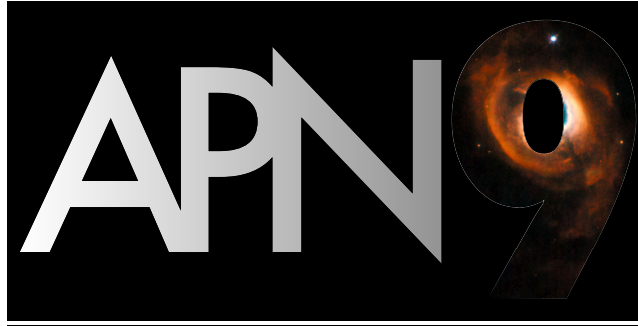




Granada, September 22-26, 2025

**Asymmetrical Post-Main-Sequence Nebulae 9**  
**The Art of Stellar Wind Sculpting**

**LIST OF CONTRIBUTIONS**

## **ORAL CONTRIBUTIONS**

### **ORAL IDa002**

#### **When a PN isn't a PN: Symbiotic stars and their relatives in Gaia data**

Jaroslav Merc

Gaia DR3 has revealed numerous emission-line objects and provided variability information and classification for many of them. However, symbiotic stars, interacting binaries composed of a red giant transferring mass to a compact companion, pose a challenge for automated classification pipelines. Their complex nature leads to frequent misidentifications, often as planetary nebulae or other related sources. In this contribution, I present our approach to identifying genuine symbiotic stars using Gaia DR3 data combined with information from other surveys, and discuss strategies for disentangling them from misclassified and mimicking objects.

### **ORAL IDa003**

#### **A morphological catalogue of nova remnants**

Edgar I Santamaria, [Martín A Guerrero](#), Gerardo Ramos Larios, Jesus A Toala, Laurence Sabin

We present the first optical imaging catalogue of resolved galactic nova remnants including images for 66 novae. Diffuse emission is detected in 45 sources, with resolved nova remnants being mostly round (27%) or elliptical (56%), with very few bipolar (13%). The effects of binarity in shaping are minimal. Most nova remnants are younger than 150 yr and their physical size increases with age at a rate of 0.0725 pc per century up to a median value of 0.03 pc. Then they mostly disperse into the ISM and vanish.

### **ORAL IDa004**

#### **The residual kinematical structure in Galactic planetary nebulae**

[Francisco Ruiz-Escobedo](#), Michael Richer

We present an analysis of the residual velocities of a sample 105 spatially resolved planetary nebulae. We measured these values for [N II], [O III] and He II lines. We found an average value of 15 km s<sup>-1</sup> for the whole sample; however, the residual velocities of highly ionized species tend to be larger. There is no correlation between residual velocities and nebular parameters, such as morphology; however, values for objects with H-poor CSPNe are larger than for objects with H-rich CSPNe. This effect may arise from a macroscopic process, such as turbulence, rather than a microscopic one, such as thermal motions.

**ORAL IDa005****Unraveling the History of NGC 2440 with JWST and ALMA**

**Paula Moraga Baez**, Joel Kastner, Bruce Balick

We present first results from a comprehensive sub-arcsecond line imaging survey of bipolar PN NGC 2440 using the combined power of newly obtained JWST/NIRCam H<sub>2</sub>, Br $\alpha$ , [Fe II], and PAH-imaging and archival ALMA 1.3-mm interferometric molecular line and continuum-mapping observations. JWST/NIRCam reveals dust and molecular-gas surviving and evolving under the influence of the CSPN, and shocked regions of the nebula, with mm-wave emission line ratios (e.g., HCN/HNC) and near-IR [Fe II] and H<sub>2</sub> lines serving as diagnostics of UV-irradiation and shocks, respectively. JWST+ALMA-imaging reveals a series of complex morphological features that cannot be explained by a single mass-ejection event.

**ORAL IDa007****Astrochemistry of the Highly Positively Charged Fullerenes in Light of Quantum Mechanics**

**Seyed-Abdolreza Sadjadi**, Quentin Andrew Parker, Chih Hao Hsia, Yong Zhang

We report the extreme resilience of C<sub>60</sub> fullerene and the smallest member of the fullerene family, C<sub>20</sub>, to destruction by ionizing radiation in planetary nebula environments. This characteristic manifests in the formation of a range of highly positively charged species with strong bonding between their carbon atoms. The phenomenon not only leads to the preservation of the cage structure but also to the emission of detectable radiation within the mid-infrared wavelength range. It is anticipated that each of these exotic species could be the origin of a variety of astrochemical reactions and the formation of other complex organic molecules.

**ORAL IDa008****DROPPED!****GTC Deep Spectroscopy of Galactic Compact Planetary Nebulae**

**Xuan Fang**, Haomiao Huang, Letizia Stanghellini, Martín A. Guerrero, Ting-hui Lee, Richard Shaw

We report spectroscopic survey of Galactic compact planetary nebulae (PNe) using the 10.4m Gran Telescopio Canarias (GTC). The deep spectra cover a broad wavelength range of ~3630–10370 Å, enabling detection of numerous emission lines critical for nebular analysis. These GTC optical-NIR spectra were analyzed in conjunction with the Spitzer/IRS mid-IR spectra available from archive, and nebular elemental abundances derived. Photoionization models were constructed for the compact PNe using CLOUDY to derive the parameters of their central stars and consequently properties of their main-sequence progenitors. AGB model predictions were also used to help constrain the population of these PNe.

### **ORAL IDa009**

#### **JWST/NIRCam imaging of NGC 6537: the (Infra)red Spider, Revealed**

**Joel H Kastner**, Paula Moraga Baez, Bruce Balick

We present new JWST/NIRCam Br $\alpha$ , H $_2$ , [Fe II], and PAH imaging of the dusty, molecule-rich, high-excitation bipolar planetary nebula NGC 6537. Emission from H $_2$  traces the full extent of the bubble-like polar lobes, whereas [Fe II] displays an extended S-shaped morphology (a la NGC 6302). The NIRCam imaging furthermore reveals a near-IR excess at the central star indicative of a dusty, (perhaps) circumbinary disk; this central binary configuration also likely underlies the ongoing fast, collimated outflows that generate the [Fe II] emission. The JWST near-IR imaging thus exposes the evolved-binary-system-driven processes underlying the formation and evolution of the Red Spider.

### **ORAL IDa012**

#### **DeMCELS Detects Giant Halos of PNe and Giant PNe in the Magellanic Clouds**

**You-Hua Chu**, Tsung-Chi Chen, Quentin Parker, Sean Points

The DeMCELS survey of the Magellanic Clouds (MCs), with a resolution of about 1.1", has been used to search for halos of PNe and circumstellar nebulae. Because of their known distances, the linear sizes of nebulae can be determined accurately. While we find extended structures around some PNe and large evolved PNe, we also find PN-like nebulae around eclipsing binaries or without identifiable central stars. These nebulae have sizes up to a few pc, but not as large as bubbles around massive stars. These giant PN-like nebulae may result from the mass ejection during close binary interactions.

