Symbiotic stars,
weird novae, and related embarrassing binaries

ABSTRACT BOOK

June 3 - 7, 2024

Charles University, Prague, Czech Republic

This abstract book was prepared by Jaroslav Merc and is using modified template based on the original versions from `LaTeXTemplates.com` and `https://github.com/maximelucas/AMCOS_booklet`.

Picture of R Aqr used in the graphics: Hubble, NASA, ESA; processing by Judy Schmidt.

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Foreword

It is my pleasure to present to you the abstract book for the conference 'Symbiotic stars, weird novae, and related embarrassing binaries', held from June 3 to June 7, 2024, at the Faculty of Mathematics and Physics of Charles University.

First of all, let me warmly welcome you to Prague, the capital of the Czech Republic, a city with a rich astronomical heritage, and to Charles University, one of the world's oldest universities, founded in 1348. With 51 000 students and 8 800 employees across 17 faculties, it is the largest university in the Czech Republic and consistently ranks among the highest in international rankings. Prague and Charles University thus provide an ideal setting for an international astronomy conference.

While symbiotic binaries have been discussed at various conferences over the years, a meeting focused specifically on these and other intriguing "weird and embarrassing" binaries has not been held for a long time. I sincerely believe that this conference will build on the success of previous meetings, such as those held in 2002 (La Palma, Canary Islands, Spain), 2006, and 2013 (both in Wierzba, Poland).

The conditions to achieve that are ideal. With almost 90 participants (far exceeding my initial expectations!), more than 60 oral contributions, and nearly 30 poster presentations, we are set for a busy and extremely interesting week.

As advertised on the conference website and in our announcements, this conference aims to unite a community of researchers working in our field. Please take advantage of this opportunity during the conference week (and beyond) to exchange ideas, discuss your research, and start new collaborations.

I am looking forward to meeting you all in Prague soon!

On behalf of the organizers,

Jaroslav Merc
Chair of the LOC, co-chair of the SOC

Astronomical Institute of Charles University
European Southern Observatory

About

Symbiotic stars, weird novae, and related embarrassing binaries

The conference '**Symbiotic stars, weird novae, and related embarrassing binaries**' will take place from **June 3 to June 7**, 2024, hosted at the Faculty of Mathematics and Physics of Charles University. Nestled in the heart of Prague, the capital of the Czech Republic, our conference venue resides in a city steeped in rich cultural and scientific heritage. Prague hosts the oldest operational astronomical clock in the world and has been witness to significant astronomical discoveries, echoing the intellectual pursuits of scientific pioneers like Johannes Kepler, Tycho Brahe, or Albert Einstein.

This historical backdrop provides an inspiring setting for the exchange of knowledge and groundbreaking ideas. The conference aims to **unite a global community**, fostering discussions on recent advancements in the field achieved through dedicated ground- and space-based observations and the introduction of innovative data analysis methods. We anticipate that this event will facilitate intensive idea exchange, discussions, and the initiation of new collaborations, potentially shaping novel research directions. While the core conference topics include symbiotic stars, novae, peculiar cataclysmic variables, red novae, and other mergers, along with extreme Algols and W Ser-type interacting binaries, their relationships, behavior, parameters, and evolution, the **program's final shape will be driven by contributions submitted by participants**. On Friday, a part of the program will spotlight projects and their outcomes stemming from collaborations between **professional and amateur astronomers**.

Scientific rationale

Recent ground-based programs and groundbreaking space missions, together with new methods involved in data analysis, have brought **significant discoveries** while outlining **future directions** of research of multiple stellar systems. However, within the realm of objects like symbiotic stars and other peculiar binaries, numerous aspects concerning their behavior, parameters, and evolution **remain unresolved**. The conference aims to discuss and build upon recent advancements in the field, made possible through dedicated research by the **global scientific community**.

A few of the **key topics** to be addressed include:

- relationship between symbiotic stars, novae, peculiar cataclysmic variables, and red novae/mergers,
- recurrent novae, super-soft X-ray sources, and the symbiotic channel leading to Type Ia supernovae,
- stability and time scales of mass transfer and the accretion disk in eruptive systems,
- novae with evolved giant donors,
- interaction of nova ejecta with its circumstellar and interstellar surroundings,
- R Aqr as a proxy for interacting binaries with AGB donors,
- X-ray emitting symbiotic stars,
- extragalactic populations of symbiotic systems,
- red novae and other mergers,
- extreme Algols and W Ser-type interacting binaries.

The list is **open**, and participants are encouraged to propose other related topics, enriching the conference's discourse. The conference program remains dynamic and will be shaped by the SOC based on the **abstracts submitted by participants**. We anticipate that this conference will foster collaboration, inspire new research directions, and enhance our comprehension of these enigmatic stellar systems.

Scientific organizing committee

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Marek Wolf
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Timetable

Monday, June 3

09:00 - 09:50	**Registration**
09:50 - 10:20	**Coffee break**
10:20 - 10:35	**Welcome address**
10:35 - 12:00	**Morning session** *(Symbiotic stars)*
10:35	*Joanna Mikołajewska:* Symbiotic stars: highlights, challenges and lessons for the future
11:05	*Stavros Akras:* Hide-and-seek with symbiotic stars
11:25	*Marco Laversveiler:* The Symbiotic Star Population in Nearby Galaxies and its Tenuous Link with Type Ia Supernovae Events
12:00 - 14:00	**Lunch break**
14:00 - 15:30	**Afternoon session - part I** *(Symbiotic stars)*
14:00	*Jennifer L. Sokoloski:* A new way to find symbiotic stars: accretion disc detection with optical survey photometry
14:20	*Denise R. Gonçalves:* The RAMan Search for Extragalactic Symbiotic Stars project – RAMSES II - in the dwarf spheroidal NGC 205
14:40	*Jeong-Eun Heo:* Can Raman O VI Features Trace the Evolutionary Paths of Symbiotic Stars?
15:00	*Seok-Jun Chang:* Studying Raman Scattering Features in Symbiotic Stars through 3D Monte Carlo Code STaRS
15:15	*Hee-Won Lee:* Raman-scattered He II feature at 6545 in the D-type Symbiotic Star H1-36
15:30 - 16:00	**Coffee break**
16:00 - 17:45	**Afternoon session - part II** *(Symbiotic stars)* **and Poster session**
16:00	*Sara Saeedi:* Symbiotic stars in X-rays: eROSITA and XMM-Newton observations of Galactic and extragalactic symbiotic stars
16:20	*Kenneth H. Hinkle:* A Symbiotic Rosetta Stone: the Neutron Star - M Giant Symbiotic X-Ray Binary, IGR J16194-2810
16:40	*Jesús Toalá:* Reflection physics in X-ray-emitting symbiotic systems
16:55	*Pranav Nagarajan:* New Light on Symbiotic X-ray Binaries
17:10	*Antonio Rodriguez:* Accreting White Dwarfs in the new X-ray Sky as seen with SRG/eROSITA
17:25	**Short poster presentations** (2 min each)
18:00 - 19:30	**Welcome reception**

Tuesday, June 4

09:00 - 09:55	**Morning session - part I** *(Symbiotic stars)*
09:00	*Cezary Gałan:* Chemical abundances and kinematics of symbiotic giants in S-type systems
09:20	*Jaroslav Merc:* Variability of symbiotic stars from the New Online Database of Symbiotic Variables with NASA TESS
09:40	*Vladyslava Marsakova:* Pulsational activity of red giants in symbiotic variables PU Vul, RT Ser and UV Aur
09:55 - 10:00	**Conference photo**
10:00 - 10:30	**Coffee break**
10:30 - 12:00	**Morning session - part II** *(R Aquarii)*
10:30	*Javier Alcolea:* mas-resolution ALMA observations of the core of R Aqr after periastron passage: the orbit, the jet, and the changes in the distribution of the molecular species
10:50	*Hans Martin Schmid:* Temporal changes in the R Aqr system based on high resolution imaging with SPHERE/ZIMPOL
11:10	*Markus Wittkowski:* Infrared interferometric imaging of the symbiotic Mira R Aqr
11:30	*Miguel Gómez-Garrido:* Continuum and molecular emission from the inner regions of the symbiotic system R Aquarii
11:45	*Tiina Liimets:* Influence of the periastron passage to the large-scale jet of R Aquarii
12:00 - 14:00	**Lunch break**
14:00 - 15:30	**Afternoon session - part I** *(Red novae, mergers, and ultra-compact binaries)*
14:00	*Natalia Ivanova:* Simulating the light curves of luminous red novae
14:20	*Tomasz Kamiński:* Nova 1670 (CK Vul) as a merger event
14:40	*Kishalay De:* Discovering red novae at extremes: From planetary engulfment to dusty evolved stars
15:00	*Nela Dvořáková:* Unravelling the complex nature of FS CMa stars
15:15	*Alicia Moranchel-Basurto:* 2.5-MHD models of circumstellar discs around FS CMa post-mergers
15:30 - 16:00	**Coffee break**
16:00 - 17:00	**Afternoon session - part II** *(Red novae, mergers, and ultra-compact binaries)* **and Poster session**
16:00	*Tiina Liimets:* V838 Mon: is the Sleeping Beauty really waking up?
16:15	**Short poster presentations** (2 min each)
17:00 - 17:45	**Panel discussion: Physical definition of symbiotic stars**

Wednesday, June 5

09:00 - 10:00	**Morning session - part I** *(Mass transfer and evolution of symbotic stars and related systems)*
09:00	*Philipp Podsiadlowski:* Understanding the evolution of symbiotic binaries
09:30	*Natalia Shagatova:* Asymmetries of the wind from giants in S-type symbiotic binaries from UV and optical observations
09:45	*Camille Landri:* Explaining Asymmetric Winds in Red Supergiants with Binary Interaction
10:00 - 10:30	**Coffee break**
10:30 - 12:00	**Morning session - part II** *(Mass transfer and evolution of symbotic stars and related systems)*
10:30	*Iminhaji Ablimit:* The role of magnetic field in the evolution of symbiotic binaries to type Ia supernovae
10:50	*Ondřej Pejcha:* Signatures of intense mass-transfer in binary stars
11:10	*Miguel Santander-García:* Are we missing something beyond the mass from post-common-envelope PNe?
11:30	*Jakub Cehula:* A theory of mass transfer in binary stars
11:45	*Natalia Ivanova:* Unified mass transfer scheme
12:00 - 14:00	**Lunch break**
14:00 - 14:45	**Panel discussion: Mass transfer and related issues**
15:00 - 17:00	**Guided tour through the astronomical Prague**

Thursday, June 6

09:00 - 10:00	**Morning session - part I** *(Novae)*
09:00	*Peter Craig:* The BVRI Color Distributions of Classical Novae
09:15	*Kenta Taguchi:* Spectra of Nova V1405 Cas at the Very Beginning Indicate a Low-mass ONeMg White Dwarf Progenitor
09:30	*Augustin Skopal:* Possible connections of thermonuclear outbursts in accreting white dwarf binaries
09:45	*Vladislav Dragomirov Marchev:* Evolution of the mass accretion rate in symbiotic stars
10:00 - 10:30	**Coffee break**
10:30 - 12:00	**Morning session - part II** *(Novae)*
10:30	*Przemek Mróz:* Millinovae: A new class of transient supersoft X-ray sources without a classical nova eruption?
10:50	*Krystian Iłkiewicz:* Short bursts in cataclysmic variables with TESS and Kepler
11:10	*Irin Babu Vathachira:* Eruptive novae in symbiotic systems
11:30	*Yanko Marinov Nikolov:* Spectropolarimetric observations of the recurrent novae RS Oph and T CrB
11:45	*Gesesew R. Habtie:* Spectroscopic Insights into the Quiescent Stage of RS Ophiuchi (2006-2021): Photoionization Modeling and Accretion Dynamics
12:00 - 14:00	**Lunch break**
14:00 - 15:30	**Afternoon session - part I** *(Nova shells, winds, and circumstellar environment)*
14:00	*Yael Hillman:* Modeling colliding nova shells
14:30	*Michael William Healy-Kalesh:* On the Nova Super-Remnant Phenomenon
14:50	*Michael Shara:* Detections of New Classical Nova, Symbiotic Nova and Dwarf Nova Ejecta
15:10	*Linda Schmidtobreick:* Analysing nova shells in 3D
15:30 - 16:00	**Coffee break and Nova shell in VR**
16:00 - 17:05	**Afternoon session - part II** *(Nova shells, winds, and circumstellar environment)*
16:00	*Martin A. Guerrero:* 3D visualisation of nova remnants
16:15	*Lientur Celedon:* The enigmatic nova shell around V1425 Aql as seen by MUSE
16:30	*Albert Bruch:* AH Pictoris stars: A new class of novalike variables?
16:50	*Jan Kára:* Structure of accretion flow of IX Velorum
19:00 - 22:30	**Conference dinner** *(restaurant open since 18:15)*

Friday, June 7

10:00 - 10:30	**Wake-up coffee**
10:30 - 12:00	**Morning session** *(Symbiotic stars and related binaries)*
10:30	*Olivier Garde:* 2SPOT: A remotely-operated amateur spectroscopic observatory located in Chile
10:50	*Thomas Petit:* DeGaPe 35: Amateur discovery and characterization of a new southern symbiotic star
11:10	*Lionel Mulato:* Search for new symbiotic stars using the Gaia DR3 data
11:30	*Kazuko Ando:* Spectroscopic observations of MWC560
11:45	*Jaime Alonso Hernández:* Effects of (internal) UV and X-ray emission in AGB's envelopes
12:00 - 14:00	**Lunch break**
14:00 - 15:40	**Afternoon session** *(Other embarrasing binaries)*
14:00	*Ana Escorza:* 56 Ursae Majoris: a binary evolution puzzle
14:20	*Léa Planquart:* V Hydrae: a dusty binary with a conical jet
14:35	*Ernst Paunzen:* X-ray binaries in Galactic star clusters
14:50	*Francesco Gabrielli:* The cosmic rate of Pair Instability Supernovae
15:05 - 15:30	**Concluding remarks and summary of the conference**
15:30 - 16:00	**Farewell coffee**

Oral Contributions

Monday, June 3

Symbiotic stars: highlights, challenges and lessons for the future

Joanna Mikołajewska[1]

[1]Nicolaus Copernicus Astronomical Center of the Polish Academy of Sciences, Warsaw, Poland

I will present and discuss some recent observational results, including distribution of basic parameters, constraints on mass loss and accretion and their census in Galaxy and beyond as well as their challenges which these systems continually pose to theoretical models.

Hide-and-seek with symbiotic stars

Stavros Akras[1]

[1]National Observatory of Athens - IAASARS, Greece

Symbiotic stars (SySts) are perfect laboratories for the study of several astrophysical phenomena such as accretion disk, jets formation, flickering, X-ray emission as well as potential progenitors of type Ia supernova. However, the population of known Galactic SySts still remain highly discrepant with the theoretical predictions by 2–3 orders. Here, I discuss the updated catalog of SySts I published in 2019 and the results of the statistical analysis. I will then talk about the newly near-infrared selection criteria for identifying and distinguishing SySts from other Hα emitters, employing for the first time machine learning algorithms. I will finish my talk presenting the results from the follow-up spectroscopic survey of 14 candidates and the discovery of nine new SySts thus far.

