running this monitoring program, which was among the first program combining different telescopes and observatories, was a challenge for the SAO group of AGN optical variability investigations. We have encountered many unique problems (e.g. methods of observation, data processing, data calibration, analysis of AGN spectra, hardware problems, lack of obtained observation time on the telescope, etc.), that were successfully overcame during the monitoring program. Here we present how we have addressed and solved these problems, as well as some results of long-term monitoring of individual AGNs. This work was supported by the Russian Science Foundation (grant no. 20-12-00030 "Investigation of geometry and kinematics of ionized gas in active galactic nuclei by polarimetry methods").

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Invited Lecture

EXPRESSIONS OF "FAST" AND "SLOW" CHAMELEON DRESSED STATES IN AUTLER-TOWNES SPECTRA OF ALKALI-METAL ATOMS

A. Cinins[1], M. S. Dimitrijević[2], V. A. Srećković[3], M. Bruvelis[4], D. K. Efimov[5], K. Miculis[1], N. N. Bezuglov[6,1] and A. Ekers[4]

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Upon interaction with atoms or molecules, resonant laser radiation alters ("dresses") the structure of unperturbed quantum states, transforming them into superpositions of the initial ("bare") states. Contemporary scientific literature categorizes the dressed states emerging in Λ type excitation schemes, and their higher–dimensional generalizations such as tripods, as either "bright" or "dark" states (Shore, 2011). The bright states interact with the laser radiation, while the dark states remain decoupled from the radiation. The absence of laser-induced transitions is a fundamental property of the dark states, responsible for a number of their unique features, which are widely demanded in practical applications of laser manipulation of matter, such as laser cooling, optical frequency standards, implementations of slow light and creation of ultrafast systems for storing and reading optical information (Fleischhauer et al. 2005).

To register and study the dressed states, one can implement an Autler-Townes (AT) spectroscopic experiment, as it allows to observe intermediate (i) and the highest excited (final, f) state papulations in a 2-step excitation scheme. In a typical AT arrangement (see Kirova et al. (2017) for details), a strong laser (S) couples intermediate and final levels, producing laser-dressed states, and a weak probe laser (P) provides a modest population transfer to the dressed states by coupling ground (g) and intermediate levels.

In a recent work (Kirova et al., 2017), a new class of dressed states ("chameleon" states) has been identified along with the dark and bright states. Properties of the chameleon states resemble a mixture of bright and dark state properties. In this report and in the subsequent publication we will show that these states can be further

categorized into "fast" and "slow" chameleon states. Their manifestations will be illustrated using simulated Autler-Townes absorption spectra of alkali metal atoms. Formation of the chameleon and bright states is associated with different, complementary characteristics of the density matrix, which provide additional opportunities for optical diagnostics of atomic media, including those of astrophysical relevance.

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Invited Lecture

NEW QUASAR MICROLENSING CONSTRAINTS ON THE SPIN OF HIGH REDSHIFT QUASARS

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Gravitational microlensing provides a unique probe to study the emission region of the innermost parts of quasar accretion disks and the discrete lens popolution in the lensing galaxy. We present new quasar microlensing constraints on the spin of high redshift quasars from a joint analysis of the excess equivalent widths of the FeK line observed in the lensed quasars. We first confirm the positive offset from the Iwasawa-Taniguchi effect for lensed quasars, and then performed microlensing analysis to constrain the emission size of the reflection region and the average spin of supermassive black holes, assuming that the X-ray corona and the reflection region, responsible for the iron emission line, both follow power-law emissivity profiles. The microlensing analysis yields a steep emissivity index and a large spin parameter, suggesting that the X-ray reflection region is ultra-compact and very close to the innermost stable circular orbits of black holes, which are spinning close the maximal value. The analysis represents a new technique to measure black hole spins for high redshift quasars.

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Invited Lecture

BLACK HOLE MASSES FROM EMISSION LINE WIDTHS

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Reverberation mapping and scaling relationships based on reverberation results provide the underpinning of all estimates of quasar black hole masses. When applying these scaling relationships, there are potential pitfalls that are widely unappreciated and can result in biases that can, in turn, lead to systematic errors in the black hole mass function and therefore conclusions about the evolution of black holes over time. I will discuss potential sources of biases with the analysis of emission line widths and show how they can be mitigated.

Invited Lecture

THE AGNSTORM 2 PROGRAM: A DETAILED VIEW OF GAS FLOWS IN Mrk 817

Gisella De Rosa and the AGNSTORM 2 collaboration

Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218, USA

AGNSTORM 2 is an intensive, multi-wavelength monitoring program of the luminous Seyfert I galaxy Mrk 817. The program is anchored to the HST program "Mapping Gas Flows in AGNs by Reverberation" (PID: 16196, 198 orbits). The ongoing HST program is mapping the UV emission of Mrk 817 with an average cadence of two days, using the COS and STIS instruments. I will present the characteristics of this unique reverberation program and its first exciting results.

Invited Lecture

RADIO-LOUD POPULATION A QUASARS AT HIGH REDSHIFT

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Different properties of quasars may be observed and analysed through the many ranges of the electromagnetic spectrum. Pioneering studies showed that an "H-R diagram" for quasars was needed to organize these data and a four-dimensional Eigenvector (4DE1) parameter space was proposed. The 4DE1 "optical plane", also known as the quasar Main Sequence (MS), present different spectral types in order to describe a consistent picture of QSOs. Moreover, the MS makes use of independent observational properties obtained from the optical and UV emission lines, as well as from the soft-X rays. In this work we present measured properties in the optical and UV regions of a sample of 22 quasars at high redshift (z=2-4) observed in the infrared at VLT/ESO, and with additional measures in UV we obtained through the fitting of the SDSS spectra. We will present a special analysis of the radio-loud sources in the sample and in particular focusing on the strong radio-loud of population A quasars. Spectral analysis was performed through the non-linear multicomponent decomposition of the line profiles. The considered radio-loud sources present very small blueshifted component, at variance with radio-quiet Pop. A quasars of comparable luminosity. The strongest radio emitters are also found with the more symmetric Hβ profiles. Results are show in order to identify the location of the sources within the Main Sequence, and highlight the effects of the radio-loudness on their emission line properties.

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Invited Lecture

MULTI OBJECT METHODS FOR FINDIND AND STUDY QSO's AND GALAXIES

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My report devoted to the memory of prof. V.L. Afanasiev who played an important role role in developping a new methods of observations on 6-m Telescope and not only on it. I will begin with Multi Slit Field Spectrograph (MSFS) which was created by prof. V.L. Afanasiev in early 80-s - first multi object spectrograph on the large telescope in the world. We use several modifications of MSFS for spectral study of hundreds faint galaxies and QSO's. In the middle of 80's we use MSFS with photon counting system and later with first CCD's. In the beginning of 90's prof. V.L. Afanasiev and our team created Multi Object Fiber Spectrograph (MOFS). Using MOFS we developed a QSO survey of 1-sq. degree field on 6-m Telescope. At the end of 90's in collaboration with french astronomers we developed a new method for detecting high redshift galaxies ("primeval" galaxies) using Multi Band Filters on 2.6-m Byurakan, 3.6-m ESO and on 6-m Telescopes. This work was continued on the 6-m Telescope with Medium Band Filters in the early 2000s, allowing us to find several tens of high redshift galaxies up to z=6. In the middle of 10's in collaboration with armenian astronomers and effisient support of prof. V.L. Afanasiev we restore famouse Byurakan 1-m Schmidt Telescope and began Medium Band Filters Survey on it. Some square degrees of the sky already observed and we obtaned new data about QSO evolution and galaxies large scale distribution.

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Invited Lecture

PARTIAL OBSCURATION AS A CAUSE OF ASYMMETRIES OF BROAD BALMER LINE PROFILES IN ACTIVE GALACTIC NUCLEI

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The broad-line region (BLR) is the region producing the broad emission lines in active galactic nuclei (AGNs). Profiles of the broad lines, and the time delays in the responses of these lines to variations in the ionizing continuum (reverberation mapping), imply that the BLR consists primarily of dense, turbulent gas in a flattened distribution co-rotating above the accretion disc of an AGN. With this geometry, the observed profiles of the broad lines depend on the viewing angle. If the BLR is seen close to face-on, the line profiles are centrally-peaked, "logarithmic" profiles. As the BLR is viewed progressively further off-axis, the profiles should become broader and double-peaked, as is expected from a rotating disc of gas. However, the expected "disc-like" profile is almost never seen in AGNs. Instead, broad double-peaked profiles are usually quite asymmetric. We have studied a sample of the most extreme Balmer line profiles. We show that the properties of these extreme profiles arise naturally because of partial obscuration of the BLR by outflowing dust clouds. Such obscuration can be a factor causing some of the anomalous responses of emission lines to continuum variability.

Invited Lecture

A PROSPECTIVE STUDY ON USING MACHINE LEARNING FROM SPECTROSCOPIC DATA FOR PLASMA PARAMETER PREDICTIONS

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This work deals with machine learning, especially the use of Python sickit-learn package to build predictive models. Sickit-learn is widely used in data science and artificial intelligence. It is focused on spectroscopic data of hydrogen isotopes or impurities from tokamaks combined with independent diagnostic systems, aiming to predict plasma parameters or isotopic ratios. The work is inspired by the very recent application of machine learning to predict plasma parameters in linear devices like PISCES-B or NAGDIS where neutral helium lines were used (Nishijima et al. 2021) to predict electron density and temperature. A line intensity ratio dataset of about 9 neutral helium lines where used as input data in a support vector machine regression analysis of a machine learning to predict n_e and T_e values which are validated by comparison with n_e and T_e deduced from an independent diagnostic technique like Langmuir probe in Nishijima et al. (2021) or Thomson scattering. Usually, He I line ratios are used in combination with collisional-radiative modeling to get the electron density and temperature since some lines are sensitive to the electron density and others to the electron temperature (Kajita et al. 2020). In this prospective work, It is proposed to use a similar method by considering some major line characteristics like line width, peak positions, line dips, intensities and some other features (shoulders) depending on the available data. The data will be split in a train set and a test set to build an appropriate regression fitting analysis allowing to predict results which will be confronted to the test data set before its use for further predictions. Applications to tokamak plasmas is foreseen in a further step of this work.

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Invited Lecture

SPECTRAL VARIABILITY OF ACTIVE GALACTIC NUCLEI IN THE CONTEXT OF LARGE TIME-DOMAIN SURVEYS

Andjelka B. Kovačević[1,2], Dragana Ilić[1,3], Luka Č. Popović[1,2,4], Viktor Radović[1], Isidora Jankov[1], Ilsang Yoon[5], Neven Caplar[6], Iva Čvorović-Hajdinjak[1] and Saša Simić[7]

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It is now widely accepted that the optical variability of active galactic nuclei (AGN) originates from the complexity of the environment surrounding the central Supermassive black hole (SMBH), producing stochastic broad line and continuum light curves. Measuring the high correlation between the light curves of the continuum and broad emission lines might indicate the common driving process of their variability.

However, the nature of physical processes behind the optical variability of AGN is still the enigma that will be subjected to an investigation of upcoming large photometric and spectroscopic synoptic time-domain surveys such as s Vera C. Rubin Observatory Legacy Survey of Space and Time (LSST), and Manuakea Spectroscopic Explorer (MSE).

Here, we report an investigation of the effects of AGN variability observables (time lag, periodicity, and structure-function time scales) in light curves on LSST survey strategy as a function of different possible operations simulations(OpSims) using the metrics analysis framework (MAF). We discuss the best observing strategies of the LSST for detecting AGN variability observables (the opensource code is publicly available at https://github.com/LSST-sersag/). However, the proposed proxies could be applied to other spectroscopic and photometric surveys to select cadence strategy decisions.

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Invited Lecture

IMPROVEMENTS TO THE SHORT-CHARACTERISTICS METHOD IN 3D-RHD SIMULATIONS AND SOME UNSOLVED PROBLEMS IN SPECTRAL LINE SHAPES OF A-TYPE STARS

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Radiative transfer is the most important physical process taking place at the surface of a star, the stellar atmosphere. For a wide range of stars their atmospheres feature also convective energy transport which nowadays is often investigated theoretically by numerical radiation hydrodynamical simulations (RHDs), in two and also in three spatial dimensions (2D and 3D). Numerical efficiency is very important in this context, since the radiative transfer equation has to be solved for each grid point and each time step and each spatial direction chosen in those simulations. To accelerate such RHDs of stellar atmospheres with the ANTARES code a modified Bézier interpolation has recently been proposed, implemented, and tested. A report on the advantages of this approach will be given. This is followed by a discussion of unsolved problems concerning the shape of spectral lines in A-type main sequence stars and supergiants where existing RHDs yet fail to reproduce observed data, contrary to the success this approach has had for stars of lower effective temperature such as our Sun.