### **ORAL IDa017**

#### **Tracing Planetary Nebula Evolution Through Dust–Gas Diagnostics**

**Şengül Yalgin**, Nurullah Erzincan, Nazım Aksaker, Aysun Akyüz, Tolgahan Kiliçoğlu

This study presents a new interpretation of 19 compact planetary nebulae (PNe) using previously analyzed spectroscopic data obtained with the TFOSC instrument on the RTT150 telescope (TUG, Antalya), combined with photoionization modeling. The investigation focuses on four key physical diagnostics: dust temperature, excitation class, the dust-to-gas mass ratio, and elemental abundances, to assess the evolutionary diversity of the sample. Trends such as enhanced dust-to-gas ratios in low-excitation nebulae are explored. The study highlights the diagnostic value of combined dust and gas indicators for understanding the late stages of stellar evolution. Future work will extend this framework to hundreds of PNe.

## ORAL IDa020

### Redefining our view of fullerenes in Tc 1 using JWST

**Morgan M. Giese**, Jan Cami, Els Peeters, Simon Van Schuylenbergh, Charmi Bhatt, Dries Van De Putte, Cedric Baerts, Michael J. Barlow, Jeronimo Bernard-Salas, Alessandra Candian, Bryan Changala, Nick Cox, Harriet Dinerstein, Vincent Esposito, Anibal Garcia-Hernandez, Marco Antonio Gomez-Muñoz, Kay Justtanont, Kathleen E. Kraemer, Eric Lagadec, Arturo Manchado, Ana Monreal Ibero, Raghvendra Sahai, Ameet Sidhu, Greg Sloan, Nicholas C. Sterling, A.G.G.M. Tielens, Jeremy Richard Walsh, Roger Wesson, Joshua Cole Whitman, Albert Zijlstra

JWST MIRI/MRS observations of the benchmark fullerene planetary nebula Tc 1 provide the first detailed, spatially resolved view of C<sub>60</sub> and C<sub>70</sub> emission throughout the object from the main ionized region (peaking in a thin shell) to the regions beyond. The observations reveal unusual band profiles for C<sub>60</sub> offering important clues to the nature of the emission. The spectral characteristics of the fullerene emission vary subtly across regions spanning large gradients in radiation field and electron density. We confirm a large abundance of C<sub>60</sub> and C<sub>70</sub> and speculate about the formation pathways and evolutionary status of Tc 1.

## ORAL IDa021

### Planetary Nebulae in the eROSITA eRASS1 catalog

**Haoyang Yuan**, Martin A Guerrero, Quentin Parker, Rodolfo Montez Jr.

While extant Chandra and XMM-Newton observations have detected X-ray emission in PNe, the numbers known remain very small (~40) compared to the overall Galactic PNe population (~4000). To further investigate their X-ray properties to elucidate what drives current X-ray PN detections, we have cross-searched the SRG eROSITA-DE eRASS1 source catalogue and Hong Kong (HASH) PNe Database. This report will show: Five known X-ray PNe have been detected (Abell 30, NGC 2392, NGC 3242, NGC 5315, and LoTr 5), two new X-ray PNe are revealed (IC 1297 and NGC 2867), and another one (K 1-27) is removed from previous X-ray compilations.

## ORAL IDa024

### Structure and kinematics of the ionized core of the pPN CRL618

**Juan P. Fonfría**, D. Tafoya, C. Sánchez Contreras, P. Fernández-Ruiz, A. Castro-Carrizo, J. Alcolea, V. Bujarrabal

The very impressive high velocity outflows developed by pre-planetary nebulae (pPNe) are launched from ionized regions very close to the central stellar system by means of still unknown mechanisms. In this talk, we will present our analysis of the highest angular resolution ALMA observations of the pPN CRL618 taken so far, which describe the HII region of this pPN through the continuum emission and the H30 $\alpha$  recombination line. These resolved brightness distributions and the main results about gas kinematics will be showed along with a detailed exploration of the region carried out with the Co3RaL radiation transfer code.

### **ORAL IDa026**

#### **Do the ionization correction factors care about PN morphology?**

**Denise R. Gonçalves**, Marco Laversveiler

This contribution presents new optical ICFs based on 3D photoionization models of PNe (computed with MOCASSIN), which provide a better description of the nebulae than 1D models. The 810 simulation inputs span several central star luminosities and effective temperatures, morphological types for round, elliptical and bipolar PNe, three densities, plus type 1 and 2 abundances. The ICFs are described as functions of He and O ions. The improved treatment of diffuse radiation in a 3D fashion reveals that 1D ICFs significantly over- or under-estimate the total abundances of He, N, O, Ne, S, and Ar, particularly in bipolar nebulae.

### **ORAL IDa027**

#### **Challenging evidences of H<sub>2</sub> in low-ionization structures of planetary nebulae**

**M Belén Mari**, Stavros Akras, Denise R. Gonçalves

We present the estimate of excited (warm) H<sub>2</sub> mass in low-ionization structures (LISs) of PNe, based on high-resolution near-IR imaging of five Galactic PNe using NIRI@Gemini. Our observations reveal H<sub>2</sub> emission in many LISs, doubling the number of detections. We find that excited H<sub>2</sub> mass in LISs is between 200 and 5000 times lower than the ionized gas mass. The presence of warm H<sub>2</sub> suggests that colder molecular gas may also exist, shielded from central star's radiation, implying that total molecular mass in LISs could exceed that inferred from ionized material alone, and thus helps reconcile observations with model predictions.

### **ORAL IDa028**

#### **HASH - resource, legacy and future**

**Quentin Parker**, Andreas Ritter

The Hong Kong / AAO / Strasbourg H-alpha PN research platform and catalogue "HASH" has become the gold standard community resource when working on Galactic and Magellanic Cloud PNe with more than 1200 registered users 60+ countries. I will present the current state of play and recent research highlights from our HKU based HASH team and the legacy and future of HASH as its contents are ported to the CDS in Strasbourg.

### **ORAL IDa030**

#### **Impact of dust grain geometry on nebular emission around evolved stars**

**Palmira Jiménez**, Jane Arthur, Daniel Girado, Olga Muñoz, Julia Martikainen, Laurence Sabin

Dust properties are key to understanding nebular evolution around evolved stars. Using the spectral synthesis code Cloudy, we present models of a Wolf-Rayet nebula with opacities calculated from spherical and irregular hexahedral grains across an MRN size distribution (0.005–0.25  $\mu\text{m}$ ), incorporating silicates, graphite, or amorphous carbon. Differences in the resulting nebula continuum of the nebula increase with grain size, especially for graphite. This suggests that traditional spherical grain assumptions may overestimate dust content. Our results highlight the importance of grain geometry in accurately modeling and interpreting nebular emissions.

### ORAL IDa031

#### **Shaping the Ring Nebula: A Tale of Two Components**

**Miguel Santander-García**, Elisa Masa, Jesús Toalá, Edgar Santamaría, Javier Alcolea, Miguel Gómez-Garrido, Martín A Guerrero

The Ring Nebula (NGC 6720) represents an iconic benchmark for studying the late stages of stellar evolution, yet its true structure remains debated. While previous modeling of optical data suggests an ellipsoidal ionized shell, recent JWST observations reveal a more complex, possibly bipolar, molecular component. We will present a unified 3D morpho-kinematical model of the nebula combining new millimetre-range, deep maps of CO emission from the IRAM 30m telescope with optical imagery and high-resolution spectroscopy, thus probing both the molecular envelope and ionized shell, and hopefully recovering the true spatial and kinematic structure of this nebula.