The Symbiotic Star Population in Nearby Galaxies and its Tenuous Link with Type Ia Supernovae Events

Marco Laversveiler[1], **Denise R. Gonçalves**[1], **Helio J. Rocha-Pinto**[1], **Jaroslav Merc**[2,3]

[1]Valongo Observatory, Federal University of Rio de Janeiro, Brazil
[2]Astronomical Institute of Charles University, Czech Republic
[3]ESO Garching, Germany

The dynamics of the symbiotic stars (SySt), evolved binary systems in which a white dwarf (WD) accretes mass from a giant star, causes variability, recurrent nova-like eruptions and jets, among others phenomena, which make them good laboratories for many binary interaction processes. This contribution deals with the problem of the SySt population and its controversial relation with type Ia supernovae (SNe Ia) events, in galaxies of the Local Group (LG). A fraction of the SySt can host massive WDs (>1 $M_\odot$), so accretion might be enough to reach the Chandrasekar mass limit – classical SNe Ia channel. Due to this possibility, SySt have been considered as potential SNe Ia progenitors. Here we attempt to pave the SySt–SN Ia relation. Particularly for the Galaxy, we study the distribution and dynamics of the SySt to establish their scale height and the minimum expected population based on their number density in the thin disk. We also employ a statistical approach for the Galaxy and some LG dwarf galaxies. The primary parameters considered are the initial mass function, the zero age main sequence semi-major axis and mass ratio distributions for binary systems, the binary fraction and the mean metallicity of the galaxy. Our results return a Galactic SySt population ranging from the empirical threshold value of 7–14$\times10^3$ to the expected statistical amount of 30–46$\times10^3$ objects. For LG dwarf galaxies, the expected SySt population varies between 2 and 4 orders of magnitudes lower, depending mainly on the galaxies' bolometric luminosity. In some cases, no SySt is expected to be found. Concerning the SNe Ia, our results support previous conclusions that SySt can not be the main progenitors of these events through the classical channel. Nonetheless, we infer that it is still expected that a few percent of the SNe Ia may have symbiotic progenitors in the Milky Way – up to 4%. While the majority of the – low-luminosity – dwarf galaxies did not experience any symbiotic type Ia supernova.

A new way to find symbiotic stars: accretion disc detection with optical survey photometry

Jennifer L. Sokoloski[1], Adrian B. Lucy[2], Gerardo Juan Manuel Luna[3], Koji Mukai[4], Hannes Breytenbach[5], David Buckley[6], Stephen Potter[6], Patrick A. Woudt[5], Paul J. Groot[7], Natalia E. Nuñez[8], Andy Howell[9], Christian Wolf[10], Rajeev Manick[11]

[1]Columbia University, USA
[2]Space Telescope Science Institute, USA
[3]CONICET, Universidad Nacional de Hurlingham, Argentina
[4]CRESST and X-ray Astrophysics Laboratory, NASA, University of Maryland Baltimore County, USA
[5]University of Cape Town, South Africa
[6]South African Astronomical Observatory, South Africa
[7]Radboud University, Netherlands
[8]Universidad Nacional de San Juan, Argentina
[9]Las Cumbres Observatory, USA
[10]Australian National University, Australia
[11]Institut de Planétologie et d'Astrophysique de Grenoble, France

We present a new way to find symbiotics that is less biased against accreting-only, non-burning symbiotics with directly detectable accretion disks than narrow-band H-alpha photometry and objective prism plate surveys. Our search methodology is based on finding outliers in SkyMapper Southern Sky Survey broad-band and intermediate-band photometry, using a parameter space built from reconstructed u-g u-v snapshot colors and rapid variability between the three exposures of a 20-minute SkyMapper Main Survey filter sequence, from a sample of luminous red objects selected with 2MASS and Gaia. In a pilot survey employing this new search design, we discovered 12 new symbiotics, including four symbiotics with optical accretion disk flickering and at least two with boundary-layer hard X rays, as well as 10 new symbiotic candidates. We also discovered optical flickering in the known symbiotic V1044 Cen (CD-36 8436). We find that there is a significant population of optically-flickering symbiotics hidden both within and beyond the known catalogs of symbiotic stars. We also find that our methods probe a completely different region of parameter space than recent work by the Munari et al. (2021) search for accreting-only symbiotics, while being surprisingly in harmony with the Akras et al. (2019) infrared selection criteria.

The RAMan Search for Extragalactic Symbiotic Stars project - RAMSES II - in the dwarf spheroidal NGC 205

Denise R. Gonçalves[1], **Germán Gimeno**[2], **Mateus Dias Ribeiro**[1], **Stavros Akras**[3]

[1]Valongo Observatory, Federal University of Rio de Janeiro, Brazil
[2]Gemini Observatory, NSF's National Optical-Infrared Astronomy Research Laboratory, Chile
[3]National Observatory of Athens - IAASARS, Greece

Following the fact that symbiotic systems (SySt) are composed of binary stars on which a hot white dwarf is accreting mass from a cool red giant, they are very relevant to deepen into the study of stellar evolution, from the point of view of binary systems. These objects are also among the contenders for Type Ia SN progenitors. The detection of the $\sim \lambda$6835 emission-line – due to Raman scattering of the O VI λ1032 resonance line by neutral hydrogen – is almost a clear-cut proof of a symbiotic star. Based on this fact, the RAMan Search for Extragalactic Symbiotic Stars project, RAMSES II, built narrow-band filters to the Gemini telescope Multi-Object Spectrographs, centred at λ6835 and its adjacent continuum, with the goal of searching for the SySt of the nearby galaxies. Such a census is actually based on the simultaneous detection of the Hα, He II λ4686 and Raman O VI emission lines. The first results of this novel technique to search for SySt was demonstrated in Angeloni et al. (2019) via Raman O IV imaging and immediate spectroscopic follow-up, as part of the science verification phase of the project. For a long time we struggled to identify the Hα, He II and Raman O VI emitters in the dwarf Andromeda's satellite NGC 205, the first galaxy on which we fully applied the RAMSES II technique. With two different methods that will be discussed in this contribution, we identified 4 bona fide SySt as Raman O VI emitters, and other 5 chosen by being asymptotic giant branch (AGB) stars that also show clear emission lines in Hα and He II. Given the difficulties to undoubtedly assign the SySt nature of the sources of this galaxy, we recently (February 2024) had obtained deep optical spectra for these 9 targets. Therefore, in this contribution the spectroscopic results will also be presented, validating the efficiency of the method for NGC 205.

Can Raman O VI Features Trace the Evolutionary Paths of Symbiotic Stars?

Jeong-Eun Heo[1], Rodolfo Angeloni[1], John Blakeslee[2]

[1]Gemini Observatory, NSF's National Optical-Infrared Astronomy Research Laboratory, Chile
[2]NSF's National Optical-Infrared Astronomy Research Laboratory, USA

In the study of symbiotic stars, the distinctive Raman O VI features at 6825 and 7082 hold particular significance. These features originate from the Raman scattering of far-UV O VI 1032 and 1038 emission lines, providing invaluable insights into both the dynamics of accretion flow and the geometry of scattering region. An additional fascinating aspect of Raman O VI features is the diversity of their profiles, ranging from single to triple peaks. Some objects exhibit remarkably similar profiles, indicating a commonality among them. As the Raman O VI features are scattered lines, they reflect the relative motion between the emission region and the scattering region. Consequently, symbiotic stars with similar Raman O VI profiles likely in a similar evolutionary stage. In this talk, I will introduce the details of the Raman-scattering process in symbiotic stars. Following that, I'll present the profiles of Raman O VI features in various symbiotic stars obtained with high-resolution spectrographs, GHOST/GEMINI and MIKE/Magellan-Clay. Finally, I'll discuss the potential connections between these profiles and other physical parameters of the systems. This comprehensive exploration aims to enhance our understanding of the nature and evolution of symbiotic stars.

Studying Raman Scattering Features in Symbiotic Stars through 3D Monte Carlo Code STaRS

Seok-Jun Chang[1], **Hee-Won Lee**[2]

[1]Max Planck Institute for Astrophysics, Germany
[2]Sejong University, South Korea

Raman scattering is an inelastic scattering process in which an incident photon is converted to one with lower energy. Specifically, Raman scattering with atomic hydrogen allows us to observe UV radiation through ground-based observations, such as the broad Raman wing near Hα, Raman O VI λ6825, 7082, and Raman He II λ6545, λ4851, λ4332. These Raman scattering features have been observed in various astronomical objects, including symbiotic stars, planetary nebulae, and star-forming regions, where strong UV radiation and optically thick H I medium coexist. The physical properties of both hot emission ($T \geq 10^5$ K) and cold scattering media ($T < 10^4$ K) are imprinted on Raman scattering features. To decode this information, we have developed a 3D Monte Carlo simulation named STaRS (Sejong radiative transfer through Raman Scattering). In this presentation, I will introduce STaRS and discuss the interpretation of Raman features observed in symbiotic stars. Additionally, time permitting, I will discuss the potential application of STaRS in hydrodynamic simulations for accretion disk formation near the white dwarf.

Raman-scattered He II feature at 6545 in the D-type Symbiotic Star H1-36

Hee-Won Lee[1], **Jiyu Kim**[1]

[1]Sejong University, South Korea

The D-type symbiotic star H1-36 was discovered and cataloged as a planetary nebula by Haro in 1952 from an objective prism survey, and the symbiotic nature was pointed out and investigated in detail by researchers including Allen (1983) and Angeloni (2007). With strong UV emission around the white dwarf component and abundant H I near the giant component, symbiotic stars provide the ideal condition for the operation of Raman scattering with atomic hydrogen. In particular, Raman-scattered O VI features at 6830 Å and 7088 Å from O VI doublet at 1032 Å and 1038 Å are important identifiers for a symbiotic star. Also, far UV He II 1025 may be Raman-scattered to form a broad Raman feature at 6545 Å. This Raman He II is known to be present in a smaller fraction of symbiotic stars than Raman O VI, despite He II having a larger scattering cross-section around 1025 Å (10^{-21} cm^{-2}) compared to that near the O VI doublet ($\sim 10^{-23}$ cm^{-2}). In this talk, we report the presence of Raman He II at 6545 in the D-type symbiotic star H1-36 from the spectrum archived in the ESO Science Portal. We discuss the HI distribution and kinematics from our analysis of Raman He II.

Symbiotic stars in X-rays: eROSITA and XMM-Newton observations of Galactic and extragalactic symbiotic stars

Sara Saeedi[1], Manami Sasaki[1], Jonathan Knies[1], Jan Robrade[2]

[1]Dr. Karl Remeis Observatory, Friedrich-Alexander University Erlangen-Nürnberg, Germany
[2]Hamburger Sternwarte der Universität Hamburg, Germany

The old population of globular clusters and nearby dwarf galaxies are ideal to search for the accreting white dwarfs and in particular the symbiotic stars. We have classified different types of symbiotic stars in many nearby dwarf galaxies and also the old population of 47 Tuc globular cluster using the data of eROSITA and XMM-Newton. We present our results of X-ray population study of symbiotic stars and also discuss some interesting and peculiar systems.

A Symbiotic Rosetta Stone: the Neutron Star - M Giant Symbiotic X-Ray Binary, IGR J16194-2810

Kenneth H. Hinkle[1], Francis C. Fekel[2], Oscar Straniero[3], Zachary G. Maas[4], Richard R. Joyce[1], Thomas Lebzelter[5], Matthew W. Muterspaugh[6], James R. Sowell[7]

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[5]University of Vienna, Austria
[6]Columbia State Community College, USA
[7]Georgia Institute of Technology, USA

We are undertaking a survey of the near-infrared spectra of M giant - NS symbiotic binaries. These objects have a range of separations, with measured orbital periods of less than a year to more than a decade. The shortest orbital period system is IGR J16194-2810. We have determined a single-lined spectroscopic orbit for the M giant from a time-series of optical spectra. The spectroscopic orbital period of 192.5 days is twice that of the photometric period, confirming that the M giant in the system is a Roche-lobe filling ellipsoidal variable. The giant is identified as a first ascent giant approaching the red giant tip. IGR J16194-2810 is among the longest orbital period members of the low mass x-ray binaries (LMXB). LMXB evolve into NS - WD systems and the evolution has been extensively modeled. IGR J16194-2810 is near the limiting orbital period where first ascent giants can evolve into NS - WD binaries. Longer orbital period systems become Roche lobe filling when the late-type star is on the AGB. As a member of the ellipsoidal, LMXB, and symbiotic families this binary can provide insight into stellar evolution of binary systems consisting of a degenerate and an evolved stellar component.

Reflection physics in X-ray-emitting symbiotic systems

Jesús Toalá[1]

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Symbiotic stars are binary systems in which a white dwarf is accreting material from a red giant. Of the 300 symbiotic systems in our Galaxy, only about 20 % have been detected to emit X-ray emission. I this talk, I will briefly review our knowledge of the X-ray properties of Symbiotic Stars and will discuss the impact produced by the presence of the accretion disk in the production of X-ray emission. For this, I will present radiative transfer simulations of X-ray-emitting symbiotic systems to demonstrate that some X-ray properties and variability are produced by the variable properties of the accretion disk.

New Light on Symbiotic X-ray Binaries

Pranav Nagarajan[1], **Kareem El-Badry**[1]

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Symbiotic X-ray Binaries (SyXBs) are an extremely rare class of objects hosting a neutron star accreting from a red giant donor. The existence of SyXBs presents an embarrassing challenge to binary evolution models, as the natal kick imparted to the neutron star upon its massive progenitor's explosive death (combined with the mass loss due to the supernova) is expected to unbind the system altogether. In this talk, I present novel optical spectroscopic observations of IGR J16194-2810, one of the few probable SyXBs. Having obtained radial velocity measurements for the donor star over several months, I combine modeling of the ellipsoidal variability and spectral energy distribution of the red giant with a Keplerian fit to its line-of-sight motion to derive its stellar parameters and determine its orbital elements. I present constraints on the system's orbital period and the neutron star's mass function, both of which have never been measured before. Finally, I explain how these optical measurements can shed new light on the formation of IGR J16194-2810 and its elusive SyXB peers.

Accreting White Dwarfs in the new X-ray Sky as seen with SRG/eROSITA

Antonio Rodriguez[1]

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The X-ray sky is being transformed through data releases from the SRG/eROSITA mission, which is the deepest all-sky X-ray survey in nearly thirty years. Furthermore, Gaia information enables the distinction between Galactic and extragalactic sources, which was difficult in the past. If that's not enough, the Zwicky Transient Facility (ZTF) has been collected optical photometry down to 21 mag across the entire Northern sky for five years. I will present a survey of accreting white dwarfs, from cataclysmic variables to symbiotic stars, that has emerged from a crossmatch of SRG/eROSITA + Gaia + ZTF. New relationships in orbital periods, X-ray luminosity, white dwarf spin periods, and variability are emerging, which will inform our current understanding of binary star evolution in ways not seen before. I will also focus on the ultracompact binary population of white dwarfs in the X-ray, and the implications for mergers and populations seen in gravitational waves with LISA.

