

**Serbian-Chinese Astronomical Scientific Meeting:
Physics and Nature of Active Galactic Nuclei
April 16-19, 2018, Belgrade, Serbia**

BOOK OF ABSTRACTS



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ОПСЕРВАТОРИЈА**

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Astronomical Observatory

Belgrade, June, 2018

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Periodic variability of AGNs: binary or something else

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Here we review variability time scales in optical light curves of AGN, with a focus on possible detection of possible periodic and quasi-periodic variability in them. Observed variability time scales that are found in typical AGN light curves show values that are consistent with orbital time scales (around their central supermassive black hole). We discuss possible scenarios that could produce variability patterns observed in these light curves, as well as the shapes of their broad emission lines. In a few cases, we modelled radial velocity curves.

Chemi-ionization/recombination processes in the AGNs Broad-Line Region

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The chemi-ionization and the corresponding chemi-recombination processes in atom - Rydberg atom collisions, are considered as factors of influence on the ionization level and atom excited-state populations in clouds in BLR region of AGN. The presented results are related to the moderately ionized layers of dense parts of the BLR clouds. It has been found that the investigated chemi ionization/ recombination processes (for principal quantum number $2 \leq n \leq 20$, densities greater than 10^{12} cm^{-3} and $4000 \text{ K} \leq T \leq 20000 \text{ K}$) dominate over the relevant concurrent processes. Consequently, this is an indication that the considered chemi ionization/recombination processes should have a very significant influence on the optical properties of regions in AGN with such conditions.

Reverberation mapping: kinematics of the BLRs

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The geometry and kinematics of the broad-line regions (BLRs) in active galactic nuclei (AGNs) are far from fully-understood, especially for those AGNs with high accretion rates. The velocity-resolved reverberation mapping (RM) is a great tool for investigating the kinematics of the BLRs. Here we present our latest progress in the velocity-resolved RM technique and observation. Those results provide new insight into the nature of the BLRs in AGNs.

Our long-term spectral optical monitoring of type 1 AGN and BLR physics

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The properties of the broad line region (BLR) of active galactic nuclei (AGN), i.e. the size of the BLR and the velocity, are widely used to estimate the mass of the supermassive black hole (SMBH) in AGN, either directly in case of the reverberation-mapped AGN or indirectly using the radius-luminosity relation which allows you to estimate the SMBH mass from one epoch observations. Therefore, we need to study in great details the physics and geometry of the BLR, which is still not fully understood. Moreover, the BLR is not yet resolved with currently available instruments even in the closest AGN, therefore the spectroscopy is still a very important method. Here we report on the results of our investigation of the physics of the BLR, e.g. the temperature, and our long-term optical monitoring of a dozen of type 1 AGN, a campaign coordinated by the Special Astrophysical Observatory.

Broad Fe K α line from accretion disc of AGNs

Predrag Jovanović

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Here we present a review of our investigations of the Fe K α line emitted from relativistic accretion disks around single and binary supermassive black holes (SMBHs) in the centers of active galactic nuclei (AGNs). We modeled the emission from the innermost parts of such accretion disks using numerical simulations based on ray-tracing method in Kerr metric. Comparisons between the resulting simulated and the corresponding observed Fe K α line profiles enable us to study space-time geometry in vicinity of SMBHs, their properties, strong gravity effects predicted by General Relativity and their accretion physics. According to the obtained results, the observed variability of Fe K α line could be explained either by some internal phenomena in the disk, such as e.g. its instability and perturbations of its emissivity, or by some external causes, such as e.g. absorption by X-ray absorbers or amplification by gravitational microlensing. Moreover, the unusual, complex and shifted composite Fe K α line profiles, if detected, could provide evidence about presence of the binary SMBHs in the centers of AGNs.

Oscillatory patterns in the light curves of five long-term monitored type 1 Active Galactic Nuclei

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We develop a novel hybrid method in a search for oscillatory behavior of type 1 AGN. Light curves can be of arbitrary length and sampling rate, without assumption of the periodicity range. Hybrid method detects numerically periods, and produce 2D correlation maps of oscillations present in the two light curves.