### ORAL IDa032

#### **The role of magnetic fields in the common-envelope phase**

**Marco Vetter**, Friedrich Röpke, Fabian Schneider, Rüdiger Pakmor, Sebastian Ohlmann, Javier Moran-Fraile, Mike Lau, Giovanni Leidi, Damien Gagnier, Róbert Andrásy

State-of-the-art three-dimensional magnetohydrodynamic simulations of the common envelope (CE) phase of binary stellar evolution reveal a robust transformation of the primary star's envelope into a thick circumbinary disk. This structure self-consistently launches bipolar, magnetically driven outflows, giving rise to a bipolar planetary nebula morphology shortly after the dynamical plunge-in. This structure may persist on longer timescales and fundamentally reshapes post-CE dynamics. While dependencies on the mass ratio and radiative cooling require further study, it is already evident that magnetic fields play a key role in driving the structural evolution of CE remnants and influence observational signatures and finale outcomes.

### ORAL IDa033

#### **The first detached, double eclipsing, double lined, and double degenerate system inside a Planetary Nebula**

**Nicole Reindl**

We report on the discovery of the first detached, double eclipsing, double-lined, and double degenerate binary nucleus inside a planetary nebula that has an orbital period of less than 10h. We acquired extensive photometry and phased-resolved X-Shooter spectra of this unique system and present preliminary results of our radial-velocity measurements, non-LTE spectral modeling as well as on multi-band light-curve fitting.

### ORAL IDa034

#### **Developments of the R Aquarii outflows during the recent periastron passage**

**Tiina Liimets**, M. Santander-Garcia, D. P. K. Banerjee, M. A. Guerrero, J. Alcolea, S. B. Howell, U. Munari, B. Deshev, E. Santamaria, D. Jones, P. Velez, P. Goodhew R. L. M. Corradi, A. Evans, E. Furlan, T. R. Geballe, R. D. Gehrz, V. Joshi Name: A. J. Korn, N. Scott, S. Starrfield, C. E. Woodward

R Aquarii is one of the best-known symbiotic stars, exhibiting multiple distinct and intriguing outflows ranging from sub-arcsecond to several arcminutes in scale. In this contribution, we reveal the first spectrum of the system's largest and faintest outflow, extending up to seven arcminutes from the central binary. We also provide an overview of recent developments in the active arcminute-scale jet, whose appearance has changed significantly during the most recent periastron passage. We present direct evidence, based on speckle imaging, of a newborn sub-arcsecond jet, likely triggered by this latest periastron event.

### ORAL IDa035

#### **Testing the Binary Hypothesis for the Shaping of Proto-Planetary Nebulae**

**Bruce Hrivnak**, Hans Van Winckel, Wen Lu

A binary companion has been proposed as the main agent in the shaping of the ejected nebula of a post-AGB star from a spherical to an axially-symmetric morphology. To test this hypothesis, we have carried out intensive radial velocity monitoring from 2008 to 2022 of a sample of seven bright proto-planetary nebulae. We are also engaged in a complementary program to find good binary candidates based on long-period variations in their light curves, attributed to periodic obscuration by a circumbinary disk. The results of each of these studies will be discussed in terms of their evidence for binarity.

### ORAL IDa036

#### **Planetary Nebulae as Tracers of the Dynamical and Chemical Evolution of Nearby Spiral Galaxies**

**Giovanna Liberato**, Denise R. Gonçalves, Arianna Cortesi, Magda Arnaboldi, Luis Lomeli, Lodovico Coccato, Steven Bamford, Michael Merrifield, Alessandro Ederoclite

Extragalactic PNe can be easily identified by their emission lines in outskirts of galaxies and are excellent tracers of stellar populations. This work analyzes PNe of M33 and NGC 891 to study their properties. For M33 we analyze the known PNe and propose new candidate selection criteria to increase the sample using multi-band imaging from J-PLUS (a 7 narrow- plus 5 SDSS broad-band filters survey). This allows us to trace the outermost stellar distribution and the PNe luminosity function. In NGC 891 we exploit PNe spectra from the Planetary Nebula Spectrograph to analyze the kinematics and the formation of its thick disc.

### **ORAL IDa037**

#### **Unraveling planetary nebulae micro-structures: X-Shooter view of NGC 7009 jet-like clumps**

**Lydia Konstantinou**, Stavros Akras, Konstantinos Bouvis, Panayotis Boumis, Jorge García-Rojas, Denise R. Gonçalves

While the large-scale structures of planetary nebulae (PNe) have been extensively studied and well explained through stellar-wind models, far less is known about their small-scale clumps, which pose challenges to our understanding of PNe formation. Employing X-Shooter@VLT data, I will present the first multi-wavelength spectroscopic analysis of PNe clumps, focusing on NGC7009. Over 200 emission lines have been detected tracing molecular, atomic and ionic gases, including key diagnostics such as [Fe II] 1.64 $\mu$ m/Bry and H<sub>2</sub>/Bry. Our results on the H<sub>2</sub> 1-0S(1)/H<sub>2</sub> 2-1S(1) ratio and H<sub>2</sub> excitation diagrams suggest collisional excitation of H<sub>2</sub>, and offer new insights into unraveling the clumps' origin.

### **ORAL IDa038**

#### **Current unsolved problems in planetary nebulae research**

**Sun Kwok**, Bruce Balick, You-Hua Chu, Bruce Hrivnak, J Alberto López, Quentin Parker, Raghvendra Sahai, Albert Zijlstra

While there has been significant progress in our understanding of the origin and evolution of planetary nebulae in the last 50 years, there remain a number of unsolved problems. These include the true 3-D morphological structure of the nebulae, origin of multipolar nebulae, the dust and molecular distribution relative to the optical nebulosity, large scale structures outside of the main nebulae, the relevance of binarity to planetary nebulae evolution, and a precise definition of the planetary nebulae phenomenon. In this talk, we will summarize current observations related to these problems and present possible future directions to tackle them.

### **ORAL IDa039**

#### **Jet-Driven Formation of Bipolar Rings in Planetary Nebulae: Numerical Simulations Inspired by NGC 1514**

**Muhammad Akashi**

I present 3D hydrodynamical simulations using the FLASH code, where bipolar jets interact with a dense spherical shell to shape planetary nebulae. The simulations reproduce the bipolar rings observed in NGC 1514, refining earlier jet-based models. While the outer rings form along the main jet axis, the messy inner morphology—absent from the simulations—may result from jets launched along a different axis, possibly in a separate mass-loss episode. This scenario suggests a triple-star interaction. The results support jets as key agents in shaping both large-scale and inner structures of bipolar and multipolar planetary nebulae.

### **ORAL IDa041**

#### **2D spectroscopy of Galactic planetary nebulae with high abundance discrepancies: Current status and future prospects**

**Jorge Garcia-Rojas**, Christophe Morisset, David Jones, Verónica Gómez-Llanos, Roger Wesson, Hektor Monteiro, Romano Corradi, Janet Drew, Michael J. Barlow, Albert Zijlstra, PN SCIP/WEAVE team

Accurate abundance determinations in planetary nebulae (PNe) are essential for understanding their emission properties and the chemical evolution of their host galaxies. In high-abundance-discrepancy (AD) PNe, abundances from recombination lines (RLs) exceed those from collisionally excited lines (CELs) by factors of at least 5–10. MUSE@VLT data for four high-AD PNe reveal spatial variations in physical and chemical properties and confirm a cold, metal-rich component emitting mainly RLs. We also highlight the potential of WEAVE-LIFU@WHT and MAAT@GTC to investigate the AD problem. Initial WEAVE-LIFU data also suggest the presence of two distinct plasma components in a high-AD PN.