Tuesday, June 4

Chemical abundances and kinematics of symbiotic giants in S-type systems

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Chemical abundances of CNO and elements around the iron peak (Fe, Ti, Ni, and Sc) were measured from high-resolution (R∼50000), near-IR spectra for 5 dozens of symbiotic giants in the S-type systems using the spectrum synthesis method. I will discuss the obtained results, implications on the evolutionary status of these objects, and their chemical evolution in the Galactic population taking into account kinematic aspects.

Variability of symbiotic stars from the New Online Database of Symbiotic Variables with NASA TESS

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Symbiotic binaries exhibit a wide range of photometric variability across different timescales. In the range from minutes to hours, a variability induced by accretion processes that is likely to originate from the accretion disks has been detected and denoted as flickering. We aimed to utilize the precise observations of the NASA TESS mission to detect and study short-term variability in confirmed symbiotic stars from the New Online Database of Symbiotic Variables, the most up-to-date catalog of these binaries published in the literature.

In this talk, I will introduce the Database and present the results of the analysis of TESS light curves for known symbiotic stars. Despite flickering studies typically being conducted at shorter wavelengths than those of TESS observations, our findings suggest that these data can be utilized for the detection of flickering when studied stars are not located in crowded regions. Through newly identified cases of variability, potentially originating in accretion disks, we propose that accretion disks may be prevalent in symbiotic binaries.

Pulsational activity of red giants in symbiotic variables PU Vul, RT Ser and UV Aur

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We conducted a time-series analysis of photometric observations obtained in the Astronomical Institute of the Slovak Academy of Sciences, AAVSO multicolor observations, ASAS-SN data, and archival photographic data for symbiotic variables PU Vul, RT Ser, and UV Aur. These symbiotic stars exhibit both long-term waves (ranging from approximately 4400 to 6800 days) and shorter cycles (100-400 days), likely associated with the pulsation activity of their red giant components. By utilizing multicolor observations and their multi-frequency approximations, we refined the parameters of the long waves, suggesting that their origin lies in the varying visibility conditions (during orbital motion) of a partially optically thick nebula ionized by the intense radiation from the white dwarf. Both PU Vul and RT Ser are symbiotic novae; furthermore, PU Vul displayed three eclipses after the nova outburst, while UV Aur, observed over a century, did not reveal any such outbursts. In the case of PU Vul, our analysis of VRI-observations revealed, for the first time, an increase in the pulsational period of the red giant from approximately 206 to 222 days over a 50-year observation period. Additionally, we observed a rising occurrence of irregularities in the pulsation cycles, with intervals seemingly correlated with orbital motion (period of about 5000 days). For UV Aur, pulsations with a cycle of about 394 days were analyzed, indicating a slow increase in cycle length at a rate of about 0.8 days per cycle (on average). These long-term period changes (in case of both, PU Vul and UV Aur) bear similarities to changes observed in Mira-type variables during the helium shell flash stage (e.g., R Aql, R Hya, W Dra, and T UMi). Finally, our examination of time series for RT Ser identified multiperiodic behavior on a short timescale, with cycles of 90-94, 107, and 160 days, suggesting a connection to the semiregular pulsations of the red component.

mas-resolution ALMA observations of the core of R Aqr after periastron passage: the orbit, the jet, and the changes in the distribution of the molecular species

Javier Alcolea[1], Joanna Mikołajewska[2], Miguel Gómez-Garrido[1], Valentin Bujarrabal[1], Arancha Castro-Carrizo[3], Jean-François Desmurs[1], Miguel Santander-García[1]

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R Aqr is a symbiotic system consisting of a Mira primary and a white dwarf companion. It is also the closest interacting binary system and the most fascinating and best-studied D-type symbiotic. In our previous works based on ALMA observations, we conclude that the molecular envelope of the mass-losing primary is strongly affected by the gravitational pull and photodissociation due to the hot secondary. We also derived the first accurate orbital parameters of the system, which agree with the spiral structure seen in CO. Here, we present the results of new (2023) 11 to 20 mas-resolution ALMA observations of the core of the system in bands 6 and 7 (1.3 and 0.9 mm). We have refined the orbital parameters using five images resolving the two components and a velocity curve for the primary (based on SiO masers) for 45 yr. Our continuum images show the structure of the jet at 3 to 30 AU scales: it is one-sided and shows variations in timescales of days. We also report the detection of a second radio recombination line, H26alpha, which, as it happens with the previously detected H30alpha, closely follows the free-free continuum distribution (from the jet and the companion close surroundings). Regarding the circumstellar envelope of the AGB primary, we confirm a lack of molecular emission on the side illuminated by the companion (now on the other side of the primary). Finally, we also report on the first molecular species associated with the secondary, HCN, and discuss its possible origin.

Temporal changes in the R Aqr system based on high resolution imaging with SPHERE/ZIMPOL

Hans Martin Schmid[1]

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R Aqr was used as test source for the visible channel of the SPHERE adaptive optics instrument at the VLT. This instrument provides a spatial resolution of 25 mas for imaging in the Hα emission line and the polarized scattered emission from circumstellar dust for the innermost 3.6" x 3.6" region of the system. With the first data from 2014, we could resolve the binary (separation 45 mas) and characterized many Hα emission clouds in the jet. Since then we have re-observed R Aqr three times in 2016, 2019, and 2021 and we discuss results from this monitoring.

After 2014 the central Hα jet source could not be detected anymore because the separation to the red giant diminished and probably also because its emission was engulfed by circumstellar material. All Hα emission clouds are moving outwards roughly along the jet axis, and in addition we see strong changes in their structure and brightness with even some Hα clouds disappearing and new Hα clouds appearing.

We can also measure the polarized light from circumstellar dust scattering from which we infer a flattened distribution of dust around the binary. We see extended dust structures and clouds in the system which move radially outwards with a smaller velocity than the Hα emission. A few dust clouds have a comet like structure which could be caused by the radiation pressure from the red giant.

We compare our images with other contemporary high resolution observations from HST, ALMA, JVLA and literature data from the past and try to clarify some geometric and hydro-dynamical properties of this complex symbiotic system.

Infrared interferometric imaging of the symbiotic Mira R Aqr

Markus Wittkowski[1], **Elizabeth Humphreys**[2], **Claudia Paladini**[2], **Gioia Rau**[3]

[1]ESO Garching, Germany
[2]ESO Vitacura, Chile
[3]Catholic University of America, USA

We obtained infrared interferometric imaging observations in the H, L, M, and N bands of the well-known symbiotic Mira R Aqr in July-September 2019 with the instruments PIONIER and MATISSE at the Very Large Telescope Interferometer (VLTI), along with snapshots obtained in the K-band with the GRAVITY instrument at a few epochs. In this talk, we will review infrared interferometric observations of R Aqr available in the literature at different wavelength bands, and will present preliminary results from our observing campaign on the morphology and characteristic sizes of R Aqr and its environment. Our observing epoch coincided with a conjunction of obscuring material surrounding the companion, which complicates the analysis but also offers unique insights into the system. We will also explore the potential of interferometric imaging observations at mas scales for studying symbiotic binaries in general.

Continuum and molecular emission from the inner regions of the symbiotic system R Aquarii

Miguel Gómez-Garrido[1], **Valentin Bujarrabal**[1], **Javier Alcolea**[1], **Arancha Castro-Carrizo**[2], **Joanna Mikołajewska**[3], **Miguel Santander-García**[1]

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Most of the molecules surrounding symbiotic systems hosting a white dwarf are believed to be rapidly photodissociated due to the intense ultraviolet emission from the hot companion, hence the molecular content of these objects is poor. Nevertheless, the emission of CO, being one of the most abundant molecules detectable towards AGB stars, can provide information about the surviving molecular gas distribution, but observations of this molecule are essentially limited to R Aqr, the best-studied D-type symbiotic system. Less abundant molecules, however, are much more difficult to detect, and thus they have not been studied in detail in symbiotic systems beforehand.

We present very sensitive ALMA maps of R Aqr. They show an interesting distribution of molecular species other than CO, as well as radio recombination lines and continuum emission. The observations were performed at 1.3, 0.9, and 0.45 mm during the periastron of the system. The low-resolution continuum map at 1.3mm shows the emission of the radio photosphere of the AGB star, its surroundings, and the structure of the bipolar jet launched by the companion. The high-resolution continuum map at 1.3 mm shows the innermost part of the jet, probably revealing the position of the secondary. The recombination line H30alpha is also mapped with high and moderate angular resolution and the resulting brightness distribution is compared with the emission of the continuum at 1.3 mm. We also study the molecular emission detected in high-resolution maps in the three observed ALMA Bands. A variety of shapes are found in the brightness distribution of the studied molecular lines, showing CO and SiO relatively extended structures. On the contrary, the maps of less abundant and rare molecules show compact distributions of the gas. We use a simplified model to explain the structures seen in the central position of our maps. We discuss the spatial distribution of these different components in the context of our knowledge of this intriguing symbiotic binary.

Influence of the periastron passage to the large-scale jet of R Aquarii

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R Aquarii stands out as one of the most famous and studied symbiotic stars. Its hour-glass nebula intrigues us since its discovery over a century ago, together with its bipolar, precessing active jet. Recent advancements in resolving its central binary and directly detecting accretion between its components have further contributed to adding more pieces to the puzzle. The latest significant topic of discussion revolves around the recent period of reduced Mira light, occurring every 44 years in association with the periastron passage, believed to influence the jet launching activity. According to the AAVSO light curve, the most recent dimming began in 2019 and concluded around mid-2023. This presents the first opportunity to explore the influence of the periastron passage on the binary and the mass exchange between the components using modern observational techniques. Initial publications detailing this influence, including enhanced jet launching activity, have emerged. However, as our investigations present, unexpected morphological changes were also detected in the large-scale jet at the onset of the dimming event. The evolution of these changes since then remains a topic of interest. Have they persisted, or has the large-scale jet returned to its pre-dimming appearance? We will discuss this during our presentation, exploiting our unpublished imaging and spectral data collected periodically up to the present day.

Simulating the light curves of luminous red novae

Natalia Ivanova[1]

[1]University of Alberta, Canada

Luminous red novae are transient events likely produced by common envelope events. We present a smoothed-particle hydrodynamic code with radiation transfer included. While performing common envelope events in a self-consistent way, the code output allows the simulation of the light curves, including spectral evolution. We show the application of the code to a progenitor binary representing a progenitor of the V1309 Sco binary and compare the obtained light curve to the V1309 Sco event.

Nova 1670 (CK Vul) as a merger event

Tomasz Kamiński[1], **Romuald Tylenda**[1]

[1]Nicolaus Copernicus Astronomical Center of the Polish Academy of Sciences, Toruń, Poland

Some 340 yr after the eruption of Nova 1670 observed by Hevelius we are starting to understand it was no ordinary nova. I am going to present contemporary observations which completely rule out a classical nova scenario for Nova 1670. All observations, including rarely observed nucleosynthesis products, incl. 26Al, can be explained, if Nova 1670 was a coalescence event involving 1-2 $M_{\odot}$ red-giant-branch star with a helium white dwarf. I am going to present details of this extraordinary collision and speculate on the future of the remnant.

Discovering red novae at extremes: From planetary engulfment to dusty evolved stars

Kishalay De[1], Morgan MacLeod[2], et al.

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[2]Harvard University, USA

While optical surveys have led the discovery of red novae associated with common envelope events in the last decade, they become insensitive to mergers enshrouded by dust in the Galactic plane and to binaries self enshrouded in dust prior to mergers. In pursuit of revealing the complete landscape of stellar mergers, I will present the WISE Transients Project (WTP) – a new effort aimed at the systematic discovery of infrared transients from 15 years of NEOWISE data. I will highlight key new results from the project ranging from the discovery of the lowest luminosity red nova known from a planetary engulfment event to a new and previously missed population of stellar mergers in the local group from dusty evolved primary stars.

Unravelling the complex nature of FS CMa stars

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We introduce new insights into a rare group of the FS CMa stars. These complex and variable objects are known for the presence of a large amount of strong emission lines (permitted as well as forbidden) and the distinctive infrared excess. Even though it is nearly impossible to glimpse any information directly from the star, observations show spectral variability on many different timescales, photometric multiperiodicity and in the case of IRAS 17449+2320 even a very strong magnetic field. This in combination with unusually high space velocity indicates that we are likely dealing with post-merger objects. Binarity is still a widely accepted scenario to explain the behaviour of FS CMa stars, but in a lot of cases, their characteristics can also be explained by something else. New magnetohydrodynamical models and polarimetric measurements move the research of these exciting objects forward and the results of our Nbody6 simulations support the post-merger hypothesis as they show that among the detected mergers over 50% are B-type stars. Moreover, we found that between 12.54% and 23.24% of all B-type stars are mergers.

2.5-MHD models of circumstellar discs around FS CMa post-mergers

Alicia Moranchel-Basurto[1], Daniela Korčáková[1], Raúl Ortega Chametla[1]

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We investigate the star-disc magnetospheric interaction (SDMI) of FS CMa post-mergers objects. Motivated by the previous observational results of the measurement of the magnetic field ($B_\star \simeq 6.2kG$) and the mass ($M_\star \simeq 6M_\odot$) of stellar objects type FS CMa we perform a set of 2.5D resistive and viscosity magnetohydrodynamical simulations of SDMI using PLUTO code. Focused on analyzing the different stages of accretion, we vary the density, resistivity and viscosity within the disc as well as the rotation of the star. This last parameter generates a bifurcation in the accretion process: I. Non-stationary accretion stage characterized by a null rotation of the star. And, II. Stationary accretion stage where a slow-rotation rate of the star is included. In the first case we find that, the dynamics is driven mainly by the magnetic field of the central star that results in a jet and hot-plasmoid formation in the inner edge of the disc and in the corona region, respectively. In the second case, we find that the fall of gas towards the star occurs in the mid-plane, and remarkably, intermittent backflow takes place in the mid-plane in all of our models for $R \geq 10R_\star$. However, we do not rule out that the funnel effect may occur and cause the accretion closer to the poles. Also, when larger values of viscosity ($\alpha_\nu = 1$) and stellar rotation rate ($\delta_\star = 0.2$) are considered, we find that the disc exhibits a thickening which is characteristic of FS CMa-type stellar objects. Lastly, we find that the poloidal magnetic field lines twist over short periods of time, leading to magnetic reconnection causing coronal heating that could explain the presence of the Raman lines found observationally in several FS CMa stars. Therefore, our results are relevant for the interpretation of the observed properties of FS CMa post-mergers stellar objects.

V838 Mon: is the Sleeping Beauty really waking up?