Invited Lecture

THE QUASAR MAIN SEQUENCE: RECENT DEVELOPMENTS

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The last few years have seen the confirmation of several main trends associated with the quasar main sequence. The idea of a main sequence for quasars is relatively recent, and its full potential for the observational classification and contextualization of quasars' properties has yet to be fully exploited. We briefly summarize developments that permit a less-inaccurate estimate of the supermassive black hole masses, inferences on the chemical composition of the broad line emitting gas, and on the nature of radio emission along the quasar main sequence. Last, we'll relate the main sequence to other important scaling laws, such as the fundamental plane of black hole activity.

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Invited Lecture

OBSERVATIONS OF LARGE-SCALE IONIZING CONES IN SEYFERT GALAXIES

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Along with jet-induced outflows, ionizing cones give us one of the most powerful examples of the impact of active galactic nuclei on the interstellar and intergalactic medium at spatial scales from hundred parsecs to tens of kiloparsecs. We considered the results of observations of cone-like extended emission-line regions (EELRs) in Seyfert galaxies obtained at the Russian 2.5-m and 6-m telescopes using 3D and long-slit spectroscopic techniques. The observations aimed at the following main objectives: (i) Testing the predictions of the AGN unified model and constraining the central engine parameters. (ii) Probing the history of an AGN radiative output across the light-travel times to the external gaseous clouds. (iii) Studying the kinematics and origin of the off-plane gas illuminated by AGN. The contribution of Victor Afanasiev's works to our understanding of the EELR properties is also considered. *(The study was supported by the Russian Science Foundation, project No. 17-12-01335).*

Invited Lecture

CHANGING LOOKS OF THE NUCLEUS OF SEYFERT GALAXY NGC 1566 IN COMARISON WITH OTHER CL AGNs

V. L. Oknyansky

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We present results of the long-term multi-wavelength study of optical, UV and X-ray variability of the nearby changing-look (CL) Seyfert NGC 1566 observed with the *Swift* Observatory and the MASTER Global Robotic Network from 2007 to 2019. We started spectral observations with South African Astronomical Observatory 1.9-m telescope soon after the brightening was discovered in July 2018 and present here the data for the interval between Aug. 2018 to Sep. 2019. In the first publication (Oknyansky et al., 2019), we reported on the change in the spectral type of the object. Here we concentrates on the remarkable post-maximum behaviour after July 2018 when all bands decreased with some fluctuations (Oknyansky et al., 2020). We observed three significant re-brightenings in the post-maximum period during 17 Nov. 2018–10 Jan. 2019, 29 Apr.–19 Jun. 2019 and 27 Jul.–6 Aug. 2019. An X-ray flux minimum occurred in Mar. 2019. The UV minimum occurred about 3 months later. It was accompanied by a decrease of the $L_{\rm uv}/L_{\rm x}$ ratio. New post-maximum spectra covering (31 Nov. 2018 – 23 Sep. 2019) show dramatic changes compared to 2 Aug. 2018, with fading of the broad lines and [Fe X] λ6374 until Mar. 2019. These lines became somewhat brighter in Aug.-Sep. 2019. Effectively, two CL states were observed for this object: changing to type 1.2 and then returning to the low state as a type 1.8 Sy. We suggest that the changes are due mostly to fluctuations in the energy generation. The estimated Eddington ratios are about 0.055% for minimum in 2014 and 2.8% for maximum in 2018.

Variability properties of NGC1566 are compared with our results for other CL AGNs: NGC4151, NGC2617, NGC3516, and Mrk6.

Invited Lecture

OBSCURED AGN AT THE COSMIC NOON

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Most bulge-dominated galaxies host black holes (BH) with masses that tightly correlate with the masses of their bulges. The quest to understand how, when, and where those BH formed motivates much of extragalactic astronomy. One population of galaxies with active BH in their nuclei (active galactic nuclei or AGN) that are fully or partially hidden by dust and gas, may hold the key with which to unlock this puzzle. Recent studies show that the luminosity functions of obscured and non-obscured AGN differ. Also, the most luminous, and dustiest of quasars are major mergers and are the most reddened by dust.

Those tantalizing discoveries point the way forward for the next decade. We can target obscured quasars to get a statistically sound handle on their demographics using photometry X-ray through radio alone. The next generation of X-ray, radio, and IR wide field/all-sky surveys, the Nancy Grace Roman Mission, and the Vera Rubin Observatory's Legacy Survey of Space and Time must be leveraged by efficient (i.e., sensitive/wide aperture/highly multiplexed) spectroscopic surveys in the optical and NIR. In this talk, I will emphasize the need for optical-NIR surveys (e.g., with the Maunakea Spectroscopic Explorer) to study the reddening properties, star-formation histories, and excitation conditions in obscured AGN. These critical studies will shed light on the role of black holes in galaxy evolution during the epoch of peak growth activity.

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Invited Lecture

POLARIZATION IN BROAD EMISSION LINES OF ACTIVE GALACTIC NUCLEI

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Active Galactic Nuclei (AGNs) are one of the most powerful sources in the Universe. AGNs are emitting broad emission lines (BELs), which are coming from the broad line region (BLR) that is close to the supermassive black hole (SMBH) assumed to reside in the center of these objects. The BEL shapes can indicate the emission gas dynamics and are thus used to investigate the BLR characteristics, but moreover they can be used to determine the SMBH mass. Polarization in BELs depends on the geometry of the BLR, but also on the polarization mechanism. The polarization rate and angle across the line profile can be used to measure the SMBH mass, and constrain the BLR characteristics. Here we give an overview of our recent investigations of the polarization in BELs from both aspects: theoretical and observational. This lecture is devoted to Victor L. Afanasiev, who led the observational part of these investigations and who sadly passed away at the end of 2020.

Invited Lecture

ADDRESSING THE ACCURACY OF THE COMPUTER SIMULATION METHOD INVOLVED IN STARK BROADENING CALCULATIONS

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In this work, we examine the accuracy of the so-called computer simulation method used for the modeling of Stark-broadened line shapes. The main idea of this tool is to reproduce the power spectrum radiated by the neutrals by retaining the physical mechanisms occurring at the microscopic scale in a way as realistic as possible. One part of the algorithm is devoted to the calculation of the plasma microfield based on the motion of the charged particles located at the vicinity of the atoms. For a set of simulated microfield histories, corresponding to different initial conditions, the time-dependent Schrödinger equation is solved numerically and the resulting dipole operator is evaluated. It is next inserted in the power spectrum formula, which serves in the evaluation of observable spectroscopic signals. The computer simulation method is well established in the plasma spectroscopy community (e.g., Stambulchik and Maron 2010), it has been applied to the diagnostic of laboratory and astrophysical plasmas, but the reliability of the results has not been systematically addressed. By construction, the algorithm involves various causes of uncertainty (discretization, finite number of particles, etc.), which can result in the occurrence of significant error bars in the results. We examine this issue along the lines of a recent work Rosato et al. (2020). We present new simulations of Stark line shapes in conditions relevant to white dwarf atmospheres. The Lyman and Balmer series are considered. The sensitivity of density diagnostics involving Stark broadening models to the model accuracy is examined through calculations in specific cases.

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Invited Lecture

25 YEARS OF INTEGRAL FIELD SPECTROSCOPY – FROM THE BTA TO THE VLT

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This talk is dedicated to the memory of Victor Afanasiev, an early pioneer of integral field spectroscopy. With a personal perspective and anecdotes from first observations with MPFS at the Selentchuk 6m Telescope, I will review the development of integral field spectroscopy from the first experiments to the state-of-the art, from predominantly instrumental expert driven science, to factors of 10 oversubscription rates at the most demanded ground—based optical telescope of the world. I will particularly highlight the very broad application of integral field spectroscopy to numerous science cases, ending with an outlook to the next promising instruments.

Invited Lecture

NEW CAPABILITIES OF AGN POLARIMETRY

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This talk is devoted to the memory of Dr Viktor Afanasiev and the last results of his work. All achievements highlighted here was gained thanks to his scientific intuition and working energy. In recent years, our team under Dr Afanasiev's supervision has discovered new possibilities for studying AGN in polarized light, which has been a "reboot" for some branches of optical researches. First, it was shown that all-night monitoring of BL Lac type objects with high accuracy and temporal resolution in polarized light allows us to estimate the size of an optical jet and the intraday variability is consistent with a simple geometric model of the jet. Second, the technique of AGN reverberation mapping in polarized light was reinterpreted. It was shown that in the case of Sy 1 galaxies with equatorial scattering, the delay of the polarized signal in a broad emission line allows us to estimate the size of the scattering region, which is closely related to the radius of dust sublimation. These approaches have already been successfully applied to several well-known AGNs and have produced quantitative results that will be presented in the report. At the same time, these methods are suitable not only for large instruments, as in the case of AGN spectropolarimetry but also for small telescopes.

This work was supported by the Russian Science Foundation (grant no. 20-12-00030 "Investigation of geometry and kinematics of ionized gas in active galactic nuclei by polarimetry methods").

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STUDY OF UV Ne II LINE SHAPES IN THE CATHODE SHEATH OF AN ABNORMAL GLOW DISCHARGE

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We present an optical emission spectroscopic study of Ne II 369.421 nm, Ne II 371.308 nm, and Ne II 372.711 nm spectral line shapes performed in the cathode sheath (CS) region of an abnormal glow discharge in pure neon together with a theoretical study by a novel iterative CS kinetic model which successfully described the experimental profiles of these lines providing estimates of the most important CS parameters (e.g. the thickness of the CS region, distribution of electric field, and the gas temperature).

This work is dedicated to the memory of Nikola M. Šišović.

[*] Deceased

Invited Lecture

RYDBERG ATOMS IN ASTROPHYSICS: NEW RESULTS

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Elementary processes in astrophysical phenomena traditionally attract researchers attention. This can be attributed to a group of ionization and excitation processes in Rydberg atom collisions with ground state parent atoms (Mihajlov et al. 2011). In this work we review the state-of-art of the study of these processes making special emphasis on the most relevant features regarding the dynamical mechanisms which govern these reactive collisions. We show that the atoms and molecules in Rydberg's states are important for the astrophysics of cold stars and cosmic objects from various reasons.

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Invited Lecture

SPECTRAL LINE MERGING IN HYDROGEN-LIKE SPECIES FOR DIAGNOSTIC OF LABORATORY AND SPACE PLASMAS

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Plasma density effects manifest themselves in various atomic phenomena, including spectral line broadening, delocalization of higher excited levels, and merging of the discrete and continuous spectra. A theoretical model successfully explaining benchmark spectroscopic observations is crucial for reliable density measurements.

In this study, laser-induced hydrogen plasma in the density and temperature range of $(0.1 - 5) \times 10^{23}\,\mathrm{m}^{-3}$ and $(6000 - 20000)\,\mathrm{K}$, respectively, was precisely diagnosed using two-color Thomson scattering technique, inferring the electron number density, electron temperature as well as ion temperature. Simultaneously, spectra of the Balmer series of spectral lines from H-β to H-ζ were measured and plasma emission coefficient calculated within the quasicontiguous frequency-fluctuation model. The theoretical spectra are found to be in good agreement with experimental ones, including higher-density data where discrete lines were observed to merge forming a continuum.

This calculational approach can be applied to model spectra of hydrogen-like ions or Rydberg series of any species, providing efficient density diagnostic of laboratory and space plasmas.