Using hybrid method we show a novelty in the oscillatory patterns of the all surveys combined light curves of 5 well known type 1 AGN:

i) periodic variations in 3C 390.3, NGC 4151, NGC 5548 and E1821+643

ii) differences in dynamical regimes:

- binary black hole candidates (NGC 5548 chaotic regime, E1821+643 stable regime);

- double-peaked Balmer line objects: (3C 390.3 oscillatory pattern rapidly fluctuate in 2D correlation space, Arp 102B no oscillations);

iii) confirmation of physical background of detected oscillations:

our coupled oscillatory models describe oscillatory behavior in the light curves

The UV and optical Fe II emission lines in type 1 AGNs

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Here we present the models of the optical Fe II lines in 4000-5500 Å range and UV Fe II lines in 2650-3050 Å spectral range. We explained their application to AGN spectra and show the advantages over other empirical and theoretical Fe II templates given in literature. Afterwards, we analyse the sample of 287 AGNs from SDSS in UV and optical range, using our Fe II models for spectra decomposition. We show some correlations found between Fe II lines and other spectral properties for which physical explanation is still not clear. Specially, we analyze the relationships we found between UV and optical Fe II lines.

Test Periodic Signals in Red-Noise Time Series of Active Galactic Nuclei

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I will talk about our recent work on testing periodic signals in active galactic nuclei (AGNs). It is known that AGNs show random brightness variability at all wavebands with a broad power spectrum, usually characterized by a red-noise shape. Such random nature of variations can lead to spurious few-cycle periodicities in AGN time series, greatly complicating period searches in time-domain surveys with limited baselines. Based on our previously developed framework that models AGN time series in frequency domain, we propose a forward Bayesian approach for testing periodic signals by describing a time series as a sum of a red-noise stochastic process and a deterministic periodic process. The narrow spectral peak in periodograms caused by the periodic process is parameterized to be a Gaussian. A Markov chain Monte-Carlo technique is employed to explore posterior distributions of the parameters and perform model comparison between the periodic and purely random descriptions. The new approach is in particular adapted for irregularly sampled time series with few period cycles. Application of our testing procedure to PG1302-120, NGC 5548 and Ark 120 are presented.

Spectral and polarimetric investigation of AGNs in Serbia

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In this talk we are giving an overview of the investigation of active galactic nuclei (AGNs) in Serbia. The investigation of AGNs in Serbia started in 90s of last century, first paper in this field was published in 1995, where the gravitational shift in the broad line region was considered. After that the investigations of the Broad Line Region, Narrow Line Region, X-ray emission from the accretion disk and emission of the torus have been performed, resulting in a number of models of different AGN regions. Particularly we give some recent investigation of polarization in AGNs, and a new method for measuring of the super-massive black holes in the center of AGNs using the change of polarization angle across broad line profiles.

Polarization in broad lines of SMBHBs

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Massive galaxies are expected to host a supermassive black hole (SMBH) situated in the center. Because of the difficulty in explaining the extreme signatures in the optical spectra such as high variability and very broad double peak Balmer lines, exotic models such as close supermassive binary black holes (SMBBHs) have been proposed. To test such hypotheses, we rely on numerical modeling of the polarimetry of binary black holes systems since polarimetry is highly sensitive to geometry. We model broad line emission with the assumption that polarization comes predominantly due to scattering. We applied full 3D radiative transfer with polarization using a publicly available code STOKES. Our preliminary results have shown that polarization position angle has a unique signature across the line profile that could be used in the search for SMBBH candidates.

Variability in the AGN broad lines and continuum - an indication of SMBHB

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In compact binary systems distribution of matter around central parts in AGN could be very complex. Classical model with BL region around accretion disk is not probable since proximity of BH masses. Therefore, we proposed that only a fraction of BL region is sustained around each BH, which is delimited by Roche lobe. The rest of the BLR is distributed like envelope, surrounding the both BH components. We computed spectral energy distribution of continuum and H β line and studied the variation in emission spectrum. We showed that most of variability originate from dynamics of the system and initiated by relativistic boosting effect.