Tiina Liimets[1], Indrek Kolka[2], Michaela Kraus[1], Thomas Augusteijn[3,4], Anlaug Amanda Djupvik[3,4], Tõnis Eenmäe[2], Taavi Tuvikene[2], Larissa Antunes Amaral[5], John H. Telting[3,4], Boris Deshev[1], Erkki Kankare[6], Juliet Kankare, Johan E. Lindberg, Thomas M. Amby[7], Tapio Pursimo[3,4], Auni Somero[6], Anders O. Thygesen, Paul Strøm[8,9]

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[9]Institut d'astrophysique de Paris, France

The red luminous nova V838 Mon needs little introduction. It underwent a huge explosion in 2002, which left behind a binary star consisting of a cool L-type supergiant and a hot B3V secondary. In the following years, V838 Mon had a rather stable state, until in 2007, the ejecta from the 2002 outburst, engulfed the hot companion completely and the system entered into a deep brightness minimum. We have waited for more than a decade for it to recover. Our systematic photometric and spectroscopic monitoring with the Nordic Optical Telescope traced the slow recovery of the system and re-appearance of the hot companion out of the dense ejected matter (Liimets+2023). In addition, we find that the heliocentric radial velocity of the atomic absorption line of Ti I 6556.06 A has been stable for more than a decade. We propose that Ti I lines are tracing the velocity of the red supergiant in V838 Mon, and do not represent the infalling matter as previously stated. However, do our additionally collected data from the past two years confirm those findings? Is the Sleeping Beauty really waking up?

Wednesday, June 5

Understanding the evolution of symbiotic binaries

Philipp Podsiadlowski[1]

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Symbiotic binaries are ideal systems to study the physics of binary mass transfer. They have revealed some major problems in even our basic understanding of mass transfer. The two most glaring problems, which I will review, are the orbital-period distribution of S-type symbiotics ("standard" binary population synthesis predicts a lack of systems in the observed range) and the mass-ratio problem (many apparently stable (near-)Roche-lobe filling system have mass ratios of 3-4 where the systems should be unstable and short-lived). I will review various proposals that have been made to address these problems, also drawing on related systems that help to cast light on these problems (such as post-AGB binaries, wide hot-subdwarf binaries) and recent theoretical process in describing the mass-transfer processes. I will propose a comprehensive evolutionary scenario that can solve these problems and explore the implications for their future evolution and the treatment of other unrelated types of binaries. I will also discuss D-type symbiotics and the possible role of wind Roche-lobe overflow in these systems.

Asymmetries of the wind from giants in S-type symbiotic binaries from UV and optical observations

Natalia Shagatova[1], **Augustin Skopal**[1]

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In this contribution, we present our results concerning the distribution of the wind from the giant derived from spectroscopic observations of eclipsing S-type symbiotic binaries during their quiescent and active phases. We found that (i) the wind at the near-orbital-plane region is distributed asymmetrically with respect to the binary axis and that, (ii) it is substantially focused towards the orbital plane. These results are supported by independent findings that higher column densities are located approximately in between the binary components and that the wind is significantly diluted around the poles of the giant. The wind focusing can solve a long-standing problem concerning the high luminosities of the nuclear-powered white dwarfs, and it enables them to increase in mass more rapidly, which supports the idea that S-type symbiotic binaries are progenitors of Type Ia supernovae.

Explaining Asymmetric Winds in Red Supergiants with Binary Interaction

Camille Landri[1], **Ondřej Pejcha**[1]

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Massive stars in the red supergiant (RSG) phase are known to undergo strong mass loss through winds, with observations indicating that a substantial part of this mass loss could be driven by dramatic localised outflows. Various mechanisms, such as magnetic activity, convection, and pulsations, have been considered to explain episodic mass loss in RSGs. However, these models often focus on single-star evolution, overlooking the fact that massive stars commonly evolve in binary systems, potentially leading to interactions with companions. The lack of understanding of these mechanisms introduces large uncertainties in current stellar evolution models and as such, it is crucial to investigate episodic mass loss in RSGs.

Motivated by observations of the highly asymmetrical circumstellar ejecta around VY Canis Majoris, this study investigates the role of binary interaction in mass loss episodes of RSG. Through simple 3D smoothed particle simulations, we examine scenarios where a compact companion grazes the envelope of an extended RSG. Our simulations demonstrate that conditions for dust condensation are met as part of the outer envelope is lifted off the stellar surface and cools. While more accurate simulations are required to provide sensible predictions for massive star evolution, this study shows ejections of 0.01 solar masses from the envelope at each periastron passage. These outflows later result in wide asymmetric dust driven winds, which could be enhanced in the presence of convection or pulsations in the RSG envelope.

The role of magnetic field in the evolution of symbiotic binaries to type Ia supernovae

Iminhaji Ablimit[1]

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Various white-dwarf (WD) binary scenarios have been proposed trying to understand the nature and the diversity of Type Ia supernovae (SNe Ia). In this work, we study the evolution of carbon-oxygen WD – red giant (RG) binaries (including the role of magnetic confinement) as possible SN Ia progenitors (the so-called symbiotic progenitor channel). Using the mesa stellar evolution code, we calculate the time dependence of the structure of the RG star, the wind mass loss, the Roche-lobe-overflow (RLOF) mass-transfer rate, the polar mass-accretion rate (in the case of magnetic confinement), and the orbital and angular-momentum evolution. We consider cases where the WD is non-magnetic and cases where the magnetic field is strong enough to force accretion onto the two small polar caps of the WD. Confined accretion onto a small area allows for more efficient hydrogen burning, potentially suppressing nova outbursts. This makes it easier for the WD to grow in mass towards the Chandrasekhar mass limit and explode as a SN Ia. With magnetic confinement, the initial parameter space of the symbiotic channel for SNe Ia is shifted towards shorter orbital periods and lower donor masses compared to the case without magnetic confinement. Searches for low-mass He WDs or relatively low-mass giants with partially stripped envelopes that survived the supernova explosion and are found in SN remnants will provide crucial insights for our understanding of the contribution of this symbiotic channel.

Signatures of intense mass-transfer in binary stars

Ondřej Pejcha[1]

[1]Institute of Theoretical Physics, Charles University, Czech Republic

Many evolutionary pathways of binary stars include brief phases, where mass transfer between the components occurs on thermal or even dynamical timescale and which can culminate in common envelope evolution. Such intense mass transfer is accompanied by a number of physical effects such as additional accretion luminosity or loss of mass due to accretion disk winds. A particularly important process is mass loss from the vicinity of the L2 point, which carries away from the binary a large amount of specific angular momentum. In this contribution, I will present various outcomes of L2 mass loss based on calculations performed with test particles and smoothed particle hydrodynamics with radiation. The primary application of these results are optical transients associated with stellar mergers - Luminous red novae, but I will make connections also to classical novae and other types of binaries.

Are we missing something beyond the mass from post-common-envelope PNe?

Miguel Santander-García[1]

[1]Observatorio Astronómico Nacional, Spain

Planetary nebulae (PNe) arising from common envelope (CE) interaction represent another kind of embarrassing binary. Asymptotic Giant Branch (AGB) stars in close-binary systems undergoing CE are believed to abruptly eject their remaining envelope, giving rise to the PNe we observe around some of them. Whereas we are confident that angular momentum transfer during the CE is the main driver of the ejection, our understanding of this brief but important stage does not go much further: on the one hand, statistical analyses suggest that at least 25% of all PNe come from CE interaction, although we only know around a hundred of them; on the other hand, models struggle to unbind the whole AGB envelope from angular momentum exchange, needing to tap on alternate reservoirs such as that from recombination energy, and achieving very limited success even so. Our previous ionised + molecular mass estimates of a fifth of all known post-CE PNe added another piece to this puzzle, suggesting that PNe arising from the first CE of the system (Single Degenerates, SD) are substantially less massive, on average, than PNe arising from the second one (Double Degenerates, DD), and up to two orders of magnitude less massive than the AGB envelopes from which they are believed to arise. Where is all that missing mass?

We will present the results of an expanded, more statistically significant analysis comprising an additional 21 post-CE PNe observed in the molecular regime, and the combined ionised + molecular estimates of 10 more. We will discuss their implications, along with alternate possibilities to help reconcile these observations with our ideas of CE ejection, including having substantial neutral mass in a photodissociation region, and expectations from population synthesis models.

A theory of mass transfer in binary stars

Jakub Cehula[1], **Ondřej Pejcha**[1]

[1]Institute of Theoretical Physics, Charles University, Czech Republic

Outcomes of binary evolution simulations involving stable but intense mass transfer critically depend on how the mass-transfer rate is calculated from 1D stellar models and whether other instabilities, such as outer Lagrange point overflow leading to common-envelope evolution, are avoided. Standard mass-transfer prescriptions used in stellar evolution codes do not reflect the influence of mass flow on stellar structure and artificially separate optically-thin and optically-thick regimes. We develop a new model of mass transfer through the inner Lagrange point, based on the assumption that the Roche potential sets up a converging-diverging nozzle around the Lagrange point. By averaging 3D time-steady Euler equations, we derive a set of 1D hydrodynamic equations governing the gas flow, in which mass-transfer rate is the eigenvalue of the system. The inner boundary condition directly relates our model to the structure of the donor obtained, for example, from MESA stellar evolution code. For the polytropic equation of state (i.e. adiabatic ideal gas) we obtain an algebraic solution that gives the mass-transfer rate within a factor of 0.9 to 1.0 of existing optically-thick prescriptions and reduces to the existing optically-thin prescription for isothermal gas. In the case of a more sophisticated equation of state, such as the one provided by the MESA EOS module, the mass-transfer rates obtained differ by a factor of a few (up to 4) compared to standard prescriptions. Our results suggest that conceptual uncertainties in the treatment of mass transfer through the inner Lagrange point significantly affect conditions for outer Lagrange point overflow and binary stability against common-envelope evolution. Additionally, we will demonstrate how radiative transfer in the diffusion approximation can be implemented in our new model and what effect this has on the mass transfer.

Unified mass transfer scheme

Natalia Ivanova[1]

[1]University of Alberta, Canada

We present how to obtain the mass transfer rate for the mass loss that operates across the L1 plane. Using the atmosphere's and donor's properties at the L1 plane, our approach unifies optically thick (stream) and optically thin (atmospheric) outflows seamlessly. The mass transfer rates are obtained utilizing the donor's evolution inside the 3D averaged effective binary potential and the effective binary acceleration. The presented new mass transfer scheme has been developed specifically to obtain better initial conditions for 3D simulations of common envelope events but should be helpful in a wide range of applications, especially in binaries with extended donors where atmospheric outflow may persist for an extended time.

The BVRI Color Distributions of Classical Novae

Peter Craig[1], Elias Aydi[1], Laura Chomiuk[1], Jay Strader[1]

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We present a systematic study of the colors of novae at the optical (V band) peak of their light curves and at 2 magnitudes below the peak. Our aim is to measure the distribution of nova colors based on a large sample of recent Galactic novae. Where possible, E(B-V) was measured using the equivalent widths of diffuse interstellar bands (DIBs) along with the sodium D lines. Not all novae have available spectra with sufficient resolution and signal-to-noise ratios; therefore, we supplement as necessary with 3D and 2D dust maps. Our analysis indicates that the average B-V color of novae at peak is 0.23 with a standard deviation of 0.32, based on a sample of 79 novae. Our average color is consistent with previous findings, although the standard deviation is larger. Of this sample, 29 novae have spectroscopically measured E(B-V) values, and that subset gives statistics similar to those of the complete sample. We also examined the R-I intrinsic colors at peak for a subset of this dataset containing 50 novae (limited by the availability of R and I band photometry near the peak). Here, we obtain an average color of 0.1, with a standard deviation of 0.29. Our results indicate that nova colors near the peak, which are often used to estimate reddening, typically vary by approximately 0.3 magnitudes, which should be considered when using these reddening estimates. In addition, it appears that B-V and R-I colors both can be used to make such estimates for classical novae.

Spectra of Nova V1405 Cas at the Very Beginning Indicate a Low-mass ONeMg White Dwarf Progenitor

Kenta Taguchi[1], **Keiichi Maeda**[1], **Hiroyuki Maehara**[2], **Akito Tajitsu**[2], **Masayuki Yamanaka**[3], **Akira Arai**[2], **Keisuke Isogai**[1], **Masaaki Shibata**[1], **Yusuke Tampo**[1], **Naoto Kojiguchi**[1], **Daisaku Nogami**[1], **Taichi Kato**[1]

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The lowest possible mass of ONeMg white dwarfs (WDs) has not been clarified despite its importance in the formation and evolution of WDs. We tackle this issue by studying the properties of V1405 Cas (Nova Cassiopeiae 2021), which is an outlier given a combination of its very slow light-curve evolution and the recently reported neon-nova identification. We report its rapid spectral evolution in the initial phase, covering 9.88, 23.77, 33.94, 53.53, 71.79, and 81.90 hr after the discovery. The first spectrum is characterized by lines from highly ionized species, most noticeably He II and N III. These lines are quickly replaced by lower-ionization lines, e.g., N II, Si II, and OI. In addition, Al II (6237 Å) starts emerging as an emission line at the second epoch. We perform emission-line strength diagnostics, showing that the density and temperature quickly decrease toward later epochs. This behavior, together with the decreasing velocity seen in Hα, Hβ, and He I, indicates that the initial nova dynamics is reasonably well described by an expanding fireball on top of an expanding photosphere. Interestingly, the strengths of the N III and Al II indicate large enhancement in abundance, pointing to a ONeMg WD progenitor as is consistent with its neon-nova classification. Given its low-mass nature inferred by the slow light-curve evolution and relatively narrow emission lines, it provides a challenge to the stellar evolution theory that predicts the lower limit of the ONeMg WD mass being $\sim$1.1 M$\odot$.

Possible connections of thermonuclear outbursts in accreting white dwarf binaries

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In my contribution, I will introduce possible connections of thermonuclear outbursts on the surface of a white dwarf accreting from an evolved giant or main sequence star in Symbiotic Binaries (SyBs) or Cataclysmic Variables (CVs), respectively. First, I will introduce the nova-like and Z And-type outbursts in SyBs and their relationships. Second, I will outline the classical nova explosion and the subsequent possibility of the formation of luminous super-soft X-ray sources, and the Z And-type outburst in CVs. Observations suggest that what appears after the nova-type explosion depends on the accretion rate onto the white dwarf that establishes after the explosion.

Evolution of the mass accretion rate in symbiotic stars

Vladislav Dragomirov Marchev[1], **Radoslav Zamanov**[1], **Dragomir Valchev Marchev**[2]

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We analyze photometric data in B and V bands from AAVSO as well as our own observations for symbiotic stars MWC560, RS Oph, and T CrB. Taking into account the interstellar reddening and subtracting the giant contribution from the binary system we estimate the parameters of the hot components such as luminosity, effective radius, effective temperature as well as mass accretion rate. Presenting the evolution of these parameters we can draw conclusions for the amount of accretion between two novae eruptions and the general trends in activity of such stars.

Millinovae: A new class of transient supersoft X-ray sources without a classical nova eruption?

Przemek Mróz[1]

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Supersoft X-ray sources form a small and heterogeneous class of objects. They are believed to be compact binary systems in which a mass transfer rate from a secondary star is high enough to sustain a stable nuclear burning on a white dwarf surface. A transient supersoft X-ray emission is also observed during classical nova eruptions and from magnetic cataclysmic variables (CVs).