### **ORAL IDa042**

#### **The heated disk of NGC 2346**

**Albert Zijlstra**

NGC 2346 is a bipolar, knotty nebula with an unusual 16-day binary. The star suffered a series of eclipses starting in the 1980's and ending after 2004. We show that the infrared flux increased after the eclipses, and declined again after a decade. We fit the increase with a dust disk temporarily increasing in temperature. The light curve is modeled using a star on an inclined, highly elliptical orbit. This can also explain the eclipses. We argue that this star is the CSPN, on a long-period orbit around a 16-day main-sequence binary.

### **ORAL IDa044**

#### **Down to the Last Drop: getting the most out of X-ray observations of planetary nebulae**

**Rodolfo Montez Jr**

X-ray emission from planetary nebulae is now well understood and sheds light on a variety of physical processes occurring in the formation of the PN. While limited by the modest low-energy sensitivity of current observatories, the complexity of the data obtained through X-ray observation provides opportunities for creative and innovative analysis. I highlight a few innovations in the analysis of X-ray observations of PNe that uncover direct evidence for hot bubble and nebular interaction. I also discuss how these techniques will fair with enhanced sensitivity offered by potential future missions.

### ORAL IDa045

#### Observational Constraints on the Common Envelope Phase

Jason Nordhaus

Population models predict that a large fraction of systems will undergo common envelope (CE) evolution - a phase that dramatically impacts nebular outflows. I will present a novel method to observationally determine the mapping between initial and final conditions of CE evolution by characterizing a set of post-CE binaries in open clusters. We recently completed a search in 299 clusters and identified 52 new systems (2 were previously known). Directly relating post-CE outcomes to their pre-CE parameters provides benefits as simulations would have initial conditions and final outcomes that their codes must reproduce, and population efforts could utilize observational mappings.

### ORAL IDa046

#### The ALMA view of the symbiotic system R Aquarii

Gómez-Garrido, Miguel, Alcolea, Javier, Bujarrabal, Valentín, Castro-Carrizo, A. , Mikołajewska, J., Santander-García, M.

R Aquarii is a symbiotic system composed of a Mira-type variable and a hot compact companion. It is an ideal system to study phenomena such as mass transfer, jet launching, and the long-standing problem of the formation of asymmetric planetary nebulae in binary systems. We will show several high-resolution ( $\sim 15\text{-}40$  mas) ALMA maps of molecular and recombination lines, as well as continuum emission, obtained at multiple wavelengths and epochs, including observations near periastron passage.

### ORAL IDa047

#### Investigating PNe using central stars: extinction and binarity

Alexander Csukai, Albert Zijlstra

The central stars (CSPN) are crucial tracers of planetary nebulae. Gaia has provided identification of and distances to a large number of these stars. We have used PySSED to determine the extinction for a complete sample of 144 CSPN, to an accuracy of  $E(B-V)=0.02$ . Interstellar extinction dominates; a handful of PNe indicate internal extinction. Four new binaries are identified and characterized. The binary fraction for this unbiased sample is between 23% and 36%, similar to low-mass main sequence stars. Luminosities agree with post-AGB evolutionary tracks even for three objects previously identified as post-RGB candidates.

### ORAL IDa050

#### Disentangling the mixed chemical environment of V510 Pup with ALMA

Mark A. Siebert

V510 Pup is a binary post-AGB star surrounded by an extremely fast ( $>150\text{km/s}$ ) bipolar pre-planetary nebula that shows signs of mixed C- and O-rich chemistry. To characterize its complex morphology, we obtained high fidelity ALMA observations mapping its continuum and molecular emission. The lines trace three distinct structures: (1) the high-velocity bipolar outflow (CO, SiO), (2) a compact, expanding circumbinary disk (SO, SO<sub>2</sub>), and (3) a secondary, off-axis bipolar structure (HC<sub>3</sub>N, CN, CS). The morphological separation of C- and O-rich products confirms that they arise from separate ejection events, offering new insights into the chemical evolution of this unique binary.

### ORAL IDa051

#### Resolving morphological and chemical complexity in Carbon-rich AGB envelopes with ALMA

Ramlal Unnikrishnan, Elvire De Beck, Lars Nyman, Hans Olofsson, W. H. T. Vlemmings, Matthias Maercker, Miora Andriantsaralaza

The morphological and chemical characterization of AGB outflows is crucial to several key fields, including wind-driving, PNe shaping, and astrochemistry. However, our current understanding of AGB circumstellar structure and composition is mostly limited to studies of a single nearby star, IRC+10216, owing to past observational constraints. In this talk, I will present results from our high-resolution ALMA observations of a sample of other carbon-rich AGB envelopes, and discuss observed deviations from spherical symmetry, and complex morphology including density enhancements and spiral shells suggestive of binary interactions. I will also present how our precise molecular abundance estimates inform circumstellar chemical/photodissociation models.

### ORAL IDa052

#### Deep mm survey of RRLs towards C-rich planetary nebulae

Teresa Huertas-Roldán, J. Alcolea, D. A. García-Hernández, D. Tafoya, J. P. Fonfría, J. J. Díaz-Luis, A. Manchado, V. Bujarraval, R. Barzaga, M. A. Gómez-Muñoz

The formation of simple and complex molecules is studied in chemically rich astrophysical laboratories like planetary nebulae (PNe). High-sensitivity mm surveys towards the C-rich PNe IC 418 and NGC 7027 show emission features associated to radio recombination lines (RRLs). The analysis and modeling of the spectra using the Co3RaL code confirmed the detection of  $\sim 200$  RRLs of light elements. This is the most extended RRL survey, with most RRLs never reported before. The data confirm the absence of known molecular emission towards IC 418. These high-sensitivity surveys should be crucial to identify unidentified features (UFs) in astrophysical environments.

### **ORAL IDa055**

#### **The dynamical and chemical shaping of evolved star winds by their binary companions**

**Taïssa Danilovich**

Studies resolving the extended circumstellar environments of AGB stars have revealed spirals, discs and bipolar outflows, with the shaping of the gas attributed to interactions with a companion. However, most of these companions are not directly observed, because their light is so strongly attenuated by the dust created around the AGB star. ALMA observations show that warm companions also trigger chemical reactions that alter the wind composition. I will discuss how binarity alters the AGB phase on the way to planetary nebulae.

### **ORAL IDa057**

#### **Probing Magnetic Fields in Evolved Intermediate-Mass Stars: New Observational Insights**

**Laurence Sabin**, Guillermo Garcia-Segura, Lucero Uscanga, Agnès Lèbre, Alexis Lavail, Luis F. Miranda

Magnetic fields are thought to play a key role in the evolution of intermediate-mass stars, particularly in shaping the departure from spherical symmetry during late evolutionary stages. Despite their importance, observational constraints remain limited. We present recent results from our on going efforts to detect and characterize magnetic fields in evolved stars using high-resolution ALMA observations and optical spectropolarimetry. These complementary techniques allow us to explore both large-scale and small-scale magnetic fields, offering new insight into their potential influence on the mass-loss processes and asymmetries in the circumstellar environment.

