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Student meeting

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Book of abstracts

Jan Kotek
Astronomical Institute of CAS

Jan Kotek: Numerical simulations in solar atmosphere
We will present several examples of analytical and numerical approach to modelling of solar atmosphere, specifically of various processes within magneto-hydrodynamic approximation.

Sofya Belov
Jihočeská univerzita v Českých Budějovicích, Přírodovědecká fakulta

Sofya Belov, Petr Jelínek: Numerické simulace dynamických procesů ve sluneční koróně
Tento příspěvek se zabývá 3D numerickými simulacemi turbulentního proudění kolem magnetických struktur ve sluneční koróně se zaměřením na jev vortex shedding. Tento jev je dobře znám v hydrodynamických podmínkách. Dosud však nebyl detailněji zkoumán v magnetohydrodynamických (MHD) podmínkách, například ve sluneční atmosféře, kde byl jeho výskyt podpořen řadou studií a mohl by vysvětlit některé jevy související s oscilacemi v různých magnetických strukturách. Pro simulace je použit numerický kód Lare3d.

Marta García Rivas
Charles University and Astronomical Institute of the CAS

García Rivas, M., Jurčák, J., Bello González, N.: The role of vertical magnetic fields on the evolution of solar spots
Since the hint of the existence of an invariable value of the vertical magnetic field (B_{ver}) on umbra-penumbra boundaries in sunspots by Jurčák (2011), many investigations have focused on studying this property. Umbra-penumbra boundaries of stable sunspots are defined by a critical B_{ver} (Jurčák et al. 2018, Schmassmann et al. 2018; Lindner et al. 2020). On the other hand, when an umbra does not hold a sufficiently strong B_{ver}, i.e. B_{ver} is weaker than the critical value, penumbral magneto-convection overtakes (Jurčák et al. 2015; Jurčák et al. 2017). Pores are a special type of spots formed by an umbra not surrounded by a penumbra. In this presentation we will talk about the similarities found between the boundary of pores and umbra-penumbra boundaries. Moreover, we will discuss the role of B_{ver} on the decay of pores and sunspots.

Jiří Wollmann
Charles University and Astronomical Institute CAS

Jiří Wollmann, Petr Heinzel: Modelling of spectral line asymmetries observed during stellar flares
Stellar flares are highly energetic events occurring in stellar atmospheres. This solar-like activity has been observed on G, K and M stars. Red dwarfs usually have vast and strong magnetic fields which often reconnect and produce strong flares, sometimes classified as the so-called superflares.
From spectroscopic observations we see, apart from typical enhancements of the line intensities, clearly asymmetrical line profiles. In analogy with solar flares, one would interpret them as due to flows in the flaring chromosphere. However, some stellar observations indicate a peculiar behaviour of such asymmetries and their nature is not well understood.
We present recent spectroscopic observations of flares on AD Leo star obtained with the Ondrejov Echelle Spectrograph. We analyze detected asymmetries using the non-LTE radiative-transfer modeling and demonstrate the importance of flare dynamics. Our interpretation is based on a close analogy with solar flares.

Małgorzata Pietras
University of Wroclaw, Astronomical Institute

M. Pietras, R. Falewicz, M. Siarkowski, K. Bicz, P. Preś: Stellar Flares from the First Three Years of TESS Observations

I would like to present the results of study stellar light curves from the TESS satellite (Transiting Exoplanet Survey Satellite) for the presence of stellar flares. Our main aim was to detect stellar flares using two-minutes cadence data and to perform statistical analysis. To find and analyze stellar flares we prepared automatic software WARPFINDER. Using our software we analyzed two-minute cadence light curves of 330 000 stars located in the first 39 sectors of TESS observations. As a result, we detected over 25 000 stars showing flare activity with the total number of more than 140 000 flares. This means that about 7.7% of all the analyzed objects are flaring stars. The estimated flare energies range between 10^{31} and 10^{36} erg. We prepared a preliminary preview of the statistical distribution of parameters such as a flare duration, amplitudes and energy, and compared it with previous results. The relationship between stellar activity and its spectral type, temperature and mass was also statistically analyzed. Based on the scaling laws, we estimated the average values of the magnetic field strength and length of the flare loops.