ASASSN-16oh was discovered as the first (and only) transient supersoft source without any signature of nova-like nuclear fusion taking place (Maccarone et al. 2019, Nature Astronomy 3, 173). Its unusual outburst light curve, narrow optical (Balmer and strong He II) emission lines, and X-ray spectrum led Maccarone et al. to propose that X-rays come from a spreading layer - a belt on the surface of the white dwarf near the inner edge of the accretion disk in which a large fraction of the total accretion energy is emitted. However, the nature of ASASSN-16oh remains controversial with an alternative interpretation being that of a non-ejecting nova outburst (Hillman et al. 2019, ApJL 879, 5; Kato et al. 2020, ApJ 892, 15).

We have carried out searches for objects showing similar optical outburst light curves in the Optical Gravitational Lensing Experiment (OGLE) survey archive, finding a few dozen new objects similar to ASASSN-16oh. Our follow-up observations of one of the targets in outburst (obtained with the South African Large Telescope and the Neil Gehrels Swift Observatory) revealed narrow optical emission lines and supersoft X-ray emission (Mróz et al. 2023, ATel #16373). The X-ray luminosity was orders of magnitude higher than that of magnetic CVs. Yet, the optical observations did not reveal any signature of a classical nova eruption.

In this talk, we will present the properties of this new class of transient supersoft X-ray sources (which we call 'millinovae') and compare them with other known types of CVs. We will also discuss possible physical mechanisms responsible for the unique characteristics of millinovae.

Short bursts in cataclysmic variables with TESS and Kepler

Krystian Iłkiewicz[1]

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Thanks to TESS and Kepler a plethora of short bursts have been discovered in cataclysmic variables. I will discuss the proposed theoretical interpretation behind them, being micronovae, magnetic gating bursts, dwarf novae, and donor flares. Moreover, I will show the bursts properties and how they connect to their the classification suggested in the literature.

Eruptive novae in symbiotic systems

Irin Babu Vathachira[1], Yael Hillman[2,3], Amit Kashi[1]

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Simulation studies were conducted to explore the influence of varying the white dwarf (WD) mass and binary separation on the evolution of systems that produce nova eruptions. These simulations were performed for symbiotic systems hosting an asymptotic giant branch (AGB) undergoing mass loss via wind, where a portion of the wind is captured by the WD. The determination of the accretion rate onto the surface of the WD is calculated by applying the Bondi-Hoyle-Lyttleton (BHL) method, while incorporating orbital momentum loss caused by gravitational radiation, magnetic braking, and drag. The systems are allowed to evolve while producing multiple consecutive nova eruptions, until the AGB companion completely sheds its envelope, thus the wind ceases. Simulations were carried out for a range of initial WD masses and binary separations accreting mass from the wind of a $1.0M_{\odot}$ AGB companion. This occurs over the evolutionary time of approximately 3×10^5 years. We find the accretion rate to increase and decrease throughout evolution correlated with the wind rate that is dominated by the AGB's thermal pulses. We additionally find the accretion rate to be correlated with the mass of the WD and with the binary separation of the system. Moreover, we our results show that the orbital period may either increase or decrease during evolution, depending on the model, while the separation consistently decreases. We have also identified some eruptions where WDs exhibit weak, non-ejective novae and undergo net mass gain. This suggests that if a more massive WD can attain and sustain the required accretion efficiency over an extended period, it has the potential to serve as a progenitor for type Ia supernovae.

Spectropolarimetric observations of the recurrent novae RS Oph and T CrB

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Spectropolarimetry is a powerful tool for the diagnostic of interstellar matter and gives information about the geometry of the ejected material and dust formation after the novae outbursts. Spectropolarimetric observations of T CrB in the wavelength range from 4800 Å to 8200 Å do not show evidence of an intrinsic component of polarization at quiescence and the observed polarization is due to the foreground dust up to a distance of 400 pc (Nikolov, Y. 2022, NewA, 97, 101859). Similar to T CrB, a symbiotic recurrent nova system RS Oph – does not show evidence of intrinsic polarization at quiescence, but interestingly 2 days after the most recent outburst of RS Oph occurred on 2021 August, RS Oph demonstrates a linear intrinsic polarization with degree of polarization $\sim$1% and position angle parallel to the radio structures (Nikolov et al. 2023, A&A, 679, A150). 3D hydrodynamical simulations of RS Oph in the quiescent phase show that the circumstellar mass distribution is highly structured with a mass enhancement in the orbital plane (Walder et al. 2008; Booth et al. 2016). For RS Oph, the interaction between the nova ejecta with the accretion disc and overdensity in the orbital plane forms an equatorial ring-like structure and limits the ejecta within a bipolar direction perpendicular to the orbital plane (Booth et al. 2016). These asymmetrical structures produce polarized light.

Spectroscopic Insights into the Quiescent Stage of RS Ophiuchi (2006-2021): Photoionization Modeling and Accretion Dynamics

Gesesew R. Habtie[1], **Ramkrishna Das**[1]

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We present a comprehensive spectroscopic analysis of the nova RS Ophiuchi during its quiescent stage, spanning a duration of approximately 13 years (between 2006 and 2021 outbursts). The spectra exhibit prominent low-ionization emission features, including hydrogen, helium, iron, and TiO absorption features originating from the cool secondary component. The CLOUDY photoionization code is employed to model these spectra, allowing us to estimate various physical parameters such as temperature, luminosity, and hydrogen density, along with elemental abundances and accretion rate. The central ionizing sources exhibit temperatures in the range of $1.05 - 1.8\ \times 10^4$ K and luminosities between $0.1 - 7.9\ \times 10^{30}$ ergs. Notably, He displays an overabundance from 2008 to 2016, returning to solar values by 2020, while Fe appears subsolar from 2008 to 2014 but becomes overabundant from 2006 onward. For a WD of masse $1.35 M_\odot$ the critical mass is found to be $\sim 3.066\ \times\ 10^{-7} M_\odot$. The mean accretion rate, as calculated from the model, is approximately $1.254 \times 10^{-8} M_\odot$ yr^{-1}. About 47% of the critical mass was accreted after April, 2020 (∼15 months up to the 2021 outburst), and approximately 88% of the critical mass was accreted after July 20, 2018. This non-uniform accretion rate suggests a more rapid approach towards reaching the critical mass in the final years, possibly attributed to the heightened gravitational pull resulting from previously accreted matter, influencing the accretion dynamics as the system approaches the critical mass limit.

Modeling colliding nova shells

Yael Hillman[1]

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A nova eruption leaves behind an expanding mass shell that is often detectable, while after a long enough time will become transparent to all bands and disperse. If an additional shell were to be ejected in a timely fashion, a double shell would be observed, but is currently extremely rare. If the system were to be producing novae on a regular basis, multiple shells would be expanding away from the white dwarf, while they may collide and merge with each other and/or produce a thick remnant, as that observed for the annually recuring nova in M31. Recently, such a super-shell has been found to surround nova KT Eridani as well. I present preliminary results of simulations of multiple consecutive nova eruptions producing such shells as they leave the surface of the WD and expand, while allowing interaction with previously ejected shells.

On the Nova Super-Remnant Phenomenon

Michael William Healy-Kalesh[1]

[1]Liverpool John Moores University, UK

The annually erupting recurrent nova M31N 2008-12a is surrounded by the prototypical nova super-remnant: a vast shell over 100 parsecs across. Hydrodynamic simulations demonstrate that such a structure can be created from millions of previous nova eruptions sweeping up the local interstellar material as the central white dwarf grows towards the Chandrasekhar limit. Crucially, further modelling has revealed that all novae should host a nova super-remnant – this has motivated the search for more of these phenomena in the Galaxy and beyond. In this talk, I will present the latest developments in this upcoming subfield of nova research including the recent discovery, and subsequent modelling, of a new Galactic nova super-remnant.

Detections of New Classical Nova, Symbiotic Nova and Dwarf Nova Ejecta

Michael Shara[1], Kenneth Lanzetta[2], Stefan Grommol[3], James Garland[4], et al.

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[3]Google, USA
[4]University of Toronto, Canada

Only one nova 'super-remnant', roughly 100 pc in size and surrounding the annually erupting nova M31-12a in the Andromeda galaxy, has been found before 2023. Using the novel low surface brightness Array Telescope 'Condor', we have located similarly huge-sized remnants surrounding the putative recurrent nova KT Eri and the symbiotic nova RS Oph. We'll show these very large structures, as well as a likely resolved wind and nova shell surrounding one of the nearest prototypical dwarf novae.

Analysing nova shells in 3D

Linda Schmidtobreick[1], Julian Blasek[2], Lientur Celedon[3], Claus Tappert[3], Fernando Selman[1]

[1]ESO Vitacura, Chile
[2]University of Aachen, Germany
[3]University of Valparaiso, Chile

During a nova eruption, material is ejected into the interstellar medium, forming an expanding shell around the binary which can be observed once its angular size is sufficiently large to be resolved and separated from the inner binary. The spectra of such nova shells are usually dominated by various emission lines including Hydrogen, Helium and forbidden metal lines. We have used the Multi Unit Spectroscopic Explorer (MUSE) to observe several such nova shells. For any of the various emission lines present in the spectra, the radial velocity distribution at each spaxel relates directly to the spatial distribution in z-direction. Using Gaia distances, also the angular distribution can be transformed into physical x,y-coordinates. Thus, full 3D-images of the expanding shell can be constructed for the various emission lines and Virtual Reality tools can be used to inspect the data. For many of these shells, we find significant differences in the distribution of H or He and the forbidden metal lines. Such discriminating 3D-structures of the shells provide information on the mechanisms and processes during the nova eruption. We will here present the results for selected nova shells and discuss the implications of their particularly unusual structures.

3D visualisation of nova remnants

Martín A. Guerrero[1], Edgar Santamaria[2], Jesús A. Toalá[2], Gerardo Ramos-Larios[3], Sara Cazzoli[1], Laurence Sabin[4], Allesandro Ederoclite[5], Larisa Takeda[6]

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[5]Centro de Estudios de Física del Cosmos de Aragón, Spain
[6]Instituto de Astronomia, Geofísica e Ciências Atmosféricas, Universidad de São Paulo, Brazil

The IFS data cube and multi-epoch images provide us with the opportunity to investigate its kinematics (along the line of sight) and its tangential velocity on the plane of the sky (by the analysis of its angular expansion) to obtain a view of the 3D physical structure of its nova remnant without geometric assumptions. This can provide accurate information on the ejecta to assess its expansion and get insights on the physics of the nova shells.

The enigmatic nova shell around V1425 Aql as seen by MUSE

Lientur Celedon[1], **Claus Tappert**[1], **Linda Schmidtobreick**[2]

[1]University of Valparaiso, Chile
[2]ESO Vitacura, Chile

Nova eruptions occur in cataclysmic variables when enough material from the companion star has been accreted onto the surface of the white dwarf primary. After the eruption the material that has been accreted is expelled into the interstellar medium, forming a nova shell around the system. Understanding the processes that shape the nova shell is necessary to obtain a full comprenhension of the physics behind a nova eruption.

An enigmatic nova shell is the one surrounding the system V1425 Aql. This young shell presents a spatial asymmetry in the observed forbidden lines of [OIII] and [NII] when compared with the allowed transitions traced by Hydrogen. Such a strong asymmetry has not been observed in other young shells.

Here we present our latter results regarding the analysis of the shell around V1425 Aql as it was observed by the Multi-Unit Spectroscopic Explorer at the Paranal Observatory. These new observations support the previous results, as well as indicate that the forbidden lines are spatially confined to an arc that surrounds the central, more spherical allowed emission.

AH Pictoris stars: A new class of novalike variables?

Albert Bruch[1]

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Novalike variables (NLs) are a large subgroup of cataclysmic variables which - unlike the semiperiodically outbursting dwarf novae - do not exhibit large variations in their long term light curves (discounting occasional low states of the VY Scl subtype of NLs). Their accretion disks are thought to be stuck in a permanent high state, similar to that of an outbursting dwarf nova. Variations over time scales of weeks, months or years are mostly restricted to irregular low amplitude modulations. However, an appreciable number of NLs exhibit occasionally so-called stunted outbursts, i.e., small scale brightenings of less than a magnitudes which last a couple of days. There is no consensus about the physical mechanisms leading to these outbursts. In the present contribution I argue in favour of the existence of a separate class of novalike variables, to be called AH Pictoris stars after their most prominent member, which exhibit a continuous train of sucessive stunted outbursts over their entire observational history, or over several years, interrupted by intervals of quiescence. The amplitudes of the brightenings are fairly stable in a given system, and always range between 0.6 and 1 magnitude in the visual band. The outburst intervals, at an overall range between 12 and 30 days, can gradually evolve in the same star between longer and shorter intervals, but no sudden changes are observed. Similarly, the light curve shape during the outburst cycle undergoes a gradual evolution. On shorter time scales the orbital waveforms of the various systems are not only surprisingly similar, but they also evolve in the same way over the outburst cycle. So far, I could identify five novalike variables with the consistent photometric behaviour which may be termed the AH Pic syndrome.

Structure of accretion flow of IX Velorum

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IX Velorum is a cataclysmic variable of the Nova-like subtype that has been proposed to show outflows from the system. Such outflows have been observed in several high-mass transfer systems, and they could play an important role in the evolution of cataclysmic variables. In my contribution, I will present a study of the structure of the accretion flow and the accretion disc of IX Velorum using high-resolution spectroscopy. We used these spectra to compute Doppler maps for the different emission lines observed in this system. The Doppler maps show that the emission originates mainly outside of the accretion disc, which we interpret as an outflow of matter from the system and the accretion disc wind. This classifies IX Velorum as a member of the RW Sex class of cataclysmic variables.

Friday, June 7

2SPOT: A remotely-operated amateur spectroscopic observatory located in Chile

Olivier Garde[1], Stéphane Charbonnel[1], Pascal Le Dû[1], Lionel Mulato[1], Thomas Petit[1]

[1]Southern Spectroscopic Project Observatory Team (2SPOT)

Amateur astronomy has undergone considerable technical development over the last two decades. Amateur astronomers are able to provide high-quality data and valuable first spectroscopic estimates to guide deeper professional observations. The key strength of amateurs lies in their unfettered availability and responsiveness to take spectra on demand, coupled with the long time that can be spent to acquire data on a single object.

Given the lack of amateur observatories dedicated to spectroscopy in the southern hemisphere, we created the Southern Spectroscopic Observatory Team (2SPOT) and decided to set up our equipment at Deep Sky Chile facilities. We operate 2 remote telescopes: a 0.3 m Newtonian telescope with a low resolution Alpy 600 spectroscope (R = 600) and a 0.3 m Ritchey-Chrétien telescope with a medium resolution eShell spectroscope (R=11 000) lent by LESIA (Paris Observatory).

We take part in various observation programmes such as surveys of Be stars and symbiotic systems, spectral confirmation of newly discovered planetary nebula candidates, and follow-up of transient events. We have developed scripts for automatic data acquisition and processing.