### **ORAL IDa058**

#### **Is There a Link Between Pulsations in PG 1159 Stars and the Morphology of Their Planetary Nebulae?**

**Paulina Sowicka**, David Jones

PG 1159 stars are hydrogen-deficient pre-white dwarfs. Some of them pulsate and define the GW Vir instability strip. A recent hypothesis suggests that only nitrogen-rich PG 1159 stars, which have a different evolutionary history, exhibit pulsations. We investigated whether the shapes of their surrounding planetary nebulae correlate with the detection of pulsations. Using archival imaging and morphological classifications, we find that certain nebular types may be more common around pulsators. This talk explores that possible connection, which - if confirmed - could link large-scale nebular structure to internal stellar properties and offer a new tool for identifying asteroseismic targets.

### ORAL IDa059

#### **Understanding circumbinary post-AGB disks: new results and interpretations**

Iván Gallardo Cava, Javier Alcolea, Hans Van Winckel, Arancha Castro-Carrizo, Miguel Gómez-Garrido, Teresa Huertas-Roldán, Valentín Bujarrabal

There is a class of binary post-AGB stars surrounded by Keplerian disks, which often exhibit outflows driven by gas escaping from the rotating component. In this work, we present new observational results that improve our understanding of the physico-chemical properties of these disk-bearing systems. Our study presents recent results based on IRAM-30m CO observations, OH maser detections with GBT/NRAO, and dust analysis from NOEMA, revealing the distribution of large and small grains. We also report newly detected fast disk winds, launched by the companion star, detected with MeerKAT. These findings offer valuable insights into disk formation, evolution, and outflow development.

### ORAL IDa060

#### **Post-AGB binaries and their jet-launching companions**

Van Winckel, Hans, De Prins, Toon, Kamath, Devika, Ferreira, Jonathan

We present results of our 16 years long spectroscopic monitoring program of post-AGB binaries we are performing at our Mercator telescope. When we phase-fold the spectra on the orbital period, we detect an absorption component in H-alpha, which appears around superior conjunction. It is now well established that this is due to a high-velocity biconical outflow or jet, which is launched from the accretion disc around the secondary. Our unique dataset offers unprecedented tomographic insight into the geometry, dynamics, and variability of these outflows. We have data of about 35 objects and will present the status of our modeling.

### ORAL IDa061

#### **A Comprehensive Database of Galactic Planetary Nebulae, and Statistical Analysis of A Large Sample**

Yuliang Hong, Xuan Fang

We report on a comprehensive database of Galactic planetary nebulae (PNe) that includes coordinates, nebular morphology, elemental abundances, distances, and central-star binarity, as collected from the literature published over the past two decades. In order to ensure data uniformity, we recalculated the elemental abundances of a significant number of PNe using the published line fluxes. This multi-dimensional database, as cross-matched with the HASH Database in coordinates, enables correlation studies and statistical analyses of an unprecedentedly large sample of PNe in various parameter spaces. Our analysis offers new insights into the PNe population as well as Galactic structure and evolution.

### ORAL IDa062

#### **A Morpho-Kinematic Study of high-ADF Planetary Nebulae: Insights from VLT/UVES High-dispersion Spectroscopy**

**Haomiao Huang**, Xuan Fang, Jorge García Rojas, Xiaowei Liu

We report deep, high-dispersion VLT/UVES spectroscopy of three high abundance discrepancy Galactic PNe, Hf 2-2, M 1-42 and NGC 6153. Careful data reduction was made, enabling position-velocity (PV) mapping. Our morpho-kinematic study of Hf 2-2 and M 1-42 reveals distinct spatial, kinematic, and physical differences between the CEL and ORL emitting regions. Moreover, heavy elements are enriched in the cold gas despite its low  $H^+$  content, suggesting the existence of two gas phases: a cold, metal-rich component and a warmer, normal-metallicity component. Our findings provide new insights into the abundance discrepancy problem and challenge the current understanding of PN chemistry and evolution.

### ORAL IDa063

#### **Investigating a New Evolutionary Channel for Dying Stars**

**Raghvendra Sahai**, Geetanjali Sarkar, Devika Kamath, Michael E. Ressler, Hans van Winckel, Ryan Lau

We discuss an exciting new evolutionary channel identified from a study of evolved stars in the Magellanic Clouds, believed to be driven by a strong binary interaction (e.g., common-envelope ejection) on the RGB, resulting in the formation of dusty post-RGB objects that resemble post-AGB objects. Modeling the SEDs of a sample of LMC post-RGB objects reveals that the observed ejecta masses are far smaller than what is required for a successful RGB-to-post-RGB transition. We report JWST and Herschel results of representative post-RGB objects, and discuss new JWST, ALMA & (far-IR) PRIMA observations that are needed to investigate their formation.

### ORAL IDa064

#### **Characterisation of the dusty envelopes surrounding AGB stars with ultraviolet and X-ray emission**

**Jaime Alonso-Hernández**, Carmen Sánchez Contreras

In this contribution, we present our on going work on the characterization of the dusty envelopes surrounding a newly identified class of AGB stars that, in contrast to typical AGB stars, exhibit ultraviolet excesses and, in some cases, X-ray emission. The presence of high-energy radiation in these AGB stars is likely linked to binarity and accretion processes. We are conducting a comprehensive and systematic study to characterize their circumstellar envelopes, both gas and dust components, and explore the impact of this internal high-energy radiation on the dynamics and chemistry.

### ORAL IDa065

#### **M1-92: AGB interruption and isotopic ratio paradox**

**Elisa Masa**, Javier Alcolea, Miguel Santander-García, Valentín Bujarrabal, Carmen Sánchez Contreras, Arancha Castro-Carrizo, Wolfgang Steffen, Nicholas Koning

The shaping of planetary nebulae on their evolution from AGB circumstellar envelopes to their final form is still a process with many unknown details that pre-planetary nebulae (pPNe) can help to understand. In the newest update of the SHAPE+shapemol modeling tool we include 10 new molecular species to work with, and we put it into practice to study M 1-92, a pPN with a very rich chemistry. With a 3-D morpho-kinematical model we obtain a full description of the physical and chemical properties and analyze the isotopic ratios, finding robust discrepancies in the  $^{12}\text{C}/^{13}\text{C}$  ratio across structures, motivating an ALMA survey.

### ORAL IDa066

#### **Spectral evolution of hot hybrid white dwarfs**

**Filiz Semih**, Klaus Werner, Nicole Reindl, Thomas Rauch

About two-thirds of all central stars of planetary nebulae (CSPNe) have hydrogen-rich atmospheres, representing the hottest phase in the canonical evolution from an asymptotic giant branch star to a hydrogen-rich white dwarf (WD). We performed the most comprehensive non-LTE analysis to date, employing metal line-blanketed models to analyze ultraviolet and optical spectra of 19 DA and 13 DAO WDs, including 9 CSPNe, with effective temperatures above 60,000 K. I will present a comparison of elemental abundances derived from both central stars and their surrounding nebulae and address the persistent challenge of the discrepancy between spectroscopic and parallax distances for CSPNe.

### ORAL IDa067

#### **Asymmetry Revealed in the Wind Forming Region of CW Leo**

**Hyosun Kim**

Recent HST images of the AGB star CW Leo cast doubt on the previously suggested bipolar geometry bisected by a dust lane. However, Gemini-N NIFS observations reveal an asymmetrical distribution of molecular absorption features and a wind velocity profile that varies with position angle, supporting a (bi)conical cavity scenario. Comparison with spiral-shell model velocities suggests an eccentric binary on a nearly face-on orbit, which can be reconciled with the earlier edge-on picture by invoking a second companion. A triple-star model is developed and shown to explain the enigmatic circumstellar features of CW Leo at a pivotal transition toward the post-AGB phase.