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Invited Lecture

ACCRETION-MODIFIED STARS IN ACCRETION DISKS OF ACTIVE GALACTIC NUCLEI

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Compact objects are expected to exist in the accretion disks of supermassive black holes (SMBHs) in active galactic nuclei (AGNs), and in the presence of such a dense environment ($\sim 10^{14}\,\mathrm{cm}^{-3}$), they will form a new kind of stellar population denoted as Accretion-Modified Stars (AMSs). This hypothesis is supported by recent LIGO/Virgo detection of the mergers of very high-mass stellar binary black holes (BHs). We show that the AMSs will be trapped by the SMBH-disk within a typical AGN lifetime. In the context of SMBH-disks, the rates of Bondi accretion onto BHs are $\sim 10^9 L_{\rm Edd}/c^2$, where $L_{\rm Edd}$ is the Eddington luminosity and c is the speed of light. Outflows developed from the hyper-Eddington accretion strongly impact the Bondi sphere and induce episodic accretion. We show that the hyper-Eddington accretion will be halted after an accretion interval of $t_{\rm a} \sim 10^5 m_1\,\mathrm{s}$, where $m_1 = m_\bullet/10M_\odot$ is the BH mass. The kinetic energy of the outflows accumulated during $t_{\rm a}$ is equivalent to 10 supernovae driving an explosion of the Bondi sphere and developing blast waves. We demonstrate that a synchrotron flare from relativistic electrons accelerated by the blast waves peaks in the soft X-ray band ($\sim 0.1\,\mathrm{keV}$), significantly contributing to the radio, optical, UV, and soft X-ray emission of typical radio-quiet quasars. External inverse Compton scattering of the electrons peaks around 40 GeV and is detectable through *Fermi*-LAT. The flare, decaying with $t^{-6/5}$ with a few months, will appear as a slowly varying transient. The flares, occurring at a rate of a few per year in radio-quiet quasars, provide a new mechanism for explaining AGN variability.

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Progress Report

ENERGY LEVELS, OSCILLATOR STRENGTHS AND TRANSITION PROBABILITIES FOR THE Ti II ION

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In this work, energy levels, oscillator strengths and transition probabilities for the Ti II ion are calculated by the Hartree-Fock pseudo-Relativistic (HFR) method using the Cowan (CW) atomic structure code and by the Thomas-Fermi-Dirac-Amaldi (TFDA) method using the AUTOSTRUCTURE (AS) atomic structure code.

We used the terms and levels generated by the 12 configurations: $3d^2$ ns (n=4-6), $3d^2$ np (n=4,5), $3d^2$ nd (n=4,5), $3d^2$ 4f, 3d 4s np (n=4,5), 3d $4s^2$, $3d^3$.

We improved our *ab initio* calculated data by using the semi-empirical methods in the CW and AS atomic structure codes. We also compared with other theoretical and experimental results and obtained new data for this ion.

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Progress Report

STARK BROADENING OF STRONTIUM ION Sr V SPECTRAL LINES IN HOT WHITE DWARF ATMOSPHERES

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Stark broadening and atomic data calculations have been developed for the most recent years, especially atomic and line broadening data for highly ionized ions. The aim of the present work is to perform calculations of Stark broadening for ten Sr V lines recently discovered in the UV spectrum of the hot white dwarf RE 0503−289, which have never been detected before in hot white dwarfs (Rauch et al. 2017). The recent discovery of new Sr V lines encourages us to provide their Stark broadening to enrich the databases and to be used in the interpretations of the observed spectra. No Stark broadening results in the literature to compare with. So, our results come to fill this lack of data.

Calculations have been performed at electron density $N_e = 10^{17}$ cm^{-3} and for electron temperature varying from 10^4 to 10^5 K. Calculations have been performed using our quantum mechanical approach (Elabidi et al. 2004, 2008). Along our calculations, radiative atomic data (energy levels, line strengths, oscillator strengths and radiative decay rates) for this ion have been calculated using the UCL codes (SUPERSTRUCTURE, DW, JAJOM). Stark broadening results, together with atomic radiative data, are useful for non-local thermodynamic equilibrium (NLTE) stellar-atmosphere modelling.

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Progress Report

HUNTING FOR PLANET-MASS OBJECTS IN EXTRAGALACTIC SYSTEMS

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Quasar microlensing serves as a unique tool to probe discrete objects within galaxies and galaxy clusters. Recent developments have enabled us to constrain the planet-mass objects beyond our home galaxy by studying the microlensing signatures in the X-ray emission line emerging from the innermost region of the supermassive black hole of a high redshift quasar. We implement this technique to impose effective constraints on the planet-mass distribution within two lens systems, Q J0158−4325 ($z_l = 0.317$) and SDSS J1004+4112 ($z_l = 0.68$), using Chandra monitoring observations for two gravitationally lensed quasars. The observed variations of the emission line peak energy can be explained as microlensing of the FeKα emission region induced by planet-mass microlenses. To confirm, we perform microlensing simulations to determine the probability of a caustic transiting the source region and compare this with the observed line shift rates. Our analysis yields constraints on the substellar population, with masses ranging from Moon ($10^{-8}M_{\odot}$) to Jupiter ($10^{-3}M_{\odot}$) sized bodies, within these galaxy or cluster scale structures, with total mass fractions of $\sim 3\times10^{-4}$ and $\sim 1\times10^{-4}$ with respect to halo mass for Q J0158−4325 and SDSS J1004+4112, respectively. Our analysis suggests that unbound planet-mass objects are universal in galaxies, and these objects are conjectured to be either free-floating planets or primordial black holes. This work presents the first-ever constraints on the substellar mass distribution in the ICL of a galaxy cluster. Our results provide the most stringent limit on the mass fraction of primordial black holes at the mass range.

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Progress Report

STATISTICAL ANALYSIS OF THE AlIII1860 LINE AS A VIRIAL BLACK HOLE MASS ESTIMATOR

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At low redshift (z≤0.8) the black hole mass of active galactic nuclei is estimated using FWHM(Hβ), but as further in redshift we go the options are to follow the Hβ line into the infrared or adopt other broad lines in the UV. Previous work found that the intermediate ionization lines (∼20-40 eV) AlIIIλ1860 and CIII]λ1909 are probably emitted in a virialized region associated with the production of the Hydrogen Balmer line and of singly-ionised iron FeII ($n_e \sim 10^{12}$ cm^{-3}, U∼2 and $N_c \geq 10^{23}$ cm^{-2}), present in type-1 quasars.

Taking the previous results into account, we selected a high S/N (>20) sample from the SDSS DR16 where AlIIIλ1860 and the forbidden line [OII]λ3728 are observed simultaneously (z∼1.2-1.4) and a sample with coverage of Hβ and CIVλ1549 in order to compare them. A sample with coverage of Hβ, AlIII and CIII] supports the usefulness of both AlIIIλ1860 and CIII]λ1909 as surrogate virial broadening estimators in place of Hβ. However, the AlIII profile shows a blueshift with respect to the quasar rest-frame identified by the [OII] line. This could mean that a mixture of two non-resolved components are present in the nuclei of the quasar: a virialized one plus an outflow. The shifts, although present, are fewer and fainter than the ones observed for CIV in sources of comparable luminosity. The implication is that the AlIIIλ1860 and CIII]λ1909 line widths can still be considered as acceptable virial broadening estimators.

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Progress Report

DEEP LEARNING OF AGN SPECTRAL VARIABILITY

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The optical variability has long been a proposed diagnostic of the central engines of active galactic nuclei (AGNs). However, one important problem in monitoring of AGN optical variability is the observational sampling (cadence), since an AGN cannot be observed constantly and periods between observations are not equal. However, the reproduction of AGN light curves is very important for exploring their spectral variability.

Deep learning networks offer a way to model nonlinear behavior based on representations learnt from data and promise new insights into the underlying physical processes. This makes them a potentially great tool for modeling AGN light curves, since complex perturbed interactions of hot gas, dust, and magnetic fields in close proximity to a super-massive black hole cannot be fully described with the standard statistical model of optical quasar variability.

In this talk, we describe tools for modeling photometric and spectroscopic AGN light curves data. We developed a deep learning engine (DLE) for modeling AGN light curves and extraction of variability properties which has been implemented in Python (https://github.com/LSST-sersag/dle).

The first results of DLEs testing are encouraging and show good potential for future use in the Vera C. Rubin Observatory Legacy Survey of Space and Time (LSST) which will comprise the 10-year photometric observations of southern sky in an optical domain.

Progress Report

STARK BROADENING OF B I SPECTRAL LINES

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This study is a continuation of our previous work on the Stark broadening parameters of boron spectral lines. In Dimitrijević et al. (2016), Stark broadening parameters, widths and shifts due to collisions with electrons, protons and He II ions have been calculated for 157 B IV multiplets and in Christova and Dimitrijević (2019) and Christova et al. (2019) regularities and systematic trends within B I spectral series have ben examined. Here, we calculated widths and shifts due to collisions with electrons, protons and He II ions for 66 multiplets of neutral boron using the semiclassical perturbation theory (Sahal-Bréchot, 1969ab; Sahal-Bréchot et al. 2014). The range of temperatures is from 2 500 K to 50 000 K and electron density values are within the range 10^{11} – 10^{19} cm^{-3}. The obtained Stark broadening parameters have been used to examine the importance of Stark broadening mechanism in stellar atmospheres.

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Progress Report

STATISTICAL AND DYNAMICAL PROPERTIES IN PLASMAS GOVERNED BY H.G.K PSEUDO-POTENTIAL

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The objective of this work is to introduce the ionic structure effect on the electric micro-fields distribution and on the temporal auto-correlation functions of a plasma perturbed by a positive impurity. This study is carried out in mean-field theory, under one component plasma model (OCP). Firstly, we established the nonlinear integral equation governing the effective potential of the electrons, by considering the Hellmann-Gurskii-Krasko Pseudo-potential (HGK), which introduces the ionic structure into the interaction between the electrons and the positive impurity. At the second stage, we solved this integral equation by the fixed point method to determine this effective potential which allows us to calculate the electric microfield distribution and the trajectories of the electrons around the impurity. Finally we use the Monte Carlo simulation to calculate the temporal auto-correlation function of the electric microfield acting on the impurity.

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Progress Report

DENSITY WAVES OF IONIZED GAS IN BROAD-LINE REGIONS OF ACTIVE GALACTIC NUCLEI

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There are growing evidence that the broad-line regions (BLRs) in AGNs have substructures or inhomogeneity, e.g., the sub-features of the velocity-delay maps in reverberation mapping. These substructures in BLRs may originate from or be connected with the instabilities in the self-gravitating regions of accretion disks. We will present our recent work about the loosely wound spiral arms excited by gravitational instabilities in disk-like BLRs and their observational characteristics. It is found that the spiral arms can explain some phenomena in observations.

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Progress Report

DETECTION OF QUASI-PERIODIC OSCILLATIONS IN γ-RAY AND OPTICAL LIGHT CURVES OF THE BL Lac 4FGL J0650.7+2503

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In this work, we have assembled the long-term variability data of the blazar 4FGL J0650.7+2503 in the γ-ray and the optical bands, spanning about 11.9 and 8.6 yr, respectively. The light curves are then analyzed by using Lomb-Scargle Periodogram, Weighted Wavelet Z-transform, Jurkevich and discrete correlation function techniques, and the results reveal two possible timescales of quasi-periodic oscillation: 500$\pm$37 days for γ-ray and 330$\pm$20 days for optical. To explore the origin of the γ-ray, we investigated between the optical and γ-ray bands correlations, and found that the correlation between the two bands is very significant. This correlation can be reasonably explained by the lepton self-synchro-Compton model. Basing on the supermassive binary black hole system model, we estimate the primary black hole mass $M \sim 8.5 \times 10^8\ M_\odot$.

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Progress Report

EXPLORING THE ENVIRONMENT OF ACTIVE GALAXIES

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We present the results of studying the effects of Active Galactic Nuclei (AGN) on neighboring galaxies in a dense local environment in the HS47.5-22 field. We identified galaxy groups in the HS47.5-22 field based on medium-band photometric data obtained at the 1-meter Schmidt Telescope of the Byurakan Astrophysical Observatory. The physical properties of galaxies, such as the star formation rate (SFR), the stellar and gas mass, colors in the rest frame, etc. were obtained with the software package CIGALE [1]. Next, a sample of galaxies with active nuclei in a dense local environment was selected for further observations with the 6-meter BTA telescope. The results will be presented in the report.

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Progress Report

STARK BROADENING EFFECT IN HOT DA WHITE DWARFS: ULTRAVIOLET LINES OF Fe V

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Ultraviolet spectral lines of Fe V ion are observed in many hot white dwarfs atmospheres (Preval et al. 2013, 2019). Fe V spectral lines are also used to measure the fine structure constant α, at the surface of the white dwarf G191-B2B (Hu et al. 2019, 2021). Recently in Hamdi et al. (2021), we have calculated Stark broadening parameters (widths and shifts) for a large number of Fe V spectral lines using semiclassical perturbation approach (Sahal-Bréchot 1969a,b). The work was motivated by the importance of Fe V spectral lines for the study of white dwarfs atmospheres and specially for the measure of the variation of the fine structure constant in strong gravitational field. In this work, we present Stark broadening widths and shifts for 15 UV lines of Fe V calculated using semiclassical perturbation approach. The needed atomic data are calculated using Hartree-Fock approch with relativistic corrections (Cowan 1981). Our results are presented as a function of temperature for collisions with electrons, protons singly and doubly charged helium. Finally, we have investigated the importance of electron impact broadening effect in the atmospheric conditions of hot DA white dwarfs. We use the atmospheric models of Wesemael et al. (1980).