We specifically present responsive follows-up that we successfully undertook on classical novae in their early stage of expansion (V1716 Scorpii, V6598 Sagitarii, V1723 Scorpii), and on ASASSN-21qj which contributed to confirming the first detection of a collision between two exoplanets of several to tens of Earth masses.

DeGaPe 35: Amateur discovery and characterization of a new southern symbiotic star

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The growing availability of affordable spectrographs for amateur observers in recent years has increased the opportunities for amateurs to participate in the scientific research of many interesting objects in the night sky. One of the fields that benefits significantly from the long-term, high-cadence observations of amateur astronomers is the research of symbiotic binaries. In this contribution, we present the discovery and characterization of DeGape 35, a previously anonymous field star that was identified as a possible emission-line object in the scope of an amateur survey searching for planetary nebulae. This survey is operated as a supplementary program at the amateur-built, remotely-operated Atacama Photographic Observatory.

DeGaPe 35 was discovered in the field of the well-known Wolf-Rayet star WR 68, with a visual appearance typical of stellar-sized planetary nebulae and other emission-line objects. Such candidates are subjected to spectroscopic follow-up to confirm the planetary nebula nature or reclassify them as mimics. Our spectroscopic follow-up using the 2SPOT remotely-operated amateur observatory located at the Deep Sky Chile facilities confirmed the symbiotic nature of DeGaPe 35. Our data, together with the archival observations from various sources, allowed us to characterize the components of the binary and to tentatively detect its orbital period.

Search for new symbiotic stars using the Gaia DR3 data

Lionel Mulato[1], **Jaroslav Merc**[2,3], **Stéphane Charbonnel**[1], **Olivier Garde**[1], **Pascal Le Dû**[1], **Thomas Petit**[1]

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Gaia DR3 was released in June 2022. The photometric variability of sources was used in classifying various object types using machine-learning techniques. Such an effort led to the discovery of several new symbiotic candidates. However, it became apparent that a significant portion of the sample was contaminated by pulsating giants lacking indications of symbiotic nature.

We have aimed to utilize the Gaia DR3 data to identify new symbiotic stars with less contaminated candidate samples. We utilized Hα measurements from Gaia to identify promising candidates, initially concentrating on Wray's and Henize's catalogs of emission line stars before expanding our search to objects classified as LPVs in Gaia DR3. The candidates were selected based on the Gaia and 2MASS data and we obtained spectroscopic follow-up using the 2SPOT setups in Chile and France. Up to now, we have carried out more than 200 hours of observations. Although the project is still ongoing, we have already confirmed the symbiotic nature of several tens of new symbiotic objects. Additionally, our observations have unveiled rare examples of carbon symbiotic stars among them.

Spectroscopic observations of MWC560

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[1]Okayama University of Science, Japan

The symbiotic star MWC 560 (=V694Mon) showed the first outburst in 1990, with a maximum magnitude of about 9 mag (V). A blue shifted absorption component was seen in Balmer lines and the velocity shift of the absorption components was reported to be at about -6000 km/s (e.g. Tomov et al. 1990). The periodicity had been discussed at 9570, 1860, 1930 and 331 days from the light curve (e.g. Doroshenko et al. 1993, Gromadzki et al. 2007). In recent years, it brightened to magnitude 8.8 in 2016, February (AAVSO: Time Sensitive Alerts). In 2018 November, it attracted attention when it showed an unexpected brightening (Goranskij,et al. Atel #12227), and the maximum magnitude has been updated in every observing season since then.

We have been observing this object with the 28cm telescope with low resolution spectrograph DSS-7 at the Okayama University of Science Observatory (OUSO) from 2016, and low-resolution spectroscopic observations with the 101cm telescope at the Bisei Astronomical Observatory (BAO) since 2019, and high-resolution spectroscopic observations with HIDES-F on the 188 cm telescope at the Okayama branch of the Subaru from 2018.

Our early results were reported by Ando et al. (2021a, 2021b). At the OUSO, blue shifted absorption lines were seen in the Balmer emission lines from 2016 to 8 April 2018. The blue shifted absorption lines disappeared in the spectrum on 14 November 2018 similar spectral changes were reported by Goranskij et. al. (Atel #12227). The velocity resolution at OUSO was about 700 km/s in Hα. On the other hand, a high-resolution spectroscopic observation (R≈65000) with HIDES-F done on 25 December 2018 showed the blue shifted absorption component with the velocity of -150 km/s in Hα. About a month after this observation, on 27 January 2019, continuous brightening to about 8.7 mag was reported. Our continuous high-resolution spectroscopic observations showed a change in the Balmer lines. A wing component with $v_{FWHM} \approx 700$ km/s was seen in November 2018 and disappeared in February 2020.

We have monitored the spectra of MWC560 with low-resolution spectroscopic observations at the BAO. An absorption line with an 8 Å blue shift in HeI λ5876 was detected on 27 December 2019 (418 days after the 2018 outburst). On the observations of 10 December 2021 (about three years after the outburst), the hydrogen and Si II lines changed deep absorption lines, which are typical spectra of A-type stars. Our medium-resolution spectroscopic observations at the BAO (R≈10000) showed that the velocity of the absorption component of the Balmer line slowed down to v≈-45 km/s on 6 January 2024.

Our observations denote that the absorption lines seen in Hα have slowed down since the 2018 outburst, and the deceleration was calculated from the velocity. Then we can estimate the distance between WD and the absorption component.

Effects of (internal) UV and X-ray emission in AGB's envelopes

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In this presentation, I will show the results from our current project to study AGB stars with ultraviolet and X-ray emission. This recently discovered, yet poorly characterized class of uv/xAGB stars could represent a hidden group in the population of symbiotic stars with AGB donors.

I will report on our CO emission survey of a sample of uv/xAGB stars carried out with the IRAM 30m milimmeter radio telescope (MRT). This CO-based study has enabled us to characterize for the first time the properties of the molecular envelopes of these uv/xAGB stars (binary candidates) as as class (Alonso-Hernandez, in press). Using the rotational diagram technique we estimate the main circumstellar envelope (CSE) physical parameters. From our analysis, we find that the gas/dust ratio is lower in our sample than in previous surveys of standard AGB stars with similar mass-loss rates.

I will also show preliminary results from our ongoing study to characterize the chemical properties of the CSEs of a subsample of 2 xAGB and 2 uvAGB stars, based on a sensitive line search for HCO+ emission with the IRAM 30m MRT. Our analysis, which includes gas and dust radiative transfer and chemical modeling, indicates that HCO+ is an X-ray sensitive specie and its abundance is enhanced by the internal X-ray emission in xAGBs.

56 Ursae Majoris: a binary evolution puzzle

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56 Ursae Majoris is a long-period binary that contains a chemically peculiar red giant and a faint companion. Due to its chemical abundances, the red giant was classified as a barium (Ba) star in the 70s. This would imply that the companion had to be a white dwarf, since Ba stars form when s-process rich Asymptotic Giant Branch (AGB) companions transfer mass to them. Recently, combining more than 50 years of radial velocity data with Hipparcos and Gaia astrometry, we measured 56UMa's orbital inclination for the first time, and we discovered that the faint companion was about 1.3 $M_\odot$. If it is a white dwarf, it is too massive to be the progeny of an AGB star that could efficiently produce s-process elements such as barium.

This puzzle motivated us to perform a full spectral analysis, reinvestigate the Ba-star classification of the giant, and study the morphology of the interstellar gas in the vicinity. In my contribution, I will discuss our findings, including marginal heavy-metal enrichment with a mixed s+r abundance profile on the giant (confirming that it is not a barium star) and the clear identification of a cavity around the system. The later could indicate that a supernova exploded in the system long ago, and that the faint companion is in fact a neutron star. However, finding an evolutionary scenario that explains all these observables is not trivial, and I will discuss different possible configurations and their respective merits.

V Hydrae: a dusty binary with a conical jet

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V Hydrae (V Hya) is a well-studied AGB star known to exhibit a complex environment, hinting at its transition from the AGB to the pre-planetary nebula phase. Thanks to a multi-epoch and multi-instrumental study (combining spectroscopy, astrometry, and interferometry), we prove the existence of a close-by companion around the AGB star. Its orbit is found to be correlated with the visual obscuration events occurring every 17 years. Based on spatio-kinematic modeling of a conical jet attached to the companion, we give constraints on the gas and dust distribution in the system. Our model, connecting the orbit-scale properties of the binary with previous large-scale observations, gives further evidence that close-by companions are an essential ingredient to shape bipolar pre-planetary nebulae.

X-ray binaries in Galactic star clusters

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We present a review of the status of our knowledge about X-ray binaries in Galactic star clusters. X-ray binaries are present in a wide range of Galactic star clusters, from very young to old globular clusters. The properties of X-ray binaries reflect the properties of the underlying star clusters, such as their ages, densities, and masses. Observations of X-ray binaries in star clusters have important implications for various astrophysical phenomena, such as gravitational wave progenitors, fast radio bursts, and intermediate-mass black holes. Moreover, X-ray binaries are essential components of the total X-ray makeup of a galaxy because they dominate the hard X-ray emission. Their observations provide unique insights into the properties of star clusters and compact objects. However, especially in Globular clusters, we are challenged by their densities and individual members' faintness.

The cosmic rate of Pair Instability Supernovae

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Pair Instability Supernovae (PISNe) are explosions developing in the core of massive stars due to a thermonuclear, runaway process, ultimately leading to the total disruption of the progenitor. They are expected to be the endpoint of the evolution of low-metallicity stars in the mass range between $\sim$ 140 and 260 solar masses, and responsible for the existence of the upper mass gap in the black hole mass spectrum. Despite the robust theoretical understanding of the pair-production mechanism, and their crucial implications for many astrophysical observations, PISNe have never been confidently observed. However, they are expected to be up to two orders of magnitude more luminous than typical Core Collapse Supernovae (CCSNe), for which we have hundreds of observations. This leads to naturally wonder what could be the reason of their missed detection.

In this talk, I will present new results on the PISN rate as a function of redshift, obtained using up-to-date stellar evolution tracks, and an up-to-date empirical determination of the galaxy star formation rate and metallicity evolution throughout cosmic history. The goal is to provide a robust theoretical framework to understand where PISNe are across cosmic time, and study their detectability with instruments like JWST. I will present estimates for the relative rate of PISNe and CCSNe, and discuss how the PISN rate is affected by various assumptions in the theoretical models, including the criterion adopted to identify stars unstable against pair production, the maximum stellar metallicity to have PISNe, the upper limit of the stellar initial mass function, and the dispersion of the galaxy metallicity distribution in redshift. We investigate how considering PISNe arising in binary stars, as opposed to single stars only, affects their rate of occurrance. This allows us to understand how relevant the interaction with a companion star during binary evolution is for the explosion of a star as PISN, and thus whether binaries should be taken into account in computing the cosmic rate of these transients. Finally, I will show what are the most favourable galaxies to host PISNe, and how possible (or lack of) future PISN observations can help us constrain stellar and galaxy evolutionary models.

P01 The first magnetic B[e], IRAS17449+2320: Open door to a new interpretation of the origin of FS CMa stars

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FS CMa stars are a subgroup of peculiar B-type stars that present the B[e] phenomenon. This phenomenon is created by the large amount of gas and dust surrounding the central star. The origin of this circumstellar matter is unclear, being the binarity of these objects the most accepted scenario to explain it. However, the discovery of a magnetic field in IRAS 17449+2320, one of the most representative objects of this group, opened the door to a new scenario: the post-merger origin.

We have analyzed six polarimetric observations obtained with ESPaDOnS at the CFHT of IRAS 17449+2320. Through this analysis, we have calculated the longitudinal magnetic field, and the magnetic modulus of each observation, and estimated the rotation period of this star. All these data were used to obtain its magnetic model with the Oblique Rotator Model. IRAS 17449+2320 presents one of the strongest magnetic fields among main sequence stars, and it could be the key to explaining the origin of Ap stars.

P02 R Aquarii: An X-ray Journey through a Glorious Symbiotic System

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R Aquarii is a widely recognized symbiotic star that has been the subject of extensive research across different wavelengths, particularly optics and radio. We present archival Chandra data observations of R Aqr that cover the years 2017 to 2022 including both the eclipse and periastron passage era of the system. We compared our findings with the older Chandra data of the system. We investigated the changes in the system by analyzing its morphology and spectrum. The system morphology indicates extended emission around the central source within the 5-8 arcsec radius. There is an old jet remnant in the NE region of the 2017 data, but it cools and disappears as detected in subsequent observations. Since the system is a β/δ type symbiotic star, it exhibits two different spectral characteristics, in the soft and the hard X-rays. We used two different absorption models in addition to interstellar absorption and two different temperature plasmas models using non-equilibrium ionization (NEI) model in the spectral analysis. The approximate temperature of the soft and hard part of the central region spectra is kT $\approx$ 0.2 keV and kT $\approx$ 10 keV respectively. The approximate temperature the off-center region is kT $\approx 0.4 - 0.8$ keV. The central region luminosities are L $\approx 5 - 10 \times 10^{30}$ erg s^{-1} and the off-center region luminosities are L $\approx 2 - 6 \times 10^{29}$ erg s^{-1}. The central region luminosities decrease from 10×10^{30} erg s^{-1} to 5×10^{30} erg s^{-1}. The off center extended region towards the south west indicates similar behaviour where the luminosity changes from 6×10^{29} erg s^{-1} to 2×10^{29} erg s^{-1}.

P03 An ALMA Close-Up of the central ionized core (<100au) of M2-9

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This presentation will highlight recent findings from our pioneering study with the Atacama Large Millimeter Array (ALMA) of the emerging ultra-compact H II regions within pre-Planetary Nebulae (pPNe). By utilizing mm-wavelength recombination lines (mm-RRLs) as novel tracers, we're able to delve deeper than ever before into the inner workings of M2-9, a symbiotic candidate with a prominent large-scale bipolar nebula, also known as The "Butterfly" Nebula. Our research unveils the structural and kinematic characteristics of the elusive inner nebular regions of M2-9, achieved with an unprecedented angular resolution of 20-30 mas (i.e., down to ∼15-30AU linear scales). The ionized central regions are elongated along the main symmetry axis of the large-scale nebulae and show notable axial velocity gradients, consistent with a bent bipolar jet. The presence of high-velocity spots, exhibiting the highest expansion velocities of up to ∼80-100km/s, suggests either rapid wind acceleration or shocks at radial distances from the center of 15-20au. Our ALMA observations detect variations in wind kinematics and physical conditions on scales of less than two years, indicative of a dynamic environment within the nebula. To comprehensively interpret our findings, we employ 3D non-LTE radiative transfer modeling. Through this approach, we elucidate the intricate interplay between tenuous companion-launched jets and the dense primary star's wind, offering invaluable insights into the processes shaping the morphology and dynamics of M2-9. This research not only advances our understanding of the specific case of M2-9 but also contributes to broader insights into the evolutionary pathways of symbiotic stars and the mechanisms governing their nebular environments.