Kamil Bicz
University of Wrocław, Astronomical Institute

Kamil Bicz, Robert Falewicz, Małgorzata Pietras, Marek Siarkowski, Paweł Preś: Starspots Modelling and Flare Analysis on Selected MV Stars

Quasi-periodic modulations of the stellar light curve may result from dark spots crossing the visible stellar disc. Since the release of the first TESS sector the possibility of examining such quasi-periodic modulations by assumed dark spots has increased. Thanks to this observations we tried to detect starspot coverage of low mass stars with visible variability of their luminosity. We modelled light curves of spotted stars and estimated the number of spots along with their parameters using their observational light curves from the TESS satellite. To achieve this we used our original BASSMAN software light curves of spotted stars. We tested these models to reveal a connection between the starspots and the stellar flares, in order to provide insight into the overall stellar magnetic field. Here we present the results of modeling of starspots on YZ CMi with our new tool and compare the results with the previous reconstructions of the spotedness of this star.

Jan Kára
Astronomical Institute of Charles University

Jan Kára, Marek Wolf and Sergey Zharikov: Unravelling the Structure of Cataclysmic Variables

Cataclysmic variables are close interacting binaries consisting of a late-type secondary star and a white dwarf primary star surrounded by an accretion disc. I will present how we can study the structure of these systems using photometric and spectroscopic observations, which include modelling of light curves and Doppler tomography.

Pavol Mártonfi
Prírodovedecká fakulta UPJŠ v Košiciach

Pavol Mártonfi, Rudolf Gális, Jaroslav Merc: Emission spectral lines in the spectra of symbiotic system AX Persei

Symbiotic variable stars are interacting binary systems in which matter is transferred from a cool giant to a hot component, mostly a white dwarf by stellar wind causing various manifestations of their activity. This activity is related to both photometric and spectroscopic changes of these systems. The goal of this research was to investigate the behaviour of the prominent emission spectral lines in the spectra of symbiotic system AX Persei. We supplemented our data obtained by analysis of the spectra from the ARAS database with the data taken from the literature. We compared the time evolution of equivalent widths and integrated fluxes of investigated emission spectral lines and pointed out the changes in their behaviour. We also determined the temperature of the hot component from the parameters of the investigated emission lines and followed its

changes in time. We showed the apparent variations of this temperature with the period of (683.6 ± 1.8) days, the value close to the orbital period of the studied system.

Jaroslav Merc

Astronomical Institute of Charles University; Institute of Physics, P. J. Šafárik University in Košice

Merc, J., Gális, R., Wolf, M.: New Online Database of Symbiotic Variables as a tool for understanding the symbiotic population

Symbiotic stars belong to an interesting group of interacting binaries that display a wide variety of phenomena including prominent outbursts connected with the mass transfer, stellar winds, jets, eclipses, or intrinsic variability of the components. Specialized surveys discovered several dozens of new symbiotic stars in recent years. An increase in the number of known systems allows for the investigation of the characteristic of the symbiotic population. Catalogs are essential tools for such research, but the previous one is almost twenty years old. For this reason, we decided to prepare a new, modern and dynamic database - the New Online Database of Symbiotic Variables. In this contribution, we present the database and selected results coming from the systematic and statistical analysis of the symbiotic population included in the catalog.

Viktor Zabolotnii

Pavol Jozef Šafárik University in Košice

Viktor Zabolotnii, Stefan Parimucha: Slovak Virtual Observatory

Slovak Virtual Observatory is big project of connection data from a small telescopes. It's a complex of instruments for uploading, downloading, analyzing and creating new data for amateur and university telescopes all over the world.

Jakub Kolář

Masaryk University

Jakub Kolář, Miloslav Zejda: Doubly eclipsing systems

Quadruple stars with two binary pairs are still quite new and rare type of astronomical objects. Their numbers are growing with new satellite data and efforts of the observers. There is no strong theory of the mechanism of their evolution which could clarify their behavior. Many questions about their fraction or the statistics of the parameters are yet unresolved. We present more information about these multiple stellar systems, our research methods, and current results.

Jakub Cehula

Faculty of Mathematics and Physics, Charles University

Cehula J.: A theory of binary mass transfer

Binary mass transfer (BMT) is a common phenomenon in stellar astrophysics. It is responsible for two main formation channels of compact binaries. Namely, common envelope evolution and formation through stable BMT. Compact binaries include progenitors of gravitational wave sources detected by LIGO. By finding new ways of looking at the BMT we can constraint the formation rates of compact binaries. I will introduce new model of BMT. The new model predicts mass transfer rates which may differ by a factor of 2 compared to the standard models. This has implications for binary stability.