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CALCULATING THE SIMULTANEOUS EFFECT OF ION DYNAMICS AND OSCILLATING ELECTRIC FIELDS ON STARK PROFILES

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Oscillating electric fields can change the radiative properties of plasmas, with e.g. changes in the line shape. Such fields can be generated by an external source, as e.g. a microwave generator or laser radiation, with the aim of diagnosing or heating the plasma. They may also be created inside the plasma, resulting from a nonthermal effect driven by a plasma instability. For this case a current interest is the diagnostic of energetic particle beams in tokamak edge plasmas, with the potential use of the line shape changes (Meireni et al. 2018) caused by the generated Langmuir waves. The effect of oscillating fields on spectral line shapes has been studied since several decades by using approaches based on kinetic theory and retaining the quantum effects of the emitting particles (Baranger and Mozer 1961, Lisitsa 2014). We study here with a computer simulation the simultaneous effect of ion dynamics and oscillating electric fields on hydrogen Stark profiles. Ion dynamics is well known to affect the central region of the first Lyman and Balmer lines for e.g. plasma densities of 10^{19} to 10^{23} m^{-3} and temperatures of the order of the eV or larger, corresponding to many laboratory, fusion and astrophysical plasmas. Reliable models for ion dynamics are based on a computer simulation coupled to a numerical integration of the Schrödinger equation for the emitter evolution operator (Ferri 2014). We discuss here some of the features of the models required in the different situations considered: fixed or sampled oscillating electric field magnitudes, fixed direction or randomly oriented oscillating field, effect of a simulation of the electrons, comparison to a convolution model.

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Progress Report

GAS AND STARS IN THE TEACUP QUASAR

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We present new results on the radio-quiet type 2 QSO known as the Teacup galaxy (SDSSJ1430+1339) based on long-slit and 3D spectroscopic data obtained at the Russian 6-m telescope. We mapped the ionized gas extending up to 50 kpc in the [OIII] emission line.

To discriminate the ionization mechanism of extended gas the optical diagnostic diagrams of the emission line ratios were used. We find out that the nebula is ionized by the AGN similar with the gas in the galaxy disc.

We also have studied the properties of the stellar population and the structure and velocity field of the ionized gas nebula surrounding the galaxy. We have discovered a previously unknown system of ionized gas bubbles and gas-stars counter-rotation in the main galaxy.

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Progress Report

REPRESENTATION AND CHARACTERIZATION OF BROAD-LINE AGN SPECTRA BASED ON MANIFOLD LEARNING

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Considerable progress has been made in the contextualization of broad-line active galactic nuclei (AGN) spectral diversity, providing a basis for meaningful classification and analysis of underlying physical processes based on linear low-dimensional representations of multidimensional parameter space (e.g., Marziani et al. 2018 and references therein, Jankov & Ilić 2020). There is a subset of spectral features, such as the variation in spectral line widths and dust obscuration, exhibiting nonlinearity and thus needing a different approach in order to be taken into account. For this, we use a manifold learning algorithm called Locally Linear Embedding (LLE), which has been previously applied to non-linear data sets (e.g., Vanderplas & Connolly 2009). We further develop our LLE analysis presented in Jankov et al. (2020). In this work, the robust LEE was applied to 19-dimensional space of spectral parameters of low-redshift broad-line AGN extracted from the Sloan Digital Sky Survey Data Release 7 catalogue (Liu et al. 2019). In the next step, we aim to apply this procedure directly to the spectra of the same AGN sample, for a more complete account of their spectral features. Here we present our preliminary findings, aiming to demonstrate the usefulness of the LLE algorithm for visual representation of broad-line AGN properties, and the characterization of distinct sub-populations, which might prove to be of use in future big sky surveys.

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Progress Report

QUASARS PHYSICAL PROPERTIES STUDY BASED ON THE MEDIUM-BAND PHOTOMETRIC SURVEY

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We carried out a medium-band photometric survey on the 1-m Schmidt telescope of the BAO NAS. We have developed a method focused on obtaining the maximum completeness of the sample of quasars. The selection algorithm was tested on the data of the HS47.22 field. The selection of objects was carried out in the following stages: using the morphology of objects from the DECaLS survey; using the method of nearest neighbors in the color space of broadband and medium-band filters; using infrared colors (WISE); using GAIA data on parallax and proper motions; using X-ray data (ROSAT) and radio data (FIRST). At the final stage, objects were added to the main sample of quasars after visual observation of the medium-band spectral energy distributions. By means of this technique, we created the sample of quasars in the field HS47.22 with maximum completeness, determined the photometric redshifts, and carried out studies of the physical properties of the quasars. In this report, we compared the luminosity function of quasars obtained by our method and the results of other authors.

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Progress Report

THE LINE PROFILES IN AGNs TYPE 1.8-2: UNRAVELING THE COMPLEX KINEMATICAL PROPERTIES

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We used the sample of 577 spectra of Active Galactic Nuclei (AGNs) type 1.8-2, obtained from SDSS to analyze the kinematical properties of the narrow emission lines. We fit these lines ([O III], Hβ, Hα, [N II] and [S II]) with single and double (core+wing components) Gaussian models and investigate the influence of the gravitational and non-gravitational kinematics to the line components of different lines. We focused to the wing components of the double Gaussian lines since they represent the pure non-gravitational contribution. Using the subsample in which Hα and [N II] lines are unblended (can be fitted independently), we found the empirical relationships between their wing components which we used to establish the procedure of decomposition of the blended Hα+[N II] wavelength band, which is present in 40% of spectra in our sample. We found the strong correlations between the shifts of the wing components for all analyzed lines, and between their widths (with exception of the Hβ) which implies the systemic influence of the outflow kinematics to the line profiles in spectra. We found that in 2.5% of the sample, the [O III] lines have complex shapes, which cannot be fitted with double Gaussian model. We discuss these examples separately in context of the outflow biconical model.

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Progress Report

IONIZED-GAS CLOUDS IN THE 2MASX J013130.00-062550.8 GALAXY

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Search of the extended emission-line regions (EELRs) ionized with the AGN radiation allows to study the history of the active nuclei luminosity at the time scales of 10 – 100 thousand years, intergalactic medium gas distribution and the radio jets influence on the gas in the host galaxy.

In this work we present a detailed study of the EELRs in the Seyfert 2 galaxy 2MASX J013130.00-062550.8. We discovered two symmetric extended ($\sim 20''$, i.e. $\sim$17.6 kpc away from nucleus) ionized-gas clouds emitting in the [OIII]λ5007 line.

Observations were carried out at the prime focus of the 6-m SAO RAS telescope with the multi-mode focal reducer SCORPIO-2. We used the long-slit spectroscopic mode to probe ionization state of the gas and the 3D spectroscopy with the scanning Fabry-Perot interferometer to analyze the gas kinematics.

Optical diagnostic diagrams and the presence of the HeIIλ4686 in the long-slit spectra demonstrate that EELRs are ionized by the nuclear radiation. We consider various hypothesis about the origin of the observed structures.

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Progress Report

VARIABILITY OF THE NEAR-INFRARED CORONAL EMISSION LINES IN THE ACTIVE GALAXY NGC 5548

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The spectra of active galactic nuclei (AGN) often contain forbidden emission lines from ions with very high ionisation potentials (> 100 eV). These lines are commonly named 'coronal lines' (CLs) after their presence in spectra of the Solar corona. CLs are important to study since they likely trace the AGN's ionising flux in the extreme-UV and soft X-ray bands, which are not directly visible. The precise nature of the CL emitting gas (its location, kinematics, and ionisation mechanism) in AGN is still not well understood. However, the fact that CLs are generally stronger in type 1 (unobscured) than in type 2 (obscured) AGN implies that there are two CL emitting regions: one compact (which is obscured by the dust torus in type 2 AGN) and a larger region which extends beyond the obscuring torus.

Time-resolved spectroscopy provides a means of probing the CL region, by revealing changes in the fluxes and profile shapes of the lines. In 2016–17, near-infrared spectroscopic monitoring was undertaken on the well-studied, nearby, type 1 AGN NGC 5548. I present ongoing work investigating the variability of the CLs [S VIII] λ9914, [S IX] λ12523, [Si X] λ14305 and [Si VI] λ19650 during this campaign. The CLs are found to be broader than the low-ionisation [S III] λ9532 line and blueshifted with respect to it by a few hundred km s^{-1}. These imply CL emission from an outflowing gas on more compact scales than the low-ionisation narrow line emitting region, consistent with previous studies. Prominent, broad and variable wings on [S VIII] and [Si VI] suggest an additional CL emitting region to that which produces the narrower line core. Differences in the emission line profiles and behaviours indicate the complexity of the CL emitting region.

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Progress Report

SYSTEMATIC TRENDS AMONG THE STARK WIDTHS OF Co II SPECTRAL LINES

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The possibility of finding systematic trends among the electron-impact broadening parameters of Co II spectral lines were investigated. We compared previously calculated full widths at half maximum of 46 Co II multiplets obtained using modified semiempirical approach with simple estimates of Cowley and Lakićević. In our analysis two verions of Cowley's estimates were used, according to our similar discussion about regularities and systematic trends found among the Stark broadening parameters of Zr IV and Lu III spectral lines, while simple estimate of Lakićević has already been commonly used very often in the case of single-ionized emitters, either for comparison with more exact results, or to approximate unknown Stark width values. We aditionally found two new correlations between considering Stark width sample and lower ionization potential where better accuracy was achieved than in the case of using Lakićević's formula. We also shortly attempt to discuss possible consequences of our results on semiempirical Stark broadening theory.

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Progress Report

THE PHOTOMETRIC REVERBERATION MAPPING OF ACTIVE GALAXIES IN SAO RAS

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The most popular method to estimate the supermassive black hole (SMBH) mass in active galactic nuclei (AGN) is reverberation mapping. This classical method is based on measuring the time delay between the continuum flux and the flux in the broad emission line. We apply the method of photometric reverberation mapping in medium-band filters, adapted for observations on the telescopes of SAO RAS, primarily 1-m Zeiss-1000. We present the results of ongoing long-term photometric monitoring of several AGN and give the estimates of their SMBH masses.

This work was supported by the Russian Science Foundation (grant no. 20-12-00030 "Investigation of geometry and kinematics of ionized gas in active galactic nuclei by polarimetry methods").

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Progress Report

DRAMATIC VARIABILITY IN A CHANGING-LOOK BLAZAR, B2 1420+32

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Blazars are active galactic nuclei with their relativistic jets pointing toward the observer, with two major sub-classes, the flat spectrum radio quasars (FSRQ) and BL Lac objects. We present multi-wavelength photometric and spectroscopic monitoring observations of the blazar, B2 1420+32, focusing on its outbursts in 2018-2020. Multi-epoch observations show that the blazar exhibited large scale spectral variability in both its continuum and line emission, as well as dramatic gamma-ray and optical variability by factors of up to 40 and 15, respectively, on week to month timescales. Over a period of 15 years, the gamma-ray and optical fluxes increased by factors of 1500 and 100, respectively.

B2 1420+32 was an FSRQ with broad emission lines in 1995. It transitioned between BL Lac and FSRQ states multiple times, with the emergence of a strong Fe pseudo continuum after multiple flares were observed starting in December 2017. Two spectra also contain components that can be modeled as single-temperature black bodies of 12,000 and 5,200 K. Such a collection of "changing look" features has never been observed previously in a blazar. Most emission line flux variations, except the Fe continuum, are within a factor of 2–3, and we conclude the transitions between FSRQ and BL Lac classifications are mainly caused by the continuum variability. The large increase in the Fe continuum flux suggests the occurrence of dust sublimation which released more Fe ions in the central engine and an energy transfer from the relativistic jet to sub-relativistic emission components. This study is published in its entirety in the Astrophysical Journal and can be found at https://iopscience.iop.org/article/10.3847/1538-4357/abf63d/pdf.