P04 Appearance of optical QPO with time scale of $\sim$3300 s after outburst of nova V1405 Cas

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We investigated the optical photometry of the nova V1405 Cas obtained by ground observations. The data show the known orbital period but additional non-periodic variability is present too. We conclude that this aperiodic variability is a red noise with a QPO fully appearing 2 years (September - October 2003) after maximum. The time scale of this QPO is about 3300 s. Since the fast variability with red noise characteristics is a typical manifestation of the ongoing accretion, we discuss the connection of the QPO appearance with the restart of the accretion process after the nova event.

P05 SALT/HRS monitoring of symbiotic stars with yellow giants and active systems during outbursts

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The long-term monitoring of the yellow symbiotic systems (programs: 2019-1-MLT-008 and 2018-2-SCI-021) is ongoing since 2018 with the aim to study atmospheric parameters and chemical composition of the giant stars as well as analysis of the spectroscopic orbits of the system components. So far we have covered most of the orbit for the majority of the sample. The selected active symbiotic systems including SyNe (e.g. V618 Sgr, St 2-22) during and around outbursts are also monitored. The sample of the obtained results is presented.

P06 Chemical abundances of the stripped giant in the X-ray binary GX 339-4

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GX 339-4 is the short period (P_{orb} = 1.76 days) X-ray binary (XRB) containing black-hole (BH) which accretes material from its stripped giant donor. The mass of BH, estimated by Heida et al. (2016) as 2.3–9.5 $M_{\odot}$, makes it a very interesting case with the potential to fill the mass gap 2–5 $M_{\odot}$. The cool component is a K1-2-type giant donor. Zdziarski et al. (2019) constructed a detailed evolutionary model for the donor and obtained its possible mass ($M_g \approx 0.5$–$1.4\ M_{\odot}$). The near-infrared VLT/X-shooter spectra of GX 339-4 revealed atomic absorption features from Al, Mg, Fe, and Ca (Heida et al. 2016). We retrieved these spectra from publicly available ESO archives, which after carefully removing all telluric features and correcting for radial velocity effects were coadded to get a single spectrum with an improved S/N ratio. In the resulting average spectrum, we were able to identify nearly one hundred lines from MgI, AlI, SiI, KI, CaI, TiI, MnI, and FeI which allowed us to derive chemical abundances of these elements.

P07 Activity stages of the symbiotic system AG Draconis

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AG Draconis is a well-known yellow symbiotic star with a cool component of spectral type earlier than K4, which appears to be brighter than a luminosity class III star. The hot component is a white dwarf which accretes matter from the wind of the giant and thus retains a high temperature and luminosity due to thermonuclear shell burning on its surface. AG Draconis manifests characteristic symbiotic activity with alternating quiescent and active stages. The latter ones consist of the series of individual outbursts repeating at about a one-year interval. The nature of these outbursts has been a matter of long-term debate. Although there is general agreement that the orbital period of AG Draconis is around 550 d, variations on shorter timescales (350 - 380 d) are also detected, the nature of which is unclear. In the contribution, we present our study of the properties and behaviour of the symbiotic system AG Draconic, which is based on the analysis of long-term photometric and spectroscopic observations. Specific characteristics of outbursts occurred during the most recent, quite atypical period of activity (2015-2018) inferred from the analysis of prominent emission lines present in the spectra of AG Draconis will also be presented.

P08 Unveiling Progenitors of Luminous Red Novae through Gaia and WISE data analysis

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Luminous Red Novae (LRNe), a class of optical transients in the luminosity gap between novae and supernovae, represent a unique phenomenon in time-domain astrophysics, due to their association with common-envelope (CE) evolution and the merger of stellar binary systems. Understanding their progenitors is crucial for unraveling the mechanisms behind the evolution of binaries through the CE phase, which can lead either to a stellar merger or, if the envelope is successfully ejected, to a binary with a much-reduced separation. Making use of the unprecedented dataset provided by the data release 3 of the Gaia mission, we searched for potential Galactic progenitors. Our methodology involved utilizing Gaia's precise photometric data and parallaxes to target regions of interest on the Hertzsprung-Russell diagram, specifically the Hertzsprung gap, which contains fast evolving post-main sequence stars (yellow giants and supergiants), potentially filling their Roche Lobe and starting a mass transfer episode in the binary system, a key step that leads to the CE phase. By combining Gaia low-resolution spectrophotometry analysis to detect hydrogen emission lines and assessing variability through Gaia magnitude error measurements, we identified candidate systems primed for further investigation. Moreover, we incorporate near infrared observations from the WISE mission to detect potential infrared excess, a mark of mass transferring binaries with a CE. Through our analysis, we have identified a subset of 70 sources exhibiting characteristics compatible with mass-transferring binaries (candidate LRNe progenitors). Notably, our investigation has revealed intriguing light curves: periodic variability in the form of eclipses, sinusoidal variation associated with a reflection effect in binaries with hot companions, or non-periodic variations in the form of small outbursts. We believe these findings are the first stone to the characterization of likely LRNe progenitors in our Galaxy, as well as the properties of "contaminant" systems polluting the search of progenitors. It's essential to emphasize the pivotal role of the Gaia mission in enabling this research, which can be important for the search of LRNe progenitors outside our Galaxy.

P09 Issues to Search for Symbiotic Stars in VPHAS+: PSF versus Aperture Magnitudes

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Symbiotic stars (SySt) unveil binary systems where a cool giant star interacts with a hotter, compact companion, offering insights into stellar wind collimation, bipolar planetary nebula formation, and type Ia supernovae. Motivated by the need for precise selection methods, we applied optical and infrared color criteria to find SySt in the VPHAS+ DR3 catalog. To uncover new SySt in the Galaxy and validate the selection method used for this purpose, spectroscopic observations were conducted to confirm candidate stars. Contrasting results obtained with aperture magnitudes and previous works using PSF magnitudes reveal discrepancies in SySt candidate selection. Only 19% of our candidates found in DR3, which also appear in DR2 and thus have PSF magnitudes, meet the original criterion. Our study highlights the differences between aperture and PSF magnitudes in the VPHAS+ catalog and their impact on SySt candidate selection.

P10 The 2020 Eclipse of R Aquarii in the Near-infrared

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The Mira in the bright, dusty, symbiotic binary R Aqr undergoes partial eclipses of multiyear duration every 44 years by the large, opaque, accretion disk surrounding the white dwarf companion. An eclipse took place in the early part of this decade. We report on 2.3 and 4.6 micron spectroscopy of the eclipse. Line profile changes occur in the 2.3 micron CO first overtone during eclipse. A more conspicuous change occurs to the 4.6 micron spectrum. It changes from a typical Mira spectrum into a complex blend of disk and Mira emission and absorption features. Continuum emission from the disk region contributes to both the 2.3 micron and 4.6 micron region. The lowest energy 4.6 micron vibration-rotation CO fundamental lines contain multiple absorption features from gas flowing across the disk away from the Mira. Fundamental band CO emission can be fit by gas in two regions, a thin, eccentric ring with inner radius 4.75 au and outer radius 6.9 au and a Mira-facing spot, 6.3 au from the accretion disk center, near the inner Lagrange point. The eccentricity of the orbit results in significant orbital variation in the size of the Roche lobes. At periastron, which coincides with the eclipse, the Roche radius of the secondary is 4 au, smaller than both the 5 au geometric radius for the disk and estimates for the disk size from models. The CO emission ring is exterior to the periastron Roche radius.

P11 Photometric monitoring of southern symbiotic stars

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We will present the results of monitoring of southern symbiotic stars in V and I filters. The results of the survey include measurements of orbital and pulsation periods, as well as newly discovered Z And type outbursts. In particular, the distribution of symbiotic stars orbital periods will be discussed.

P12 Ancient nova shells suggest evolution of mass transfer rate

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We will present observations of a symbiotic system with three nova shells. Dating of this triad of eruptions suggests a change in the nova recurrence time. The most likely explanation is an alteration in the mass transfer rate attributed to evolutionary changes of the mass-donor in the system.

P13 Study the photometric behavior of a symbiotic star V919 Sgr

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The photometric behavior of the poorly understood symbiotic variable V 919 Sgr of the Z And - type was studied. We collected the data from AAVSO and ASAS-SN databases as well as UBVRI observations obtained in the Astronomical Institute of the Slovak Academy of Sciences. We also analyzed archival photographic plates of the Sonneberg Observatory to search the old outbursts of this variable. While studying activity of the variable at short timescales, we have analyzed the data in different filters using the 'scalegram analysis' with a weighted 'running parabola' approximation with additional 'bi-square' weights. The statistically optimal value of window half-width was adopted to 63 days which corresponds to the smallest r.m.s. statistical errors of the approximation at arguments of observations. A set of approximated values was computed with a step of 1 day allowing to determine color indices B-V, V-R, R-I. The color index B-V ranges from 0.53 at three brightness maxima 10.15-10.76 (V) to 1.20 at 13.8. A periodogram analysis was also carried out based on the observations of AAVSO and ASAS-SN. There are several peaks in the periodograms. The variability in the I band argues for a possible period of 419.8 days that can be associated with a pulsational activity of red giant.

P14 WD 1145+017: Model of the circumstellar material and infrared radiation

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WD 1145+017 (WD1145) is the first white dwarf known to be orbited by disintegrating exoasteroids. It is a DBZ-type white dwarf with strongly variable broad circumstellar lines. Multiwavelength photometry of WD 1145 shows substantial infrared excess. Various models of the dust clouds and gaseous rings have been proposed as an explanation for this behavior. We revisited these observations and proposed alternative models of its dust clouds and gas rings. Our model of the gaseous disk consists of an inner, hotter, and almost circular disk and an outer, cooler, and eccentric disk. The structure precesses with a period of 3.83 +- 0.12 yr. We demonstrate that it fits the observed circumstellar lines reasonably well. This model solves a few drawbacks that might be associated with the previous models. Apart from that, using the Shellspec code, we created a model of dusty disc which reproduces the observed NIR radiation and predicts the radiation at longer wavelengths. This helped us to constrain the location of dust cloud, its mass, as well as its composition.

P15 UBV photometry of T CrB: linking the Super-active State to the predicted outburst

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We performed and analysed UBV photometry of the recurrent nova T CrB. For the hot component of T CrB, we find average dereddened colours (U-B)0 =-0.70±0.08 and (B-V)0 = 0.23±0.06, corresponding to an effective temperature 9400±500 K and optical luminosity 40-110 $L_\odot$ during super-active state (2016-2022). After the end of the super-active state the hot component becomes significantly redder, (U-B)0=-0.3 and (B-V)0=0.6 in August 2023. Its luminosity decreased markedly to 20-25 $L_\odot$ in April-May 2023, and to 8-9 $L_\odot$ in August 2023. We estimate, that the average mass accretion rate is of about 2.5×10^{-8} $M_\odot yr^{-1}$ during the super-active state, and decreased ten times in the second half of 2023.

P16 Emission lines in the spectra of the symbiotic system AX Persei – new analyses and results

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Symbiotic stars are the widest known interacting binaries in which the mass transfer between cool and hot components is responsible for the manifestation of their activity – outbursts related to significant photometric and spectroscopic changes. One of the first discovered symbiotic system is AX Persei. Although it is studied almost for a century, new results of its research can be still surprising. In the contribution, we present an extension of our previous investigation of the strong emission lines originating from the symbiotic nebula surrounding both components of AX Persei. Observations obtained mainly from the ARAS database were adopted, and the equivalent widths and the radial velocities of the emission lines were measured using a variety of methods. The obtained results were compared with our previous findings, indicating the individual behaviour of the studied spectral lines.

P17 Symbiotic stars in Gaia DR3

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Despite the significance of symbiotic binaries as unique astrophysical laboratories facilitating the study of diverse phenomena, many questions regarding the parameters of symbiotic components or evolutionary channels leading to the symbiotic phenomenon remain unanswered. In this poster contribution, we explore various aspects of *Gaia* DR3 in the study of symbiotic stars. We focus on the astrometric, photometric, spectroscopic, and astrophysical data provided for known symbiotic systems and compare them with the parameters presented in the literature and collected in our New Online Database of Symbiotic Variables. The task is not only to present current insights but also to lay the groundwork for future data releases and *Gaia* DPAC work.

P18 Pro-am collaboration in the classification of symbiotic candidates from the New Online Database of Symbiotic Variables

Jaroslav Merc[1,2], Rudolf Gális[3], Marek Wolf[1], Jan Kára[1], Peter Velez[4], Stéphane Charbonnel[5], Olivier Garde[5], Pascal Le Dû[5], Lionel Mulato[5], Thomas Petit[5], Forrest Sims[4], Christian Buil[4], Terry Bohlsen[4], Tom Love[4], et al.

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Ongoing systematic searches for symbiotic stars within the Milky Way and neighboring galaxies have led to a rapid expansion in the number of identified symbiotic systems. Recent years have witnessed the discovery of dozens of new symbiotic stars and candidates. However, a considerable number of objects remain insufficiently investigated. Furthermore, some objects are labeled as symbiotic stars based solely on photometric characteristics or behavior, the superposition of an X-ray source with a red-looking star or other indirect evidence. Many symbiotic candidates proposed in the literature have yet to undergo spectroscopic examination.

In this poster contribution, we present some results from a pro-am campaign focusing on symbiotic candidates selected from the New Online Database of Symbiotic Variables. Within this initiative, we analyze available data on selected symbiotic candidates and supplement them with new spectroscopic and photometric data acquired through small telescopes. Our objective is to either confirm or reject their symbiotic nature or, at the very least, pre-select promising candidates for further investigation using larger telescopes.

P19 The formation of the magnetic symbiotic star FN Sgr

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There are several symbiotic stars (e.g. BF Cyg, Z And, and FN Sgr) in which periodic signals of tens of minutes have been detected. These periods have been interpreted as the spin period of magnetic white dwarfs that accrete through a magnetic stream originating from a truncated accretion disc.

To shed light on the origin of magnetic symbiotic stars, we investigated the system FN Sgr in detail. We searched for a reasonable formation pathway to explain its stellar and binary parameters including the magnetic field of the accreting white dwarf. We used the MESA code to carry out pre-CE and post-CE binary evolution and determined the outcome of CE evolution assuming the energy formalism. For the origin and evolution of the white dwarf magnetic field, we adopted the crystallization scenario.

We found that FN Sgr can be explained as follows. First, a non-magnetic white dwarf is formed through CE evolution. Later, during post-CE evolution, the white dwarf starts to crystallize and a weak magnetic field is generated. After a few hundred Myr, the magnetic field penetrates the white dwarf surface and becomes detectable. Meanwhile, its companion evolves and becomes an evolved red giant. Subsequently, the white dwarf accretes part of the angular momentum from the red giant stellar winds. As a result, the white dwarf spin period decreases and its magnetic field reaches super-equipartition, getting amplified due to a rotation- and crystallization-driven dynamo. The binary then evolves into a symbiotic star, with a magnetic white dwarf accreting from an evolved red giant through atmospheric Roche-lobe overflow. If our formation channel is correct, our findings suggest that white dwarfs in most symbiotic stars formed through CE evolution might be magnetic, provided that the red giant has spent $\gtrsim 3$ Gyr as a main-sequence star.