A new paradigm for mid-IR emission of AGNs

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Recent high angular resolution observations resolved for the first time the mid-infrared (MIR) structure of nearby active galactic nuclei (AGN). Surprisingly, they revealed that a major fraction of their MIR emission comes from the polar regions. This is at odds with the expectation based on AGN unification, which postulates a dusty torus in the equatorial region. The nearby, archetypical AGN in the Circinus galaxy offers one of the best opportunities to study the MIR emission in greater detail. New, high quality MIR images obtained with the upgraded VISIR instrument at the Very Large Telescope show that the previously detected bar-like structure extends up to at least 40 pc on both sides of the nucleus along the edges of the ionization cone. Motivated by observations across a wide wavelength range and on different spatial scales, we propose a phenomenological dust emission model for the AGN in the Circinus galaxy consisting of a compact dusty disk and a large-scale dusty cone shell, illuminated by a tilted accretion disk with an anisotropic emission pattern. Undertaking detailed radiative transfer simulations, we demonstrate that such a model is able to explain the peculiar MIR morphology and account for the entire IR spectral energy distribution. Our results call for caution when attributing dust emission of unresolved sources entirely to the torus and warrant further investigation of the MIR emission in the polar regions of AGN.

***Serbian-Chinese Astronomical Scientific Meeting:
Physics and Nature of Active Galactic Nuclei***

April 16 - 19, 2018
Belgrade (Serbia)
Link: <http://servo.aob.rs/serbchin/>

Programme

Monday (April 16, 2018)

10:00 - 11:00 Registration and opening

Session 1. AGN variability

Chair: Edi Bon

11:00 - 11:45 Review lecture 1 (with discussion)

Jian-Min Wang: Reverberation mapping campaigns in China (or Super-Eddington accreting massive black holes for cosmology)

11:45 - 12:30 Review lecture 2 (with discussion)

Luka Č. Popović: Spectral and polarimetric AGN investigation in Serbia

12:30 -13:00 Contribution 1

Dragana Ilić: Our programme of the long term AGN monitoring

13:00-15:00 Lunch

Chair: Hu Chen

15:00-15:45 Review lecture 3 (with discussion)

Pu Du: Campaign of monitoring AGNs with Hbeta asymmetry

15:45-16:30 Review lecture 4 (with discussion)

Darko Jevremović: LSST and AGN monitoring

16:30-17:00 Coffee break

17:00-17:30 Contribution 2 (with discussion)

Jelena Kovačević-Dojčinović: The UV and optical Fe II emission lines in type IAGNs

Tuesday (April 17, 2018)

Chair: Predrag Jovanović

Session 2. AGN and super-massive binary systems

10:00 - 10:45 Review lecture 5 (with discussion)

Edi Bon: Periodic variability of AGNs - binary or something else

10:45-11:30 Review lecture 6 (with discussion)

Jian-Min Wang: Supermassive black hole binaries

11:30 - 12:00 Coffee break

Chair: Pu Du

12:00 - 12:30 Contribution 3 (with discussion)

***Saša Simić: Variability in the AGN broad lines and continuum
- an indication of SMBHB***

12:30 - 13:00 Contribution 4 (with discussion)

Djordje Savić: Polarization in broad lines of SMBHBs

13:00-15:00 Lunch

Chair: Saša Simić

Session 3. AGN spectral characteristics

15:00-15:45 Review lecture 7 (with discussion)

Hu Chen: Spectral characteristics of AGN

15:45-16:30 Review lecture 8 (with discussion)

***Predrag Jovanović: Broad Fe K α line from accretion disc
of AGNs***

16:30-17:00 Coffee break

Chair: Anđelka Kovačević

17:00-17:30 Contribution talk 5

***Marko Stalevski: A new paradigm for mid-IR emission of
AGNs***

17:30 - 18:00 Contributed talk 6

Milan S. Dimitrijević, Vladimir A. Srećković and Ljubinko M. Ignjatović: Chemi-ionization/recombination processes in the AGNs Broad-Line Region

20:00 Conference dinner

Wednesday (April 18, 2018)

Chair: Dragana Ilić

Session 4. AGN variability, structure and spectral characteristics - observations vs. theory

10:00 – 10:45 Review lecture 9

Yan-Rong Li: Test Periodic Signals in Red-Noise Time Series of Active Galactic Nuclei

10:45 - 11:30 Review lecture 10

Andjelka Kovačević: Oscillatory patterns in the light curves of five long-term monitored type 1 active galactic nuclei

Chairs: Jian-Min Wang & Luka Č. Popović

Open discussion: possibility future collaboration (with coffee and cakes) in observations and theoretical work - Closing conclusions

12:30 - Lunch

14:00 Excursion to Museum Vinča

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Thursday (April 19, 2018)

10:00 – 16:00 Work in groups at Astronomical Observatory

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