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Progress Report

THE PASCHEN BROAD LINE REGION AND TORUS IN Mrk 509

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We have carried out one of the first spectroscopic dust reverberation mapping programs in the near-infrared on an active galactic nuclei (AGN). Reverberation mapping is a powerful technique which allows constraints to be placed on the spatial extent of structures within AGN which cannot be imaged. These components include the inner region of dust heated by the continuum source, which re-radiates in the infrared. We have obtained 17 medium resolution near-IR spectra of the type 1 Seyfert galaxy Mrk 509 between May and November 2019 using the 3-m IRTF in Hawaii combined with high cadence optical photometry. Using these data we aim to obtain near-IR lag times and therefore place constraints on the spatial extent of the inner obscuring material. Our spectra enable measurements of dust flux, temperatures and covering factor with a greater precision than is possible by photometric means, allowing for investigation into the astrochemistry and geometry of the inner obscuring material. Simultaneously we measure the first Paschen line lags allowing for direct comparison of spatial extent between the broad line region (BLR) and the inner obscuring material. In addition we present preliminary results from a near-IR spectroscopic campaign on Mrk 817 with an average cadence of 3 days taken over 7 months as part of the STORM2 collaboration.

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Mrk 926 REVEALS DISCRETE LINE SATELLITES DURING A DRASTIC PHASE OF DECLINE

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It is generally accepted that the variability of the central ionizing continuum source in active galactic nuclei (AGN) causes line intensity variations of the broad emission lines. Furthermore, variations in the line profiles might be induced by changes in the kinematics and structure of the broad emission line region (BLR), or by obscuration effects. However, despite an ever increasing number of reverberation mapping (RM) campaigns, many details of the BLR – such as size, structure, kinematics and dynamics – are still poorly understood. Therefore, in order to make more robust statements about the BLR, more densely sampled spectroscopic and photometric campaigns are needed. Here, we present results of a high-cadence, optical spectroscopic and photometric monitoring campaign of Mrk 926 taken with the 10 m Hobby-Eberly-Telescope (HET) and the C18 telescope of the Wise Observatory, respectively. The campaign lasted for about 4 months with a majority of observations only 1-2 days apart. During the observing run, Mrk 926 exhibited a decline in flux of $\sim 50\%$, and the line profiles reveal distinct Balmer and Helium satellites that respond swiftly to the optical continuum variations.

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Progress Report

FLATTENING OF THE CURVE: DIAGNOSTICS OF THE Hβ AND OPTICAL Fe II EMISSION IN NGC 5548

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We report preliminary results on the analysis of the Hβ and optical Fe II light curves of the type-1 AGN NGC 5548. During a time lapse of over 13 years NGC 5548 showed remarkable changes in continuum flux, accompanied by variations in Hβ flux and EW, and in the Fe II intensity as well. An important aspect of the light curves is the flattening that occurs in the response of Hβ to large continuum flux increase. We attempt the recovery of the observed trends with photoionization using CLOUDY simulations. Using the Locally Optimized Cloud model approach to probe the line luminosity (Hβ and Fe II) as a function of broad-line region covering fraction and cloud density distribution. The analysis required a careful consideration of the spectral energy distribution as a function of continuum luminosity, and of the effect of the line emitting gas column density. This allowed us to constrain the values of the covering fraction, and to reproduce the observed flattening trends.

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Progress Report

MODELING OF COLLISIONAL REDISTRIBUTION OF LINE RADIATION BY COMPUTER SIMULATIONS

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In plasma physics, the process of radiation scattering is described by a redistribution function $R(\omega, \vec{n}, \omega', \vec{n}')$: this quantity is the joint probability density for an atom absorbing a photon with frequency ω' and direction $\vec{n}'$ and reemitting it with frequency ω and direction $\vec{n}$. Redistribution function models are widely used in astrophysics for the description of spectral line formation from stellar atmospheres out of local thermodynamic equilibrium, e.g. Mihalas (1978). In regimes where collisions between the radiator and the plasma particles are frequent, the reemitted photon loses memory of the state of the incoming photon and the corresponding emission line shape function is identical to the absorption line shape function; this situation is referred to as complete redistribution. In a more general case, the reemitted radiation spectrum presents a more elaborated structure, which is closely related to the shape of the redistribution function $R(\omega, \vec{n}, \omega', \vec{n}')$. In this work, we reconsider the modeling of collisional redistribution through a recently developed computer simulation method (Rosato in press). The power spectrum is written in terms of the dipole operator expressed in the Heisenberg picture. The latter is described as a linear response to the electric field related to the incoming photon, and collisions with neighboring particles are accounted for through an additive perturbation term in the Hamiltonian. We examine the redistribution of hydrogen line radiation in a selection of cases from astrophysics and laboratory plasma research. Calculations are performed and comparisons to already available models are done.

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Progress Report

BROAD EMISSION LINE POLARIZATION OF LENSED QUASARS

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We investigate the influence of lensing effect to the polarized light from the broad line region (BLR) of lensed quasars taking the standard model of lens system $z_l = 0.5$, and $z_s = 2$. We explore the influence of macro-, milli- and microlensing effect on the disc-like BLR light polarized by equatorial scattering of the inner side of the dusty torus. For macro-lensing we used singular isothermal elliptic (SIE) potential and for mili-lensning a group of one thousand stars. For microlensing map we took different values of convergence κ and shear γ. Broad line emission and equatorial scattering was simulated using the radiative transfer code SKIRT. Here we present some basic results obtained by simulations.

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Progress Report

MODELLING CHANGING-LOOK (CL) AGN PHENOMENON USING ACCRETION DISK INSTABILITIES

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Apart from regular, low-level stochastic variability, some AGN occasionally show exceptionally large changes in the luminosity, spectral shape and/or X-ray absorption. The most notable are the changes of the spectral type, when the source classified as a Seyfert 1 becomes a Seyfert 2 galaxy, or vice versa. Thus a name was coined of 'Changing-Look AGN' (CL AGN). The origin of this phenomenon is still unknown, but for most of the sources there are strong arguments in favor of the intrinsic changes.

Understanding the nature of such rapid changes is a challenge to the models of black hole accretion flows since the timescales of the changes are much shorter that the standard disk viscous timescale. We aim to model the CL AGN phenomenon using the time-dependent evolution of a black hole accretion disk unstable due to the dominant radiation pressure. We use a 1-dimensional, vertically integrated scheme, and focus on the variability timescales and amplitudes, which can be regulated by the action of large-scale toroidal magnetic fields and the presence of an inner optically thin flow, like Advection-Dominated Accretion Flow (ADAF). We thus modify the inner boundary condition of the cold disk flow, and we mimic the formation of the MRI-inactive zones, that suppress instabilities, by parameterizing their relative importance according to a local accretion rate.

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Progress Report

GEOMETRIC DISTANCES OF QUASARS MEASURED BY SPECTROASTROMETRY AND REVERBERATION MAPPING: MONTE CARLO SIMULATIONS

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Recently, GRAVITY onboard the Very Large Telescope Interferometer (VLTI) first spatially resolved the structure of the quasar 3C 273 with an unprecedented resolution of $\sim 10\mu$as. A new method of measuring parallax distances has been successfully applied to the quasar through joint analysis of spectroastrometry (SA) and reverberation mapping (RM) observation of its broad line region (BLR). The uncertainty of this SA and RM (SARM) measurement is about 16% from real data, showing its great potential as a powerful tool for precision cosmology. We carry out detailed analyses of mock data to study impacts of data qualities of SA observations on distance measurements and establish a quantitative relationship between statistical uncertainties of distances and relative errors of differential phases. We show that SARM analyses of observations generally generate reliable quasar distances, even for relatively poor SA measurements with error bars of 40% at peaks of phases. Inclinations and opening angles of BLRs are the major parameters governing distance uncertainties. It is found that BLRs with inclinations $\gtrsim 10$ deg and opening angles $\lesssim 40$ deg are the most reliable regimes from SARM analysis for distance measurements. Through analysis of a mock sample of AGNs generated by quasar luminosity functions, we find that if the GRAVITY/GRAVITY+ can achieve a phase error of 0.1 deg per baseline for targets with magnitudes $K \lesssim 11.5$, the SARM campaign can constrain H_0 to an uncertainty of 2% by observing 60 targets.

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Progress Report

ON THE VARIABILITY OF Lyα, N V, Si IV and C IV BAL COMPONENTS OF THE BALQSO J131912.39+534720

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Utilizing three epoch spectra of the Broad Absorption Line (BAL) quasar J131912.39+534720.5, we perform multicomponent fits to Lyα, N V, Si IV and C IV BALs. We uniquely analyze each BAL trough to nine doublets and we calculate the radial velocities, optical depths, FWHMs and column densities of each absorption component. By resolving each BAL to the uniquely determined number of components it consists of, we study the kinematics, physical conditions and time variability of each absorbing system in the line of sight. Our analysis shows that Lya, N V, Si IV and C IV BALs originate in the same clumpy clouds which have similar locations, kinematic structure and physical conditions. Variability occurs only in individual components within the BAL troughs which exhibit changes in their optical depths as well as column densities. We conclude that the most possible cause of variability is due to changes in the ionization state of the outflowing gas clouds.

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Progress Report

UNIVERSAL REDUCER FOR SMALL TELESCOPES

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This talk is devoted to the memory of Dr. Victor Afanasiev and his immense legacy. The report highlights the capabilities of two new instruments tested on the 1-meter Zeiss-1000 telescope of the SAO RAS: Stokes Polarimeter (StoP) and MAGIC reducer (within the ongoing project entitled "Monitoring of Active Galaxies by Investigation of their Cores"). Although optimized for the study of active galactic nuclei (AGN), methodically, these instruments are suitable for a wide range of small telescope tasks. The design of the instruments is based on the SCORPIO universal reducer one, which has been in use for more than 20 years in observations in various modes at the 6-meter BTA telescope of the SAO RAS. The fields of view of StoP and MAGIC are $6'$ and $13'$, respectively. The StoP device allows one to conduct photometric observations and polarimetric ones with a double Wollaston prism; the spectral mode was added to MAGIC. For targets up to 16 mag in medium-band filters, the accuracy of photometry is 0.01 mag, the accuracy of polarimetry reaches 0.1%. For a starlike target up to 14 mag in medium-band filters with a seeing of $1''$ for 20 minutes of total exposure, the photometry accuracy is better than 0.01 mag and the polarization accuracy is better than 0.6%. The available spectral range obtained with the volume phase holographic grating in MAGIC is 4000-7400A with a dispersion of 2A/px. StoP and MAGIC received the first light in 2020 and are used in test mode at the Zeiss-1000. As a modern observational multitool, MAGIC reducer together with the developed software is an effective solution for small telescopes. The report discusses the first results obtained by the authors with new instruments, as well as further prospects.

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Progress Report

SPIRAL STRUCTURE OF THE GALACTIC DISK AND ITS INFLUENCE ON THE ROTATIONAL VELOCITY CURVE

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The most spiral galaxies have a flat rotational velocity curve, according to the different observational techniques used in several wavelengths domain. Larger telescopes and improved detectors have existed for optical, radio, and mm observations; the strong emission lines of Hα and [NII] are more easily detected and measured than the weak broad H and K absorption lines; so that, the combination of high spatial and high spectral resolution digital detectors and fast computers has permitted a sophistication in the velocity analyses. However, all of them have provided almost flat curves implying the lack of mass in the outer part of galaxies. In this work, we show that non-linear terms are able to balance the dispersion, thus reviving the observed rotational curve profiles without inclusion of any other but baryonic matter concentrated in the bulge and disk, only. By using the gravitational N-body simulations with up to 10^7 particles, we test this dynamical model in the case of realistic galaxies with two different approaches. Within the direct approach, as an input condition in the simulation runs we set the spiral surface density distribution which is previously obtained as an explicit solution to non-linear Schrödinger equation (instead of a widely used exponential disk approximation). In the evolutionary approach, we initialize the runs with different initial mass and rotational velocity distributions, in order to capture the natural formation of spiral arms, and to determine their role in the disk evolution. In both cases we are able to reproduce the stable and non-expanding disk structures at the simulation end times of $\sim 10^9$ years, with no halo inclusion. These results imply that non-linear effects can significantly alter the amount of dark matter which is required to keep the galaxy in the stable dynamical configuration.

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Progress Report

MODELING OF THE PECULIAR NEBULA IN THE LOW-METALLICITY GALAXY NGC 4068

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During the analysis of the gas kinematics in the dwarf low-metallicity galaxy NGC4068 we found a bright star-like object surrounded by a rapidly expanding nebula (which follows from its broadened $H\alpha$ line). The spectra of the object obtained with the 6-meter BTA SAO RAS telescope and at the 2.5-meter CMO SAI MSU telescope show high intensity in the [NII], $H\alpha$, [OIII] lines, peculiarly low [SII]/[NII] ratio and the presence of weak emission in HeII 4686 line.