Tahere Ramezani

Masaryk University

Tahereh Ramezani, Ernst Paunzen: Observing of Star Clusters in Ultraviolet

The ultraviolet universe looks quite different from the familiar stars and galaxies seen in visible light. Ultraviolet radiation is the signature of hotter objects, typically in the early and late stages of their evolution. Ultraviolet line spectrum measurements are used to discern the chemical composition, densities, and temperatures of the interstellar medium, and the temperature and composition of hot young stars. Ultraviolet

observations can also provide essential information about the evolution of galaxies. They can be used to detect the presence of a hot white dwarf or main sequence companion in orbit around a cooler star. Ultraviolet light helps researchers trace the vibrant glow of young and blue star clusters in galaxies. The forthcoming Gaia Data Release 3 will allow to precisely study known Galactic open clusters. We collect the available photometric and astrometric data and then observe them photometrically in the Ultraviolet region in a homogeneous way. With these data, a first complete and homogeneous census of the open clusters in the Milky Way using Ultraviolet photometry can be derived and compared to the literature.

Kristína Kallová
Masaryk University

Kristína Kallová, Peter Boorman: Peering through the veil: using hard X-ray spectroscopy to probe the circum-nuclear environment in NGC 3982
Heavily obscured accreting supermassive black holes in the centers of active galaxies offer a unique opportunity to study the circum-nuclear gas in the vicinity (D <~ 20 pc) of the central engine. To understand the geometry and structure of the obscurer, the observed spectral shape in the hard X-ray band is crucial. NuSTAR is the first high-sensitivity focusing hard X-ray telescope in orbit, making it essential for such challenges. In this talk, I will present a detailed study of the circum-nuclear obscurer in Compton-thick AGN candidate NGC 3982. I fit several physically-motivated obscurer models to the broadband X-ray spectra from XMM-Newton and NuSTAR to provide physically-meaningful constraints on the circum-nuclear gas under unique model geometries. The use of global parameter exploration provides inter-parameter dependencies and degeneracies whilst ensuring issues with local minima are avoided. All models used agree that the source is Compton-thick, though I will also highlight the effect of different geometrical assumptions on other key system parameters such as intrinsic X-ray luminosity. I will conclude by presenting some exciting prospects for constraining the geometry of the circum-nuclear region in AGN, with simulated observations from the proposed High Energy X-ray Probe (HEX-P).

Nikolaos Samaras
Astronomical Institute of Charles University

Samaras, Kroupa and Thies: Theory of Milgromian Dynamics & Simulations
Milgromian Dynamics (MOND) is a generalized law of Gravitation applied to galaxy scales. Originally formulated by Mordehai Milgrom in 1983, it has been remarkably successful after a long number of tests. It is considered as an alternative to explain the mass-discrepancy problem in the outskirts of galactic systems, without invoking Dark Matter using the standard Newtonian dynamics. MOND has two important principles. A new constant of acceleration is introduced (a_0, "Milgrom 's constant"). For Newtonian acceleration smaller than a_0, Newton's force law shifts to Milgrom 's and space-time scale-invariance at this low-acceleration limit. I will present the basics of Milgromian Gravity, its predictions and the need of a parent relativistic theory. Furthermore, we make use of the Phantom of Ramses (POR) software, developed in Bonn, which is a customized version of the adaptive-mesh refinement gravity-hydrodynamics code RAMSES. MOND simulations have demonstrated that the formation of exponential disc galaxies work exceptionally well, how the planes of satellite galaxies, how the Hubble Tension and the hitherto not understood formation of very massive galaxy clusters at high redshift are solved simply and naturally. After reviewing these, I will show some preliminary results of fully-consistent High-Performance Computing Hydrodynamical Simulations on a Cosmological model and some investigatory new directions about the expansion history.

Robin Eappen
Astronomical Institute of Charles University

Eappen, Kroupa: Early-Type galaxies in MOND
Downsizing, Early-type galaxies

Samuel Amrich
Charles University, Faculty of Mathematics and Physics

S. Amrich; Š. Mackovjak; I. Strhárský; J. Baláž; and M. Hančikovský: Design and construction of hardware and software for autonomous observations of Transient Luminous Events

Transient luminous events (TLE) are phenomena which are currently on the rise in terms of sightings. However, there is no widespread uniform method of their observation and subsequent image processing. Therefore, our project focuses on the design and construction of hardware that can record TLE. It consists of a low gain, colour, CMOS camera with a bright, wide lens connected to a small, power-efficient single board computer. The project also includes writing software to control the hardware. The software decides whether to capture or not and at what orientation there is the biggest chance to capture a TLE. The software can process and classify the created photos based on deep neural networks. As a final product, we have developed the whole apparatus from a hardware and software point of view and installed it at the Astronomical Observatory at Kolonica Saddle in Slovakia, Central Europe. The plan for the future is to make similar apparatuses to spread the observation network.