### ORAL IDa068

#### **Determining precise orbital solutions for AGB binaries: the cases of R Aqr and Mira**

**Pedro Pablo Campo**, Javier Alcolea, Jean-François Desmurs, José Ángel Docobo, Arancha Castro-Carrizo, Krystian Ilkiewicz, Miguel Gómez-Garrido, Joanna Mikolajewska, Miguel Santander-García, Valentín Bujarrabal,

Many AGB stars appear in binary systems. Determining the orbits of such systems is crucial to understand the physical and dynamical processes that rule their evolution. In this work we present new precise orbital solutions for two benchmark systems with AGB components, Mira and R Aqr. We use the observations available in the literature as well as new ones from ALMA, taken in band 6 and 7, with angular resolutions of 15-20 mas, and relative astrometric precisions of 3 mas or better. We apply our own algorithms to those observations in order to calculate the new orbits.

### ORAL IDa069

#### **New detections of Ni-Fe rich clumps in PNe: tracers of binary evolution?**

**Konstantinos Bouvis**, Hektor Monteiro, Lydia Konstantinou, Panayotis Boumis, Jorge Garcia Rojas, Denise R. Goncalves, Isabel Aleman, Ana Monreal Ibero, Jan Cami

Emission lines from singly ionized iron and nickel are commonly observed in supernovae, supernova remnants, active galactic nuclei (AGN) or Herbig-Haro objects but are rarely detected in planetary nebulae (PNe). I will present results from our thorough examination of archival VLT/MUSE data of 12 PNe. Sixteen nickel-iron clumps are identified, some associated with the low ionization structures, while no emission is detected from the main nebula. Possible links between the clumps and binary central stars or X-ray emission PNe are discussed. Following a machine learning approach and new line diagnostics, we classify 10 of the clumps as shock-dominated nebular regions.

### ORAL IDa070

#### **On the morphology of proto-planetary nebulae**

**Arturo Manchado**, Minia Manteiga, Iker Gonzalez-Santamaria, Eva Villaver

Using Gaia DR3 parallaxes for a sample of post-AGB candidates, we have been able to unequivocally determine their evolutionary stages. This enabled a direct comparison with updated post-AGB evolutionary tracks, leading to estimates of their stellar masses and evolutionary ages, and carbon, nitrogen and oxygen abundances. Out of 146 candidates, we classified 63 as post-AGB stars, 27 as young stellar objects (YSOs), 5 as supergiants, and 51 unconfirmed candidates. Additionally, for a subset of the sample with HST imaging available (14), we observed that very few post-AGB objects exhibit bipolar structures.

### ORAL IDa071

#### **Formation of a Born-Again Planetary Nebula through a Late Thermal Pulse evolution**

**Janis B. Rodríguez-González**, R. Orozco-Duarte, J. A. Toalá, M. M. Miller Bertolami

Born-again planetary nebulae represent a rare and intriguing class of evolved stars that undergo a Very Late Thermal Pulse (VLTP), leading to the ejection of hydrogen-deficient material and the formation of complex nebular morphologies. This work presents a new set of stellar evolution models aimed at exploring the post-AGB evolution of low-mass stars that experience the born-again phenomenon. These are the first models to include a consistent treatment of mass loss during the hydrogen-deficient post-born-again phase, by incorporating wind prescriptions characteristic of [WR]-type central stars of planetary nebulae.

### ORAL IDa072

#### **Physicochemical properties of the circumstellar envelopes of HVCs: AFGL2233**

**Guillermo Quintana-Lacaci**, Marcelino Agúndez, Luis Velilla-Prieto

High-velocity carbon-rich (HVC) stars are rare evolved objects that exhibit both carbon-rich chemistry and properties typical of more massive stars. These sources offer a unique window into late stellar evolution and chemical enrichment. We present a detailed study of AFGL 2233, a representative HVC star, based on interferometric maps and a 3 and 1 millimeter-wave line survey. Over 270 spectral features were identified. Using rotational diagram and LVG modeling, we derived column densities, excitation temperatures, and isotopic ratios. The results reveal a chemically rich envelope and suggest a complex evolutionary history, possibly linked to a transition from an O-rich to a C-rich phase

### ORAL IDa074

#### **Constraining the properties of post-AGB stars using oxygen isotopic ratios**

**Theo Khouri**, Daniel Tafoya, Wouter Vlemmings, Hans Olofsson, Carmen Sánchez-Contreras, Javier Alcolea, José Francisco Gómez, Luis Velilla-Prieto, Raghvendra Sahai, Miguel Santander-García, Valentin Bujarrabal, Amanda Karakas, Maryam Saberi, Iván Gallardo Cava, Hiroshi Imai, Andrés F. Pérez-Sánchez

I will present the study with ALMA of a small sample of six post-AGB stars with thick circumstellar envelopes. In particular, the optically thin lines of isotopologues of CO were used to determine the circumstellar gas mass and the oxygen isotopic ratios of the ejected material. We find all sources to have relatively low initial masses ( $< 2 M_{\odot}$ ) and circumstellar envelopes ejected in at most the last 1500 years, implying high mass-loss rates  $> \sim 10^{-4} M_{\odot} \text{ yr}^{-1}$ . For the four objects with determined spectral types, the central object warmed more than three times faster than expected by evolutionary models.

### ORAL IDa075

#### **Dense, dusty, and asymmetric mass loss from an extreme red supergiant**

Elvire De Beck, Guillermo Quintana-Lacaci, Wouter Vlemmings

Although dense circumstellar material (CSM) around SN Type II progenitors is assumed, the mass loss from these progenitors, red supergiants (RSGs), is generally poorly constrained. We characterized the mass, morphology, and kinematics of dust and gas in the CSM of the extreme Galactic RSG NML Cyg. We find  $0.002 M_{\odot}$  of warm dust, offset from the star and present significantly beyond expected scales. CO emission traces a mass-loss rate of several  $10^{-4} M_{\odot} \text{ yr}^{-1}$ . Additional molecular emission reveals high-velocity components close to the star and we propose the presence of a hitherto unknown binary companion based on CSM structure.

### ORAL IDa076

#### **Understanding the $^{17}\text{O}/^{18}\text{O}$ ratio in evolved nebulae. Evidences for non-standard evolution paths?**

Javier Alcolea, Elisa Masa, Theo Khouri, Miguel Santander-García, Iván Gallardo-Cava, Hans Olofsson, Carmen Sánchez Contreras, Valentín Bujarrabal, Wouter Vlemmings, Daniel Tafoya

Nucleosynthesis models predict abundance ratios that can be used to derive fundamental parameters for stars. In the case of AGB and post-AGB stars, the C/O/N elemental ratio, as well as the  $^{12}\text{C}/^{13}\text{C}$  and  $^{16}\text{O}/^{17}\text{O}/^{18}\text{O}$  isotopic ratios, are of particular interest as they depend on the initial mass of the star. We present our latest results on the C/O  $^{12}\text{C}/^{13}\text{C}$  and  $^{17}\text{O}/^{18}\text{O}$  ratios in 13 post-AGB targets and review the status of the subject: the total number of objects studied to date is 30. Half of the objects have unexpected abundance ratios, suggesting a non-standard evolutionary sequence.