We tested several assumptions about the nature of the ionizing star, including blue supergiant and Wolf-Rayet stars. We show that the most probable scenario is that we observe the expanding nebula around the Wolf-Rayet star with mass >70 $M_\odot$. We constructed the models of stellar atmospheres using CMFGEN code and the corresponding photoionization models of the nebula calculated with the Cloudy code and argue that all observational features of the spectra can be described by the model of an expanding bubble around a rapidly rotating Wolf-Rayet star in a short-lived evolutionary stage, which locally enriches the interstellar medium with nitrogen.

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Poster

STELLAR KINEMATICS OF SIMULATED GALAXIES FROM SYNTHETIC SPECTROSCOPIC OBSERVATIONS OF OPTICAL LINES USING RADIATIVE TRANSFER

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The advent of integral-field spectroscopic (IFS) surveys has greatly improved our understanding of galaxy evolution. It is now possible to map the distribution, metallicity and kinematics of stars and star-forming gas in galaxies. We also find ourselves at a time where the resolution of cosmological hydrodynamical simulations has reached a point in which the kinematics produced by the evolutionary models can be contrasted with high spatial resolution observations. The most reliable way to compare these datasets is to generate synthetic observations that can be analysed in the same way as the observed data. However, one of the challenges in the generation of these mock observations is to take into account the effects interstellar dust has over the radiation of the sources.

We present the framework for realistic mock observations of spatially resolved galaxy spectra, using state-of-the-art hydrodynamical simulations, stellar population models, radiative transfer with SKIRT, and with a particular focus on internal galaxy kinematics. This is an essential tool for interpreting the high-quality spectroscopic datasets that are becoming available. As a first application we compare the mock observations from the AURIGA cosmological zoom simulations with integral-field observations of present-day galaxies from SAMI and long-slit observations of galaxies at large look-back time from LEGA-C.

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Poster

THE RADIO DICHOTOMY IN EXTREME OBJECTS: STUDYING QUASARS WITH FWHM GREATER THAN 15000 km/s

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The galaxies which are powered by supermassive black holes that accrete mass from their surroundings are called active galactic nuclei (AGN). Quasars which are known to be the most luminous AGN when observed through the radio window, can be defined largely into two categories, namely radio-loud and radio-quiet quasars. Surveys have shown radio-loud (RL) quasars constitute 10%-15% of the total quasar population and rest are radio-quiet (RQ). However, it is unknown if the radio-loud fraction or RLF (RL quasars/Total quasars) remains consistent among different parameter spaces. This study shows that RLF increases for increasing full width half maximum (FWHM) velocity of the $H\beta$ and $MgII$ broad emission line. Our data has been obtained from Shen et al.(2011) catalogue. To investigate the reason for increment, in this preliminary study we analyse various properties of the broadest line RL quasars and RQ quasars and we have found the difference of RL and RQ quasars only in luminosities. From our results we also have predicted accretion disk-jet connection and also predicted thick disk accretion for our sample .

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Poster

PROPERTIES OF CONTINUUM AND BROAD LINE EMISSION GAS IN AGNs Fe II EMITTERS

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A spectral characteristic common to Type I active galaxy nuclei (AGN) is the emission of Fe II, which forms a pseudo-continuum from the ultraviolet (UV) to the near infrared (NIR) due to the accumulation of hundreds of thousands of multiplets (>344,000). It is estimated that 25% of the total broad line region (BLR) emission is produced by the Fe II lines. Due to the relevance of this ion in the energy of the BLR, it is essential to understand the importance that the different excitation mechanisms make in the formation of Fe II emission. In this work we studied 67 AGNs with Fe II emission in order to study the relationship between the central source continuum and the lines produced by the BLR in particular of Fe II. We investigated the relationship between the intensity of Fe II and the object emission continuum. The result showed that there is no distinct behavior between the emission continuum of the different Fe II AGNs. In addition, we did a spectral analysis of the most relevant low potential ionization lines of the BLR, such as Paβ, O I, CaT and Fe II. The fit showed that the widths of the Fe II, O I and CaT lines are similar, suggesting that the emissions are produced in the same region of the BLR. The Fe II ratio in the NIR was calculated using Fe II lines in 1 μm and the *bump* of 9200 Å. The results show that the NIR ($R_{1\mu m}$) and optical (R_{4570}) Fe II intensity are strongly correlated, exhibiting the existence of a common excitation mechanism for the Fe II emissions. Also, the comparison between the intensities of $R_{1\mu\,m}$ vs R_{9200} showed a weak correlation. This result indicates that despite the importance of Lyα fluorescence, there is possibly another dominant mechanism in the formation of Fe II emission in 1 μm. Finally, we explored for the first time in the literature Eigenvector 1 (EV1) in the NIR context. The result suggests that the study of EV1 can be extended to the NIR by replacing the original quantities with those in the NIR. This result acquires relevance in view of the imminent start-up of the James Webb space telescope, allowing the study of unexplored samples of AGNs.

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Poster

STARK BROADENING OF Fe XXV LINES FOR NEUTRON STAR SPECTRA RESEARCH

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Broadening of spectral lines by collisions with charged particles or Stark broadening is the most important pressure broadening mechanism of spectral lines in the X wavelengths range in conditions of neutron star atmospheres and their envirionment. Stark broadened line profiles enter in the calculations of absorption coefficient, opacity, radiative transfer, acceleration of gravity and consequently, they are of interest for equation of state.

However, in the investigations of neutron stars, Stark broadening is considered very approximately. For example, Paerels (1997) proposed a method to measure masses and radii of neutron stars by simultaneous measurement of gravitational red shift and the acceleration of gravity at the surface. In the proposition of his method, Stark broadening of hydrogen lines is approximately estimated without taking into account the effects of magnetic field. Madej (1989) and Majczyna et al. (2005), in their models of neutron star atmospheres and iron rich spectra use for Stark broadening calculations approximate formula from Griem (1974) book (cf. Chap. IV 6), without magnetic field effects. Suleimanov et al. (2014) in their modelling of carbon neutron star atmospheres, considered the Stark broadening using very approximate Cowley (1971) formula and magnetic field effects are neglected.

Highly ionized iron lines are important for neutron star atmospheres modelling and investigation. For example Cootam et al. (2002) detected X-ray burst spectra of EXO 0748–676, with a Fe XXV feature (n = 2-3 transition).

In order to enable more accurate analysis and synthesis of Fe XXV features in the spectra of neutron stars and their environment, which contributes to the better testing of the physics of neutron stars, we calculated widths of Fe XXV spectral lines broadened by collisions with important charged constituents of neutron star atmospheres, electrons, protons, Fe XXVI and Fe XXVII ions. Calculations have been performed for a grid of temperatures and electron densities for plasma conditions of interest for neutron star atmospheres and their environments. The obtained results have been used also to test approximate methods (Cowley, 1971; Griem, 1974, Chap. IV.6) used for modelling of neutron star atmospheres. Since such results are also of

interest for Virtual Observatories we will prepare them additionaly for implementation in STARK-B database (Sahal-Brechot, et al. 2015). STARK-B is also a part of Virtual Atomic and Molecular Data Center - VAMDC (Dubernet et al. 2010), which started as an FP7 project in 2009.

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Poster

THE FLUX RATIO OF THE [N II]$\lambda\lambda$6548,6583ÅÅ LINES IN SAMPLE OF AGNs TYPE 2

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In spectra of the Active Galactic Nuclei (AGNs), the [N II]$\lambda\lambda$6548,6583ÅÅ lines are commonly fitted using the fixed intensity ratio of the components. However, the used values for fixed intensity ratio are slightly different through literature and there is significant lack of the references for their theoretical calculation or experimental measurement from spectra. The obtained theoretical values for [N II]6583.45Å/6548.05Å line intensity ratio are between 2.93-3.07. Here we present the measurements of the flux ratio of the [N II]$\lambda\lambda$6548,6583ÅÅ emission lines for a sample of AGNs type 2 spectra taken form Sloan Digital Sky Survey (SDSS) data base. The spectra are chosen to have high signal-to-noise, and to [N II] lines do not overlap with Hα. The obtained value for the flux ratio is compared with the theoretical calculations.

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Poster

METALLICITY IN HIGHLY ACCRETING QUASARS

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We present an analysis of UV spectra of quasars at intermediate redshifts believed to belong to the extreme Population A (xA) quasars, aimed to estimate the chemical abundances of the broad line emitting gas. We follow the approach described in Sniegowska et al. 2021, and we extend their sample to 42 sources. The basis of our analysis are multi-component fits made with the IRAF specfit routine in three regions of the spectra centered at 1900, 1550 and 1400 Å in order to deblend the broad components of Al III, C III], C IV, HeII and Si IV + O IV] and their blue excess. By comparing the observed flux ratios of these components with the same ratios predicted by photoionization code Cloudy we found that the virialized clouds (broad components) present a metallicity higher than $10Z_{\odot}$ while for non-virilized clouds we derive a lower limit to the metallicity around $\sim 5Z_{\odot}$ under the assumption of chemical composition proportional to the solar one, confirming the previous results obtained by Sniegowska et al. (2021). We also reach out for correlations between physical parameters and flux ratios finding out a connection between BLUE C IV and BLUE Si IV + O IV].

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Poster

THE LOCATION AND NATURE OF THE Fe II EMITTING REGION IN ACTIVE GALACTIC NUCLEI

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Because of its great strength in AGNs, doubts have been cast over whether Fe II emission is produced by photoionization. We show from reverberation mapping that Fe II emission is clearly produced by photoionization. The self-shielding broad-line region (BLR) model of Gaskell, Klimek & Nazarova (2007, GKN) successfully predicts the ionization stratification of regions producing other broad lines. We have extended the GKN model to include Fe II emission. This predicts that Fe II emission should come from a region with an effective size about twice that producing Hβ and Mg II. This is in agreement with the widths of optical Fe II lines being only about 70% of the widths of broad Hβ. It has been claimed from some reverberation-mapping studies that the responsivity-weighted radius of the gas emitting Fe II is the same as for the gas emitting Hβ, which would imply that they are emitted at similar distances from the black hole. We find, however, that the ratio of radii of the Fe II and Hβ emitting regions found from reverberation mapping is anti-correlated with the quality of the data. This is consistent with known biases in the estimation of lags in reverberation mapping. The highest quality reverberation mapping data show optical Fe II arising from a region twice the size of the Hβ region. This is in agreement both with the predictions of the GKN model and with the relative line widths. We conclude that the Fe II emitting region of AGNs is simply the outermost part of the BLR.

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Poster

THE QUASI-MOLECULAR ABSORPTION BANDS CAUSED BY THE NON-SYMMETRIC ION-ATOM RADIATIVE PROCESSES IN ALKALI PLASMAS

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Opacities of the stellar atmospheres are naturally caused by a large number of radiative processes. For the development of more sophisticated stellar atmosphere models, it is needed further investigation of the known processes and the inclusion of all processes not considered before. The influence of some hydrogen and alkali radiative processes on the optical characteristics of the stellar atmospheres are investigated here. It is shown that the examined processes generate rather wide quasimolecular absorption bands in the UV and VUV regions. We present the results of calculation in the tabulated form easy for further use with a particular accent to the applications for astrophysical plasma research and low temperature laboratory plasma created in gas discharges, where plasma conditions may be favorable for processes investigated here.

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Poster

RESOLVING POWER OF SPECTROGRAPHS: IMPACT OF THE SPECTRAL LINE SPREAD FUNCTION

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When passing the spectrograph, an observed spectrum is broadened due to the limited resolving power R of the apparatus (i.e., $\Delta\lambda_{\mathrm{FWHM},R} = \lambda/R$). Theoretically, R is given by the instrument components, e.g., in the case of a diffraction grating, by the number of illuminated slits. In practice, however, the exact spectral Line Spread Function (LSF), which describes the shape of an infinitely sharp absorption (or emission) line on the spectrograph, is highly dependent on the instrument and is therefore not trivial to determine. By evaluating hundreds of absorption lines in the space telescope imaging spectrograph ultraviolet spectrum of the hot subdwarf star Feige 110, it could be shown that, in this case, the convolution with a corresponding Gaussian ($\Delta\lambda_{\mathrm{FWHM},R} = \Delta\lambda_{\mathrm{FWHM,GAUSS}}$) on average results in too-small line widths. To obtain a consistent treatment of different spectrographs' R, a correction factor can be attached to better match the respective LSF.

