EP 13: Astrophysics I

Time: Friday 9:00–10:30 Location: ZHG101

Invited Talk EP 13.1 Fri 9:00 ZHG101

High-Mass X-Ray Binaries: Living Together with a Black Hole — •Lidia Oskinova — Potsdam University, Potsdam

What happens when the life of a massive binary star takes a dramatic turn, and one of its companions collapses into a neutron star or black hole? The answer lies in high-mass X-ray binaries (HMXBs) systems where the transfer of mass from a giant star onto its compact companion generates extraordinary strong X-ray radiation.

HMXBs are among the most enigmatic and fascinating objects in cosmos, serving as natural laboratories for studying fundamental astrophysical processes. In this talk, I will present a holistic view of HMXBs, connecting their properties to the broader story of stellar lifecycles. We will delve into the intricate dynamics between donor stars and their black hole or neutron star companions, with a special focus on the rare and intriguing HMXBs hosting black holes. Recent improvements in understanding of these systems provide fresh insights into their astrophysical significance.

Finally, I will explore HMXB populations across galaxies, illustrating how X-ray observations with modern powerful X-ray telescopes uncover secrets about compact objects and their pivotal role in the Universe.

EP 13.2 Fri 9:30 ZHG101

ComPol - A Compton polarimeter in a Nanosat — •Matthias Meier[1,2], Carlo Fiorini[4], Peter Hinderberger[1,2], Philippe Laurent[3], Martin Losekamm[1,2], Susanne Mertens[1,2], Jonas Schlegel[1,2], Lorenzo Toscano[4], and Michael Willers[1,2] — [1]Excellence Cluster ORIGINS, Garching, Germany — [2]Technical University of Munich, Munich, Germany — [3]Alternative Energies and Atomic Energy Commission, Paris, France — [4]Polytechnic University of Milan, Milan, Italy

It is hardly possible to resolve the geometry of astrophysical compact objects due to their small size. One way to indirectly learn about their structure are polarization measurements. Especially in the hard X-ray range polarization data is still partially missing. Therefore, the aim of the CubeSat mission ComPol is to fill this gap and to improve the physical model of the black hole binary system Cygnus X-1.

The detector system is composed of a Silicon drift detector (SDD) used as a scatterer and a CeBr3 calorimeter to capture the full Compton kinematics. From the measured interaction points and energies it is possible to perform an event-wise reconstruction and infer the polarization of the initial radiation.

The talk will give an overview of the scientific motivation, the underlying physics, the detector setup and its performance. This research is supported by the Excellence Cluster ORIGINS which is funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) under Germany's Excellence Strategy - EXC-2094-390783311

EP 13.3 Fri 9:45 ZHG101

Newly discovered nebulae around Galactic B-type stars and their origins — •Olga Maryeva[1], Péter Németh[1], Sabina Mammadova[2], Sergey Karpov[3], Michaela Kraus[1], Lydia Cidale[4], and Anahi Granada[5] — [1]Astronomical Institute, Czech Academy of Sciences, Czech Republic — [2]Shamakhy Astrophysical Observatory, Baku, Azerbaijan — [3]Institute of Physics of the Czech Academy of Sciences, Prague, Czech Republic — [4]Instituto de Astrofísica de La Plata, La Plata, Argentina — [5]Universidad Nacional de Río Negro, San Carlos de Bariloche, Argentina

The mass loss in massive stars is an important process that determines their future evolution and affects on circumstellar environment. Besides of the continuous outflow of matter in the form of stellar winds, massive stars undergo sporadic ejections that lead to the formation of circumstellar envelopes. For today it remains unclear at what stage of evolution the first mass ejection occurs and what instabilities lead to it. We present the results of a study of four B-type stars which circumstellar nebulae have recently been found in the archive of the Wide-field Infrared Survey Explorer. Two of our objects PY Gem and HD253659 are Be stars showing emission double peak Hα profiles. The collected spectral and photometric monitoring data showed that HD253659 has strong photometric variability with an amplitude of 0.3 mag in addition to the Hα profile variability. The other two stars HD215575 and BD+141106 have spectra of usual B-type stars on the main sequence. Spectral analysis, numerical modeling, as well as high proper motions argue that these two objects undergone merging in the past.

EP 13.4 Fri 10:00 ZHG101

On the existence and (non-)uniqueness of null points of flows and magnetic fields as prerequisites for the existence of astropauses — •Dieter Nickeler[1], Kuljeet Singh Saddal[1,2], and Rodrigo Meneses[3] — [1]Astronomical Institute AV CR, Ondrejov, Czech Republic — [2]Charles University, Prague, Czech Republic — [3]Universidad de Valparaiso, Chile

The existence of null points of vector fields is prerequisite for the spanning of separating surfaces. Such surfaces guarantee that topologically disjoint field lines of the corresponding vector fields exist on each side of the separatrix. The existence of separatrices allows to define so-called pauses, e.g. magnetopause (a magnetic separatrix) or astropause (like the heliopause). To analyse the structure of fields with null points, we focus on the stationary approximation. Besides the topological perspective, other physical constraints can require the existence of null points.

We investigate the case of a non-monotonous pressure distribution driving stationary counterstreaming MHD flows such as the interstellar medium flows and the outer stellar wind flows. For a purely ideal hydrodynamical problem, and demanding on the regularity of all involved fields and their derivatives, we demonstrate that the existence of an extremum of the thermal or plasma pressure at a certain point in the generic three-dimensional case automatically implies that this point is also a stagnation point (= null point of the plasma flow). An extended analysis is performed for ideal MHD and further for MHD with additional, general non-ideal terms.

EP 13.5 Fri 10:15 ZHG101

3D Resistive MHD Perspectives on the Localized Dynamics at the Apex of an Astropause — •Kuljeet Singh Saddal[1,2], Dieter Nickeler[1], and Rodrigo Meneses[3] — [1]Astronomický ústav AV CR, Ondřejov, Czech Republic — [2]Charles University, Faculty of Mathematics and Physics, Praha, Czech Republic — [3]Universidad de Valparaíso. General Cruz 222, Valparaíso

The dynamical interaction zones where stellar winds collide with the interstellar medium, known as astrospheres, are characterized by complex hydrodynamic (HD) or magnetohydrodynamic (MHD) discontinuities. Central to this interaction is the astropause, a boundary separating stellar wind and interstellar flows, whose structure is governed by fluid flow separatrices. In the MHD framework, the presence of a magnetic null point and a velocity stagnation point near the apex of the astropause is essential. Assuming these points coincide, we derive exact solutions to the resistive MHD equations in three-dimensional space. The topology of the magnetic field and two free parameters describes the nature of these solutions. We identify flows that traverse the magnetic field separatrices, i.e., the fan plane and spine line, potentially enabling the identification of true reconnective solutions. The goal of this analysis is to identify and differentiate reconnective and non-reconnective solutions based on specific criteria. Using these solutions, we calculate dissipation rates and derive thermodynamic properties, such as pressure and temperature, at the apex. This enables the computation of radiance and the generation of synthetic sky maps for comparison with observational data.