### ORAL IDa077

#### **The PLANetary Nebulae Survey (PLANS) with MUSE**

Ana Monreal Ibero

Planetary Nebulae (PNe), key step in our understanding of the (re)cycling of processed material, are far from being simple entities. They present different levels of symmetry, and within a single PN a wide range of structures can be found from high to low ionization regions, compact high-density knots to low density extended haloes. Likewise, a mix of abundances may be present. Here, we will present "PLANS with MUSE", a program aiming at exploiting extremely deep observations of high surface brightness PNe with MUSE. The program covers a representative range of PNe morphologies, abundances, ionization class, and stellar ages.

### ORAL IDa080

#### **Planetary Nebulae in Star Clusters: Providing New Constrains in Low-to-Intermediate Mass Stellar Evolution Studies**

**Vasiliki Fragkou**, Quentin Parker, Denise Gonçalves, Arianna Cortesi, Albert Zijlstra

A major challenge in stellar evolution is establishing a robust connection between initial and final stellar properties. This link becomes accessible when stars in their final stages are confirmed members of star clusters, enabling independent constraints on their progenitors. We focus on the rare but valuable cases of planetary nebulae in Galactic open star clusters, where both current and progenitor properties can be inferred. These systems not only refine the initial-to-final mass relation for low-to intermediate-mass stars but also reveal extreme and otherwise undetectable planetary nebulae properties, offering unique insights into their diversity.

### ORAL IDa081

#### **Wind accretion in Evolving Symbiotic Systems: The Wind Roche Lobe Overflow realm**

**Raúl F. Maldonado**, Jesús A. Toalá, Emilio Tejeda, Janis B. Rodríguez-González

We present dynamical simulations of accreting symbiotic binaries comprising  $1\text{--}3\ M_{\odot}$  primaries and  $0.7\text{--}1.2\ M_{\odot}$  white dwarf companions, evolved from the red giant branch through the end of the thermally pulsing asymptotic giant branch. Compact orbital configurations are modeled, where mass transfer occurs via wind accretion using a modified Bondi-Hoyle-Lyttleton prescription and, when appropriate, Wind Roche lobe overflow. The simulations include wind drag and tidal forces. Our results provide new insights into binary evolution and assess the conditions under which companion white dwarfs may grow sufficiently in mass to approach the Chandrasekhar limit.

### ORAL IDa082

#### **From AGB to planetary nebulae: wind evolution of low- and intermediate-mass stars**

**Silvia Tosi**, Flavia Dell'Agli, Paolo Ventura, Letizia Stanghellini, Devika Kamath, Marco A. Gómez-Muñoz, D. Aníbal García-Hernández, Stefano Bianchi

Low- and intermediate-mass stars (LIMS,  $1\text{--}8\ M_{\odot}$ ) significantly impact stellar and galactic evolution through substantial mass-loss during post-main-sequence phases. Their cool temperatures promote dust formation, observable from the AGB through to the post-AGB and planetary nebula (PN) stages. In this talk, I will examine the evolution of stellar winds across these phases, focusing on single-star candidates in the Magellanic Clouds and the Milky Way. Analyzing 137 carbon-rich stars, I will show how post-AGB and PN winds trace previous AGB evolution, providing constraints on mass-loss rates and dust production based on spectral energy distributions and color-color diagram analysis.

#### **ORAL IDa084**

##### **The Formation of Neutral Spikes during Planetary Nebulae Evolution**

**Guillermo Garcia-Segura**

Two-dimensional hydrodynamical simulations are presented from the formation up to the late evolution of planetary nebula, for 6 different stellar models from 1 to 5  $M_{\odot}$ . Special emphasis is placed on the formation of neutral spikes, as recently observed by the James Webb Space Telescope. The results indicate that neutral spikes can be detected either at the formation of planetary nebulae or in their decline. In the first case, the temporal window decreases with the mass of the model, ranging from 3,000 years in the 1  $M_{\odot}$  case to 0 for 5  $M_{\odot}$ .

#### **ORAL IDa085**

##### **The Forsaken Ones: What Ignored pPNe Can Teach Us About Nebular Evolution**

**Carmen Sánchez Contreras**, Paula López Dones, Paula Muñoz Cutanda, Javier Alcolea

There is growing concern that the samples of pre-planetary nebulae (pPNe) studied to date –often considered representative of the entire class– may be biased toward objects with complex morphologies and energetic bipolar jets. The Forsaken pPNe project aims to address and eliminate these biases. In this presentation, I will report on the progress of an ALMA CO-based study of the so-called "Forsaken pPNe": a sample of genuine pPN candidates which, despite showing clear indicators of post-AGB circumstellar material, have been systematically overlooked and have lacked follow-up observations until now.

#### **ORAL IDa086**

##### **Hiding in the Light: Uncovering Structures in PNe through $H_2$ Excitation and Kinematics**

**Harriet Dinerstein**, Kyle Kaplan, William Vacca, Daniel Jaffe

While structural features of planetary nebulae are most apparent when manifested as on-sky morphology, they may instead be recognizable only via distinctive excitation and kinematics for certain orientations. To illustrate this methodology, we present  $H_2$  emission spectra obtained with IGRINS (the Immersion GRating INfrared Spectrometer), a high-resolution ( $R \sim 45,000$ ) H and K-band spectrometer. Three young PNe observed at McDonald Observatory were found to host compact, bipolar, fast-moving "bullets" exhibiting thermal  $H_2$  line ratios. In contrast, radiatively excited  $H_2$  emission from a PDR within the expanding central torus of the evolved nebula NGC 6302 was seen with IGRINS-2 on Gemini North.

### ORAL IDa087

#### Geometric correction for Wind accretion in Binary Systems

Jesús A. Toalá, Emilio Tejeda

The Bondi-Hoyle-Lyttleton (BHL) accretion model remains widely used to study mass transfer in binary systems. However, its standard implementation becomes inaccurate when the wind velocity ( $V_w$ ) of the donor is comparable to or less than the orbital velocity of the system ( $V_o$ ), predicting unphysical accretion efficiencies above unity. This regime is critical for binaries hosting AGB stars. We revisit the BHL model and introduce a geometric correction factor that considers the orientation of the accretion cylinder relative to the wind, ensuring realistic efficiencies for  $V_w < V_o$ . We discuss implications for PNe, symbiotic systems and Type Ia supernovae.

### ORAL IDa088

#### Hot Bubbles in Planetary Nebulae with [Wolf-Rayet] stars

Rogelio Orozco-Duarte, Jesús A Toalá, Janis Rodríguez-González, Jane Arthur

Some planetary nebulae (PNe) show extended X-ray emission from hot bubbles in their interiors. The CHANPLANS survey revealed that these bubbles have soft X-ray temperatures ( $T_X = [1-3] \times 10^6$  K) and X-ray luminosities up to  $1 L_\odot$ , with the most luminous associated with [WR]-type central stars. We present radiation-hydrodynamic simulations using the PLUTO code, based on MESA stellar evolution models of [WR]-type stars. These simulations trace the formation and X-ray emission of hot bubbles. Comparisons with H-rich models, observational data of [WR] central stars, and their associated hot bubbles are also discussed.