Poster

PECULIARITIES OF OPTICAL EMISSION SPECTROSCOPY OF COPPER-CHROMIUM-AIR PLASMA

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Nowadays, Cu-Cr composites are of great interest in electric power industry as contact materials due to their specific properties, such as: low tendency to welding, high strength, good vacuum getter property due to chromium, etc. It is obviously that different branches of industry require the specific features of the used materials. Therefore, in order to optimise the characteristics of the resulting product, which determine its properties, it is necessary to provide the various fabrication technologies and/or conditions of existing methods of manufacturing such materials.

Thus, this work is devoted to the peculiareties of optical emission spectroscopy of plasma of electric arc discharge between Cu-Cr composite electrodes manufactured by pressing and sintering technologies at different temperatures, namely: 650, 750, 850, 950, 1050 and 1150°C. The investigations are carried out at arc current of 3.5 A. The comparison of radial distributions of plasma temperatures, which were determined by Boltzmann plot technique both on the base of Cu I and Cr I spectral lines, are performed and discussed.

Poster

Lyα RADIATION INFLUENCE TO IONOSPHERIC D-REGION: QUIET IONOSPHERIC D-REGION (QIONDR) MODEL

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We present the Quiet Ionospheric D-Region (QIonDR) model to analyze periodical variations of ionospheric parameters induced by changes in the incoming solar hydrogen Lyα line intensity. The model is based on data collected in the ionospheric D-region observations utilizing very low/low frequency (VLF/LF) signals. It provides: (1) a procedure for estimation of ionospheric parameters during quiet midday periods as a function of the daily sunspot number, related to the long-term variations during solar cycle, and the seasonal parameter, providing the seasonal variations, and (2) a procedure for determination of ionospheric parameters during the entire daytime using their midday values. QIonDR model is applied to VLF data acquired in Serbia that are related to the DHO and ICV signals emitted in Germany and Italy, respectively. We show time evolutions of the daytime Wait's parameters over the middle and low latitudes, and analytical expressions for midday parameters valid over a part of Europe.

Acknowledgment. The authors acknowledge funding provided by the Institute of Physics Belgrade, Geographical Institute "Jovan Cvijić" SASA and Astronomical Observatory (the contract 451-03-68/2020-14/200002) through the grants by the Ministry of Education, Science, and Technological Development of the Republic of Serbia.

XIII SERBIAN CONFERENCE ON SPECTRAL LINE SHAPES IN ASTROPHYSICS
August 23-27, 2021, Belgrade, Serbia
Book of Abstracts, Eds. A. Kovačević, L. Č. Popović and S. Simić
Astronomical Observatory Belgrade, 2021

Poster

VIRILIZATION OF THE BROAD LINE REGION IN THE SDSS SAMPLE OF TYPE 1 AGNs

N. Rakić[1,2], D. Ilić[2,3] and L. Č. Popović[1,2,4]

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Usually, the virilization of the Broad Line Region of Active Galactic Nuclei (AGNs) is considered *apriori* and is widely used as an assumption for the estimates of the AGN supermassive black hole mass. Here we investigate the widths and asymmetry of the broad Hβ and Hα emission lines in a sample of high quality (i.e. high signal to noise ratio) spectra of Type 1 Active Galactic Nuclei taken from the Data Release 16 of the Sloan Digital Sky Survey telescope, in order to explore possible deviation from the gravitationally bounded motion. We use the FANTASY (Fully Automated pythoN Tool for AGN Spectra analYsis) code for the multi-component modeling of the AGN spectra and for careful extraction of the broad emission line parameters.

Poster

INFLUENCE OF THE SMBBH TO THE BROAD LINE ASYMMETRY IN CASE OF LOW MASS RATIO SYSTEMS

S. Simić[1], L. Č. Popović[2], A. Kovačević[3] and D. Ilić[1,3]

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We investigate broad line shapes emitted from the supermassive binary black holes (SMBBHs) for a special case of components having quite different masses, (mass ratio $q \sim 0.1$) with the accretion present only in the less massive component. We used the model presented in Popović et al. (2021) that assumes a complex broad line region (BLR), composed of a moving BLR of the less massive component and one circumbinary BLR. We analyze the Hβ line shapes and light curves taking the different total masses of the SMBBH, in the range 10^6 to 10^9 Solar masses. The asymmetry of the line shape is discussed in terms of expected differences between SMBBH with one active component and a recoiling black hole.

Poster

THE COLLISIONAL ATOMIC PROCESSES IN GEO-COSMICAL PLASMAS: DATA NEEDED FOR SPECTROSCOPY

V. A. Srećković[1], Lj. M. Ignjatović[1] and M. S. Dimitrijević[2,3]

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In this paper, we investigate the chemi-ionization (CI) processes in atom-Rydberg atom collisions. The rate coefficients for CI processes in $K^*(n) + K$ and $H^*(n) + K$ collisions are presented for a wide region of temperatures and principal quantum numbers. The data for the rate coefficients are very useful for the improvement of modelling and analysis of different layers of weakly ionized plasmas in atmospheres of various stars where these and other CI processes could be important and could change the optical characteristics (Mihajlov et al 2011; Srećković et al. 2014). Also, the results are of interest in spectroscopy of low temperature laboratory plasma.

References

Mihajlov, A. A., Ignjatović, L. M., Srećković, V. A., Dimitrijević, M. S.: 2011, *ApJS*, **2**, 193.

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Poster

MODELING THE ATMOSPHERE UNDER THE INFLUENCE OF INTENSE SOLAR X-RAY RADIATION

V. A. Srećković[1], D. M. Šulić[2] and V. Vujčić[3]

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Radio signals are ideal tool for remote monitoring ionospheric D-region. Propagation of VLF radio waves emitted by man-made transmitters takes place in the Earth-ionosphere waveguide and strongly depends on the electrical properties of the ionosphere (Šulić & Srećković, 2014, Nina et al., 2011). During occurrence of solar flare the altitude profile of ionospheric conductivity changes, a VLF signal reflects from lower height and these changes result that radio propagation is performed with more discrete modes than in normal ionospheric condition (Šulić et al., 2016). The aim of this study is to accurately model the perturbed D-region and to obtain ionospheric parameters during huge solar flares which may continuously perturb this layer for several hours.

References

Nina, A., Čadež, V. M., Srećković, V. A., Šulić, D.: 2011, *Baltic Astronomy*, **20**, 609.
Šulić, D., Srećković, V. A.: 2014, *Serb. Astron. J.*, **188**, 45.
Šulić, D., Srećković, V. A., Mihajlov, A. A.: 2016, *Adv. Space. Res.*, **57**, 1029.

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Poster

EXPLORING THE SPECTRA OF ACTIVE GALACTIC NUCLEI FROM THE GAMA DATABASE

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Active galactic nuclei (AGN) are powered by an accreting supermassive black hole (SMBH) and emit strong continua and emission lines. One important parameter which can be estimated from the AGN broad emission lines, is the mass of the SMBH. On the other hand, the SMBH mass is also known to be correlated with the properties of the host galaxy's bulge. In this work we aim to shed light on the known co-evolution of the SMBH and its host galaxy by studying these correlations.

For this analysis we consider a sample of broad-line AGN (i.e. type 1 AGN) drawn from the Galaxy And Mass Assembly (GAMA) survey, which consists of $\sim 300,000$ galaxies down to $r < 19.8$ mag, providing a photometric and spectroscopic dataset with outstanding value. Although the GAMA survey was designed to study galaxies, it also contains a fraction of AGN. In this work we select a sample of AGN with both broad emission lines in their spectra and existing photometric decompositions of their host galaxies. The AGN spectral modelling and parameter extraction is done using the multi-component FANTASY code. The SMBH mass is obtained from the AGN spectral parameters and compared to the host galaxy's bulge properties. Here we present our preliminary results of the SMBH mass estimates in type 1 AGN from the GAMA survey and their correlations with the host galaxy properties. The results are part of a master thesis conducted at the Hamburg Observatory of Universität Hamburg.

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Poster

DICHOTMY OF RADIO LOUD (RL) AND RADIO QUITE (RQ) QUASARS IN FOUR DIMENSIONAL EIGENVECTOR 1 (4DE1) PARAMETER SPACE

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Recent work has shown that it is possible to systematize quasars (QSOs) spectral diversity in 4DE1 parameter space. The spectra contained in most of the surveys have low signal to noise ratio which fed the impression that all QSO's are spectroscopically similar. Exploration of 4DE1 parameter space gave rise to the concept of two populations of QSOs that present important spectroscopic differences. We aim to quantify broad emission line differences between radio quiet and radio loud sources by exploiting more complete samples of QSO with spectral coverage in Hβ, MgII and CIV emission lines. We used a sample of 11 quasars with redshift $0.35 < z < 1$ of strong radio emitter QSOs observations from Calar Alto Observatory in Spain. We analyzed the broad lines by doing multicomponent non-linear fitting of the emission lines in particular of Hβ, FeII and MgII by using the IRAF task SPECFIT and determined the main parameters of each component. We also evaluated the parameters characteristic of the full emission line profiles, FWHM, centriods at different fractional intensities, kurtosis, asymmetry index, total flux and equivalent width as well as their uncertainitites in each parametr. We estimated the SMBH mass and the Eddington ratio L/L_{Edd} using mainly the Hβ region by using different scaling relations. Additionally, we estimated the mass of the black hole by using the MgIIλ2800$\mathring{A}$ lines as a supplementary virial estimator. We found a good correlation between all the parameters and the estimated quantities are with in the range of the acceptable results.

Poster

VARIABILITY SELECTED LOW LUMINOSITY ACTIVE GALACTIC NUCLEI FROM ASAS-SN SURVEY

Heechan Yuk[1], Xinyu Dai[1], T. Jayasinghe[2], Hora D. Mishra[1], Hai Fu[3], Christopher S. Kochanek[2,4], Benjamin J. Shappee[5] and K. Z. Stanek[2,4]

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Variability is one of key features to select active galactic nuclei (AGN). We present an analysis of All-Sky Automated Survey for Supernovae light curves of 1218 galaxies from the Sloan Digital Sky Survey spectroscopic sample with the g magnitude brighter than $g < 14$. 35 objects are identified with AGN-like structure function (SF), which is about 3% of the sample. The majority of the variability selected AGN are low luminosity AGN (LLAGN) with the Eddington ratios ranging from 10^{-4} to 10^{-2}. We estimate the fraction of LLAGN in the population of galaxies as 3% down to an Eddington limit of 10^{-4}. Traditional BPT selection is incomplete, which classifies $30 \sim 50\%$ of the LLAGN as starburst galaxies instead. On average, the fractional flux variability of a LLAGN is $\sim 10^{-3}$, and the power law index of SF is 1.88 ± 0.05. This slope is steeper than the expected value from the damped random walk model.

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Poster

EFFECT OF ION SHELL STRUCTURE ON THE SPECTRAL LINE BROADENING BY ELECTRON COLLISIONS IN ALKALI PLASMAS

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Spectral lines are rich with information that serve to describe the studied plasma. These lines are broadened by different causes: in astronomical dense plasma, the Stark broadening dominates the profile with Lorentzian structure. For alkali plasmas, the short range forces between the charged particles are of great importance. For alkali plasmas, at small distances between the particles, deviations from Coulomb law are observed which are mainly due to the influence of the shell electrons. Thus, the ion shell structure should be taken into account. In order to study this effect on spectral lines, we used HGK potential instead of Coulomb potential to compute the electron collision operator in the case of high temperatures and high densities. To do this work, we replace the integration over the impact parameter by the integration over the scattering angles. The results are compared with the theoretical work of Griem 1964 based on Coulomb interaction.