P20 Automatic search for symbiotic stars in GAIA DR2 and EDR3 databases

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Symbiotic stars are binary systems formed by evolved stars, a red giant or Mira type star and a high temperature star (generally a white dwarf). The better way to identify them is by their spectra, however some photometric colors could be used to identify them or, at least the possible candidates to be symbiotic stars. We analyzed the photometric characteristics of known symbiotic systems based on Gaia photometry from releases DR2 and EDR3 and 2MASS IR data, and tried to identify them by the training of different algorithms whose results were compared by their accuracy, sensitivity, specificity and other statistical indices. The training catalogue was constructed using the GAIA parameters (Gmag, BP mag and RP mag) which were complemented with J, H and/or K magnitudes from the 2MASS catalogue and some (b – v) colors when they were available from SIMBAD database.

Here we present the results concerning the accuracy obtained, and the better combination of parameters to achieve the best effectiveness in the identification. It was found that the b-v color, frequently used to identify SY and separate from other type of sources (like PNs) can be replaced by GAIA colors: Gmag-BPmag or BPmag-RPmag with advantage over b-v in some diagnostic diagrams.

P21 Resolving the accretion streams of T CrB

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T CrB, 'the blaze star', is an archetype of recurrent novae exhibiting symbiotic activity. From a 10-year-long spectral monitoring with the high-resolution HERMES spectrograph installed on the Mercator telescope, we provide new insights into the dynamics of the gas within the binary during its quiescent phase. The emission profiles of hydrogen, helium, and [O III] which show variations with the orbital phase, are analyzed using the Doppler tomography technique. Their velocity field compared with the canonical model of RLOF unveils the different components of the accreting stream and gives constraints for further hydrodynamical modeling.

P22 A search of symbiotic signatures among extrinsic S stars

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Extrinsic S stars are binary systems involving a giant enriched in s-process elements, believed to be the signature of mass transfer from their white dwarf companion. Despite having similar building blocks as canonical symbiotic systems, extrinsic S stars do not often exhibit the usual signature of symbiotic activity (such as X-ray detection, UV continuum, or variable emission lines). Here we report on the orbital modulation of the spectral line profile from S stars of the Henize sample where a handful of them show faint Hα modulation. We correlate the variation with the binary motion and compare it with classical symbiotic stars such as EG And. The different characteristics of those two binary families need to be understood in light of their orbital properties and evolutionary pathway, in the hope to give new light on the physical ingredients needed to trigger symbiotic activity.

P23 Variability of emission lines in the symbiotic systems of the LMC

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Symbiotic stars (SySt) are intriguing binary systems having an active mass transfer between a hot companion, usually a white dwarf, and a cold counterpart in the form of an evolved giant. Their exquisite nature turn them into ideal laboratories for studying a plethora of astrophysical phenomena, such as jets formation, soft X-ray emission, outbursts and flickering, all the way to supernovae type Ia. SySt are also highly variable sources. This variability can be extrinsic (eclipses, eccentric orbits) or intrinsic (shimmering, radial pulses of the giant star, winds, dust accumulation, flares), with time scales from minutes to years. We aim to look for potential links between the variability of emission line (i.e., Hα, Hβ, He II, and most important, Raman O VI) fluxes and ratios with these different mechanisms. Preliminary results will be presented in this contribution.

P24 Exploring the Galactic Plane: Uncovering and Analysing new CVs and Symbiotic stars

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We introduce an ongoing project aimed at not only identifying new Cataclysmic Variables (CVs) and Symbiotic Stars (SySts) but also conducting extensive photometric and spectroscopic follow-ups. Our primary goal is to scrutinize diverse stellar populations within the densely populated yet obscured Galactic Plane. Leveraging Machine Learning and advanced photometric classification techniques, we anticipate uncovering new objects, including CVs and SySts, to bridge detection gaps and explore their physical and chemical properties, as well as their influence on the Interstellar Medium (ISM). This exhaustive exploration forms part of a long-term project initiated at IA-UNAM (Ensenada) within the Evolved Stars Study Group.

P25 A morphological catalogue of nova remnants

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We present the first optical imaging catalog of resolved Galactic nova remnants. It is a compilation from public archives using different telescopes and instruments and our observations carried out at the Nordic Optical Telescope. The catalog includes images of 47 nova remnants out of the more than 500 novae detected to date. The images span from 1956 to 2020, covering the time evolution of the nebular remnant in human time life scales.

P26 V426 Sge: Photometry from an inactive binary to the nova explosion and the evolution of a classical symbiotic star

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The star V426 Sge (HBHA 1704-05) had been classified as an emission-line object until its first Z And-type outburst at the beginning of August 2018. We began to carry out regular multi-color photometric observations both in the optical (UBVRI) and the near-infrared (JHKL). In addition, we measured archival photographic plates collected at different observatories. In this way, we revealed a nova-like explosion in 1968, after which the system developed wave-like orbital-related variations with a period of 493 days, becoming a classical symbiotic star. In September 2023, V426 Sge experienced a new small outburst characterized with the amplitude of > 1 mag in U and lasting for only 2 months. We show the outburst's profile at different photometric passbands, changes in the color temperature from the two-color diagram, and present the SED based on our UBVRIJHKL photometry during the outburst and its decline. Our new photographic estimates from the archives of the Sonneberg and Asiago observatories confirmed the quiescent phase of V426 Sge as a classical symbiotic star.

P27 Observatory Úpice and variable stars – offer of possible cooperation

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The Observatory Úpice is a relatively small astronomical institution focused both on the popularization of astronomy and on scientific activities. Although mainly we are focused on the observation of the Sun, we are also interested in other fields, including the observation of variable stars. We operate several telescopes available for observing variable stars. Some of which are partially automated. In our poster, we will introduce you to our instruments, our experience with observing and processing them, as well as the offer of possible cooperation.

P28 Anatomy of a Luminous Red Nova: A Spectroscopic Study

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In binary systems, the transfer of mass crucially influences the evolution and eventual fate of their members. Once such a stellar interaction becomes unstable, it triggers a phase where the stars share a common envelope. This envelope can be expelled, altering the system's binding energy and angular momentum. During this ejection, radiation-dominated ejecta produce a first brightness peak, while hydrogen and helium recombination, along with matter-dominated ejecta, form a second luminosity peak. The sequence corresponds to a transient event named Luminous Red Novae.

The dynamics and physical properties of such explosive events are not well understood. Currently, they are mostly described through hydrodynamic simulations and semi-analytical models, which are imprecisely constrained and rely on observational data for accuracy. In this study, we introduce new insights into the ejecta's geometry and velocity patterns by analyzing the spectral and photometric development of two Luminous Red Novae, AT2021biy and AT2021blu. We employ unusually high-resolution spectra for these types of (extragalactic) events to deduce the conditions during the events.

Our spectroscopic findings reveal a slow-moving absorption component (around 10-20 km/s), likely originating from colder gas previously ejected around the binary system. I will present evidence suggesting this component has an axisymmetric shape, as indicated by the form and evolution of various spectral line profiles, including those of Hydrogen, NaI, FeII, and CaII. In addition, the spectral analysis will incorporate characteristics of the binary systems prior to the outbursts, derived from MESA modeling. Our findings indicate that binary systems capable of producing such explosions typically have a high mass ratio, with primary stars more massive than those predicted by single-star models. Moreover, our models suggest that the donor stars had to lose several solar masses of gas to align with the observed pre-outburst positions in the HR diagram for the progenitor stars.

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Useful Information

Venue

The conference will be hosted at the **Faculty of Mathematics and Physics of Charles University**, the oldest and largest university in the Czech Republic, situated in the country's capital **Prague**. The venue, located in the Prague's historic Old Town at *Malostranské náměstí 25, Prague 1*, occupies a building with a rich history. Originally constructed in the 17th century by Italian architects for the Jesuits as the so-called House for Professed, the seat of the most important representatives of the Order, it later became property of the Habsburg Monarchy, then the Czechoslovak Republic, and eventually the Charles University.

  

Adjacent to the renowned St. Nicholas Church, an exquisite example of Prague baroque built in the 18th century and nestled beneath the **Prague Castle**, this venue offers a remarkable atmosphere. A mere ten-minute walk from the conference venue will lead you to the Prague Castle and within approximately seven minutes, you can reach the iconic **Charles Bridge**. The Square and its surrounding streets boast a plethora of restaurants offering diverse cuisines, including traditional Czech one, numerous bars serving famous Czech beers, and you can find a variety of accommodation options too.

Upon arriving at the venue, please follow the arrows marked with the conference name. They will guide you to the first floor, room S09, where the conference will be held.

Public transport in Prague

Prague boasts an **efficient public transportation system**, ensuring swift access to any destination within the city. The network comprises three metro lines (A, B, C), a comprehensive tram and bus network, a funicular to Petřín Hill, and ferries operating on the Vltava River.

Tickets for public transport can be purchased at sales points, self-service vending machines at metro stations, and many tram/bus stops. Alternatively, payment can be made using a bank card directly in all trams, most buses, and metro vestibules. Mobile app options (called PID lítačka) and SMS tickets are also available. For paper tickets, **validation is required** either upon entering trams or buses or within metro vestibules (yellow machines located upstairs; not available on platforms or in trains). Ticket options include 30 and 90-minute passes (not valid for Petřín Funicular) and **24 or 72-hour** passes. The tickets allow for an unlimited number of rides within their designated time validity.

Schedules are displayed at stops, and for route planning, the Prague Public Transit Company website or a dedicated smartphone app PID lítačka can be utilized. The app, which utilizes GPS, identifies the nearest station and devises an optimal route.

The conference venue is conveniently located near the **'Malostranské náměstí'** tram station, serviced by multiple trams. Additionally, the **'Malostranská'** metro station (line A) is within walking distance.

Traveling to conference venue

To reach the conference venue from the airport, you can board trolleybus no. 59 directly from the airport to its final stop, 'Nádraží Veleslavín'. From there, transfer to metro Line A and travel to 'Malostranská' station. Then you can choose to either walk (approximately 8 minutes) or take a tram (numbers 12, 15, 20, 22, or 23) to 'Malostranské náměstí', which takes just 2 minutes.

If you arrive to Prague by train, from the main train station, take metro Line C to station 'Muzeum' and then transfer to Line A to 'Malostranská' station. From 'Malostranská', you have the option to walk or take a tram to 'Malostranské náměstí'.

When arriving at 'Florenc' bus station, board metro Line B to 'Můstek' and transfer to Line A, continuing to 'Malostranská' station. From 'Malostranská', you can choose to either take a tram to 'Malostranské náměstí' or enjoy a short walk.

Using taxi

If you opt for a taxi service, exercise caution by selecting reputable companies, e.g., Taxi Praha, AAA Taxi, or City Taxi. Unfortunately, there have been instances where foreigners were charged excessively by dubious taxi operators. Alternatively, you can consider using rideshare services such as Uber or Bolt, which are often more cost-effective. When booking through their respective apps, you receive upfront information about the final fare. It's worth noting that since September 2023, Uber is the official contracted taxi service for Prague Airport. You can book Uber rides via the app, the airport's website, and through kiosks in the arrival halls at both terminals.

Currency

The currency of the Czech Republic is the **Czech crown** ('Česká koruna'), abbreviated as CZK and represented by the symbol 'Kč'. Banknotes and coins come in various denominations, with coins ranging from 1 CZK to 50 CZK, and banknotes including 100 CZK, 200 CZK, 500 CZK, 1000 CZK, 2000 CZK, and 5000 CZK.

While major credit and debit cards are widely accepted throughout Prague, it's a good idea to have some cash on hand, especially if you plan to visit some smaller restaurants and shops or more remote establishments. Money exchange services are readily available in the city, but it's essential to be vigilant about exchange rates and commission fees. We recommend **eXchange** at *Štefánikova 203/23, Prague 5*, which is within a 25-minute walk or a 5-minute tram ride (near stop 'Arbesovo náměstí') from the conference venue. This exchange offers very good rates and does not charge any commission fees.

Exchanging money at the **airport is generally not recommended**, as the rates offered there may not be as favorable. Banks also provide currency exchange services, and the primary banking area in Prague is Wenceslas Square, where you can find banks offering reasonable exchange rates, albeit often with a small commission. Additionally, **exercise caution when using smaller exchange booths**. They may advertise zero commission but compensate with less favorable rates, so always inquire about the total amount you'll receive before making an exchange. Consider comparing the rates with the Central bank exchange rates and do not make an exchange if they differ significantly. It's advisable to avoid individuals offering cash exchange services outside official exchange booths. Numerous instances have been reported where people were scammed and received similarly looking currency of much lower value. Familiarizing yourself with the visual features of Czech banknotes is also a wise precaution to prevent any potential confusion or deception.

When using ATMs in Prague, be aware of possible fees associated with withdrawals. It is advisable to use ATMs located inside large banks to minimize transaction charges and ensure a smoother experience.

Electricity

The standard voltage of the electricity network in the Czech Republic is **230V** and the frequency is 50Hz. The most commonly used socket types in the country include the European CEE 7/5 (**Type E**), CEE 7/4 (Type F, commonly known as 'Schuko'), and CEE 7/16 (Type C, often referred to as the 'Europlug'), all featuring **two round pins**. Please note that Types E and F are interchangeable with each other and compatible with Type C plugs, but Type C socket is not compatible with Types E and F plugs. If your electrical appliances have a different plug shape, we recommend carrying a **travel adapter** to ensure compatibility with Czech sockets. While some hotels may provide adapters or have universal outlets, having one on hand will guarantee a smooth experience during your stay. The lecture room tables at the conference venue are equipped with Type E sockets.

Time zone

The Czech Republic operates in the Central European Time (CET) zone, which is UTC+1 during standard time. However, in June, the country observes daylight saving time, shifting to **Central European Summer Time** (CEST) at **UTC+2**.

Weather

The Czech Republic experiences a temperate continental climate, characterized by distinct seasons. In early June, when the conference is set to take place, you can generally expect **mild to warm weather** with maximal daytime temperatures typically ranging from 20°C to 25°C (68°F to 77°F). Evenings can be slightly cooler. While rain is possible, it's not as frequent during this period, so you can often enjoy sunny skies and pleasant weather.

Important phone numbers

For your convenience and safety during your stay in Prague, it's good to be aware of important phone numbers. **In case of emergencies**, simply dial 112, the universal emergency number connecting you to the police, medical services, and firefighters. For non-emergency police assistance, dial 158, while the city police can be reached at 156. In case of medical emergencies or a need for ambulance services, remember to call 155. Should you require assistance from the fire department or face a hazardous situation, dial 150. To access English-speaking operators and obtain valuable tourist information, reach out to the Prague Tourist Information Centre at +420 221 714 714. We encourage you to keep these numbers handy for a worry-free experience during your stay in Prague.

CHARLES UNIVERSITY
Faculty of mathematics
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planetum

International conference

Symbiotic stars,
weird novae, and related embarrassing binaries

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June 3 - 7, 2024

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