Programme of 13th SCSLSA

Venue: Faculty of Mechanical Engineering, Kraljice Marije 16, Belgrade, Serbia
Hall 513, 5th floor

The time zone is CEST

Monday, August 23, 2021

14:30 - 15:30 *Registration*
15:30 - 16:00 *Opening ceremony (G. Peach and L. Č. Popović)*

SPECTRAL LINE SHAPES FROM LABORATORY TO SPACE PLASMA
Chair: **M. S. Dimitrijević**

16:00 - 16:30	***Evgeny Stambulchik***	Spectral line merging in hydrogen-like species for diagnostic of laboratory and space plasmas
16:30 - 17:00	***Joel Rosato***	Addressing the accuracy of the computer simulation method involved in Stark broadening calculations
17:00 - 17:30	***Andrea Petric***	Obscured AGN at the Cosmic Noon
17:30 – 18:00	***Gisella de Rosa***	The AGNSTORM 2 program: A detailed view of gas flows in Mrk 817
18:00 - 21:00	*Welcome reception*	

Tuesday, August 24, 2021

SPECIAL SESSION DEDICATED TO VICTOR L. AFANASIEV: AGN Polarization
Chair: **L. Č. Popović**

9:00 - 9:30	***Serguei Dodonov***	Multi Object Methods for finding and study QSO's and Galaxies
9:30 – 10:00	***Martin Roth***	25 years of integral field spectroscopy - from the BTA to the VLT
10:00 - 10:30	***Alexei Moiseev***	Observations of large-scale ionizing cones in Seyfert galaxies
10:30 - 10:50	*Roman Uklein*	Universal reducer for small telescopes
10:50 - 11:10	*Eugene Malygin*	The photometric reverberation mapping of active galaxies in SAO RAS
11:10 - 11:30	*Coffee break*	

SPECIAL SESSION DEDICATED TO VICTOR L. AFANASIEV: AGN Polarization
Chair: **S. Dodonov**

11:30 - 12:00	***Luka Č. Popović***	Polarization in broad emission lines of active galactic nuclei
12:00 - 12:30	***Elena Shablovinskaya***	New capabilities of AGN polarimetry
12:30 - 13:00	***Alexander Burenkov***	Monitoring of Seyfert 1 galaxies at the Special Astrophysical Observatory of the Russian Academy of Science
13:00 - 13:20	*Djordje Savić*	Broad emission line polarization of lensed quasars
13:20 - 13:40	*Daria Kozlova*	Ionized-gas clouds in the 2MASX J013130.00-062550.8 galaxy
13:40 - 14:00	*Alina Ikhsanova*	Gas and stars in the Teacup quasar

14:00 - 15:30 *Lunch break*

SPECTRAL LINE PHENOMENA IN STARS
Chair: **E. Stambulchik**

15:30 - 16:00	***Friedrich Kupka***	Improvements to the short-characteristics method in 3D-RHDr simulations and some unsolved problems in spectral line shapes of a-type stars
16:00 - 16:30	***Antonios Antoniou***	A new method for calculating column densities using GR model. An application in the case of C IV, N IV and N V spectral lines in the uv spectrum of the o star HD 149757 (ζ OPH)
16:30 - 16:50	*Rihab Aloui*	Stark broadening of Strontium ion Sr V spectral lines in hot white dwarf atmospheres
16:50 - 17:10	*Rafik Hamdi*	Stark broadening effect in hot DA white dwarfs: ultraviolet lines of Fe V
17:10 - 17:30	*Coffee break*	

POSTER SESSION: SPECTRAL LINES IN ASTROPHYSICAL AND LABORATORY PLASMA
Chair: **A. Kovačević**

17:30 - 19:00 *Poster session* *3 min presentations*

Wednesday, August 25, 2021

SURVEYS AND SPECTRAL LINE VARIBILITY IN EXTRAGALACTIC OBJECTS
Chair: **D. Ilić**

9:00 - 9:30	***Victor Oknyansky***	Changing Looks of the Nucleus of Seyfert Galaxy NGC 1566 in comparison with other CL AGNs.
9:30 - 9:50	*Pu Du*	Density Waves of Ionized Gas in Broad-line Regions of Active Galactic Nuclei
9:50 - 10:10	*Sergey Kotov*	Quasars physical properties study based on the medium-band photometric survey
10:10 - 10:30	*Iva Čvorović - Hajdinjak*	Deep learning of AGN spectral variability
10:30 - 10:50	*Anastasia Yarovova*	Modeling of the peculiar nebula in the low-metallicity galaxy NGC 4068
10:50- 11:10	*Yu Yang Songsheng*	Geometric Distances of Quasars Measured by Spectroastrometry and Reverberation Mapping: Monte Carlo Simulations

11:10 - 11:40 *Coffee break*

SPECTRAL LINE PHENOMENA IN QUASARS
Chair: **S. Simić**

11:40 - 12:10	***Paola Marziani***	The quasar main sequence: recent developments
12:10 - 12:40	***Edi Bon***	Exploring the orientation of radio-loud AGN
12:40 - 13:00	*Swayamtrupta Panda*	Flattening of the curve: Diagnostics of the Hβ and optical Fe+ emission
13:00 - 13:20	*Tania Buendia Rios*	Statistical analysis of the AlIIIλ1860 line as a virial black hole mass estimator
13:20 – 13:40	*Isidora Jankov*	Representation and characterization of broad-line AGN spectra based on manifold learning

13:40 - 15:30 *Lunch break*

15:30 - *Conference excursion*

Thursday, August 26, 2021

ATOMIC PARAMETERS AND SPECTRAL LINE SHAPES
Chair: **R. Stamm**

9:00 - 9:30	***Vladimir Srećković***	Rydberg atoms in astrophysics: new results
9:30 - 10:00	***Mohammed Koubiti***	A prospective study on using machine learning from spectroscopic data for plasma parameter predictions
10:00 - 10:20	*Lamia Abu El Maaty*	Energy levels, oscillator strengths and transition probabilities for the Ti II ion
10:20 - 10:40	*Saïd Douis*	Statistical and dynamical properties in plasmas governed by H.G.K pseudo-potential
10:40 - 11:00	*Ibtissem Hannachi*	Calculating the simultaneous effect of ion dynamics and oscillating electric fields on Stark profiles
11:00 - 11:30	*Coffee break*	

SPECTRAL LINE PHENOMENA IN EXTRAGALCTIC OBJECTS
Chair: **A. Moiseev**

11:30 - 12:00	***Alice Machado***	Radio-loud population a quasars at high redshift
12:00 - 12:30	***Elena Dalla Bonta***	Black Hole masses from emission line widths
12:30 - 12:50	*Miroslava Vukcevic*	Spiral structure of the galactic disk and its influence on the rotational velocity curve
12:50 - 13:10	*Jelena Kovačević Dojčinović*	The line profiles in AGNs type 1.8-2: unraveling the complex kinematical properties
13:10 - 13:30	*Aleksandra Grokhovskaya*	Exploring the environment of active galaxies
13:30 - 15:00	*Lunch break*	

ATOMIC PARAMETERS AND SPECTRAL LINE SHAPES
Chair: **V. Srećković**

15:00 - 15:30	***Nikolay Bezuglov***	Expressions of "fast" and "slow" chameleon dressed states in autler-townes spectra of alkali-metal atoms
15:30 - 16:00	***Nabil Ben Nessib***	Ab initio and semi-empirical atomic structure calculations. Applications to the 5s-6p transitions for the Mo II ion
16:00 - 16:20	*Joel Rosato*	Modeling of collisional redistribution of line radiation by computer simulations
16:20 - 16:40	*Magdalena Christova*	Stark broadening of B I spectral lines
16:40 - 17:00	*Zlatko Majlinger*	Systematic trends among the Stark widths of Co II spectral lines
17:00 - 17:30	*Coffee break*	

SPECTRAL LINE PHENOMENA IN EXTRAGALCTIC OBJECTS
Chair: **V. Okyansky**

17:30 - 18:00	***Xinyu Dai***	New Quasar Microlensing Constraints on the Spin of High Redshift Quasars
18:00 - 18:20	*Saloni Bhatiani*	Hunting for planet-mass objects in extragalactic systems
18:20 - 18:40	*Jake Mitchell*	The Paschen broad line region and torus in Mrk 509
18:40 – 19:00	*Hora Mishra*	Dramatic variability in a changing-look blazar, B2 1420+32
19:00 - 19:30	***Martin Gaskell***	Partial obscuration as a cause of asymmetries of broad Balmer line profiles in active galactic nuclei

20:00 - *Conference Dinner*

Friday, August 27, 2021

SPECTRAL LINE RESEARCH: NEW FRONTIERS
Chair: **E. Lyratzi**

9:30 - 10:00	***Jian-Min Wang***	Accretion-modified Stars in Accretion Disks of Active Galactic Nuclei
10:00 - 10:30	***Djordje Spasojević***	Study of UV Ne II line shapes in the cathode sheath of an abnormal glow discharge
10:30 - 11:00	***Andjelka Kovačević***	Spectral variability of active galactic nuclei in the context of large time-domain surveys
11:00 - 11:30	*Coffee break*	

SPECTRAL LINE VARIABILITY
Chair: **P. Marziani**

11:30 - 11:50	*Ting Feng Yi*	Detection of quasi-periodic oscillations in γ-ray and optical light curves of the BL Lac 4FGL J0650.7+2503
11:50 - 12:10	*Marzena Sniegowska*	Modelling changing-look (CL) AGN phenomenon using accretion disk instabilities
12:10 - 12:30	*Dimitrios Stathopoulos*	On the variability of Lyα, N V, Si IV and C IV BAL components of the BALQSO J131912.39+534720
12:30 - 12:50	*Martin Ochmann*	Mrk 926 reveals discrete line satellites during a drastic phase of decline
12:50 - 13:10	*Daniel Kynoch*	Variability of the near-infrared coronal emission lines in the active galaxy NGC 5548

13:10 - 13:30 *Official closing of the conference*
13:30 - 15:00 *Lunch break*

POSTERS

P01	Daniela Barrientos, Arjen van der Wel, Maarten Baes	Stellar kinematics of simulated galaxies from synthetic spectroscopic observations of optical lines using radiative transfer
P02	Avinanda Chakraborty	The radio dichotomy in extreme objects: Stutying quasars with FWHM greater than 15000 km/s
P03	D. Dias dos Santos, A. Rodríguez-Ardila, M. Marinello	Properties of continuum and broad line emission gas in AGNs FeII emitters
P04	Milan S. Dimitrijević, Magdalena D. Christova, Sylvie Sahal-Bréchot	Stark broadening of Fe XXV lines for neutron star spectra research
P05	Ivan Dojčinović, Jelena Kovačević-Dojčinović, Luka Č. Popović	The flux ratio of the [N II]6548,6583ÅÅ lines in sample of AGNs type 2
P06	Karla Garnica Luna, Paola Marziani, A. Negrete	Metallicity in highly accreting quasars
P07	Martin Gaskell	The location and nature of the Fe II emitting region in active galactic nuclei
P08	Ljubinko M. Ignjatović, Vladimir A. Srećković, Milan S. Dimitrijević	The quasi-molecular absorption bands caused by the non-symmetric ion-atom radiative processes in alkali plasmas
P09	Alexander Landstorfer	Resolving power of spectrographs: Impact of the spectral line spread function
P10	Aleksandr Murmantsev, A. Veklich, M. Kleshych, S. Fesenko, V. Boretskij	Peculiarities of optical emission spectroscopy of copper-chromium-air plasma
P11	Aleksandra Nina, G. Nico, S. T. Mitrović, V. M. Čadež, I. R. Milošević, M. Radovanović, L. Č. Popović	Lyα influence to ionospheric D-region: quiet ionospheric d-region (QIONDR) model
P12	Nemanja Rakić, Dragana Ilić, L. Č. Popović	Virilization of the broad line region in the SDSS sample of type 1 AGNs
P13	Saša Simić, Luka Č. Popović, Andjelka Kovačević, Dragana Ilić	Influence of the SMBBH to the broad line asymmetry in the case of low mass ratio systems
P14	Vladimir A. Srećković, Lj. M. Ignjatović, M. S. Dimitrijević	The collisional atomic processes in geo-cosmical plasmas: data needed for spectroscopy
P15	Vladimir A. Srećković, D. M. Šulić, V. Vujčić	Modeling the atmosphere under the influence of intense solar X-ray radiation

P16	Jonathan Targaczewski, Dragana Ilić, Jochen Liske	Exploring the spectra of active galactic nuclei from the GAMA database
P17	Shimeles Terefe, Ascension Del Olmo Orozco, Paola Marziani, Mirjana Pović	Dichotmy of Radio Loud (RL) and Radio Quite (RQ) Quasars In Four Dimensional Eigenvector 1 (4DE1) Parameter Space
P18	Heechan Yuk, Xinyu Dai, T. Jayasinghe, Hora D. Mishra, Hai Fu, Christopher S. Kochanek, Benjamin J. Shappee, and K. Z. Stanek	Variability Selected Low Luminosity Active Galactic Nuclei from ASAS-SN Survey
P19	Djamel Eddine Zenkhri, Mohammed Tayeb Meftah, Fethi Khelfaoui	Effect of ion shell structure on the spectral line broadening by electron collisions in alkali plasmas

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