### ORAL IDa090

#### Infrared properties of Planetary Nebulae with PG1159 central stars

C. Muthumariappan, K. Khushbu, V. Kerni

We study the properties of 26 PNe with PG1159-type central stars known till date using archival photometric data from 2MASS, WISE, and IRAS. Our analysis reveals that PG1159-PNe exhibit significant near-IR emission from hot dust, while their AGB dust is cooler than other PNe groups. We observe strong correlations between IR-luminosity and dust temperature with  $H\beta$  surface brightness ( $SH\beta$ ), although the dust-to-gas mass ratio and IR excess do not show trends. Notably, younger [WR]-, wels-, and normal-PNe show a similar distribution in  $SH\beta$ , highlighting direct origin from AGB stars. Our result also shows the evolutionary connection between [WR]- and PG1159-PNe.

### **ORAL IDa093**

#### **Chemistry in the outflow of OH231.8+4.2**

**Luis Velilla-Prieto**, C. Sánchez-Contreras, M. Agúndez, J. Alcolea, W. Vlemmings, T. Khouri, H. Olofsson, A. Castro-Carrizo, G. Quintana-Lacaci, J.R. Pardo, J. Cernicharo, V. Bujarrabal

We present an updated molecular survey of OH 231.8+4.2 using the IRAM-30m, Yebes-40m, and ALMA telescopes, combined with a chemical analysis. The source exhibits an unusually rich inventory of C- and N-bearing molecules, which goes beyond its O-rich nature, including isotopologues, complex organic molecules, and known precursors. We discuss possible chemical pathways, including those leading to the formation of these and related species within the shock-processed outflow. These results shed light on the complex chemistry of this oxygen-rich evolved star and provide valuable constraints for future modeling of molecule formation in circumstellar environments.

### **ORAL IDa096**

#### **Predictions and shortcomings of proposed evolutionary channels for [WR] and PG 1159 CSPNe**

**Marcelo M Miller Bertolami**

It is currently understood that a sizable minority of all CSPNe show a strongly H-deficient surface composition. The qualitatively similar He, C, N, and/or O abundances suggest that some groups of these stars might be evolutionarily connected. Several evolutionary scenarios –both single and binary– have been devised to explain these stars and their nebulae. In this short presentation, we will discuss the main predictions of the different evolutionary scenarios, both binary and single, and examine their pros and cons in light of current observations.

### **ORAL IDa099**

#### **Identifying merger remnants among planetary nebulae**

**Thomas Steinmetz**

One possible result of a binary system that undergoes common envelope evolution is a violent merge, commonly known as a Luminous Red Nova (LRN). Such objects are difficult to identify without directly observing the spiral-in event of the eruption. This presentation goes over the difficulties in identifying LRNe among classified planetary nebulae, and includes recent observations and results that attempt to make such a distinction.

## **POSTER CONTRIBUTIONS**

### **POSTER IDa001**

#### **X-ray AGB stars: binary progenitors of PNe or symbiotic stars?**

Roberto Ortiz, [Martín A Guerrero](#), Jesús A Toala, Jaroslav Merc, Rodolfo Montez Jr., Diego Alejandro Vasquez-Torres, Janis B. Rodríguez-González, Joel H. Kastner

AGB stars are not expected to be X-ray-emitters, but searches using different facilities have revealed a small fraction of "X-AGBs". Their X-ray emission can be attributed to coronal activity of a companion or accretion onto one, making them candidates for binary progenitors of PNe. Comprehensive investigations of some X-AGBs, such Y Gem and CGCS 6306, have shown them to be bona-fide symbiotic stars where the WD is outshone by the primary AGB. We present here those findings and discuss on the different accretion rate regimes of those systems.

### **POSTER IDa006**

#### **High-resolution spectroscopy of the bipolar proto-planetary nebula Hen 3-1475, the Garden Sprinkler Nebula**

[Valeria Beltrán](#), Miriam Peña, Mudumba Parthasarathy

We present a detailed analysis of high-resolution optical and near-infrared spectra of the proto-planetary nebula Hen 3-1475, obtained in 2006 and 2024. The spectra show prominent stellar lines of Fe I, Fe II, [Fe II], H Balmer and Paschen series, He I, Ca II, [Ca II], O I, and Na I, with several lines displaying P-Cygni profiles and bumps, indicating strong stellar winds up to  $\sim 800 \text{ km s}^{-1}$ . No photoionized nebular lines were found. New features include a probable emerging jet and a broad H $\alpha$  component. NW1 knot spectra from 2024 reveal shocked gas, lacking previously reported ionized lines.

### **POSTER IDa010**

#### **Protoplanetary Nebulae are not the Progenitors of Planetary Nebulae with Close Binary Stars**

[Todd Hillwig](#), Bruce Hrivnak

While proto-planetary nebulae are considered to be the link between AGB stars and planetary nebulae, it has become clear that they must not be the progenitors of PNe with close binary central stars. This has become apparent through our current knowledge of common envelope evolution combined with the observed properties of proto-PNe, PNe, and close binary central stars. We present a review of each of these topics, provide a few newly revised values for some proto-PNe, and explain how we arrive at the ultimate conclusion that proto-PNe are not the progenitors of PNe with close binary central stars.

#### **POSTER IDa014**

##### **Emission characteristics and evolution of Polycyclic Aromatic Hydrocarbons in the Butterfly Nebula as probed with JWST**

**Nicholas Clark**, Els Peeters, Jan Cami, G. C. Sloan, Mikako Matsuura, Kevin Volk, Patrick Kavanagh, Bruce Balick, Roger Wesson, Albert A. Zijlstra, Harriet L. Dinerstein, N. C. Sterling, Michael J. Barlow, Joel Kastner, Jeremy R. Walsh, L. B. F. M. Waters, Naomi Hirano, Isabel Aleman, Jeronimo Bernard-Salas, Charmi Bhatt, Joris Blommaert, Olivia Jones, Kay Justtanont, F. Kemper, Kathleen E. Kraemer, Eric Lagadec, J. Martin Laming, F. Molster, Paula Moraga Baez, H. Monteiro, Anita M. S. Richards, Raghvendra Sahai, Maryam Torki, Peter A. M. van Hoof, Nicholas J. Wright, Alexander Csukai

JWST MIRI-MRS observations of the O-rich planetary nebula NGC 6302 (the Butterfly Nebula) reveal unexpectedly large spatial variations in the PAH features (width, sub-structure, relative strength). This behavior is seldom observed in planetary nebulae to date. We present an analysis of four spatially distinct PAH emission regions across the object. Feature ratios imply a largely cationic PAH population with a range of edge geometries, linked to local UV flux and density. These trends offer new clues to PAH formation, processing, and survival in O-rich, highly asymmetric and irradiated environments, as found in the dense tori of some planetary nebulae.

#### **POSTER IDa015**

##### **Dust destruction by supernova remnants in a stellar wind bubble**

**Tassilo Scheffler**, Nina Sartorio, Florian Kirchschrager, Ilse De Looze, Michael Barlow, Franziska Schmidt

Before its explosion, massive stars often sweep up interstellar dust into dense shells due to stellar winds. Normally, the SN shock would destroy most of this dust, but dense enough shells can stop the shock and shield most of the ISM dust. In a turbulent medium, it is unclear whether the shell is strong enough to provide such shielding. To study this, we run hydrodynamic simulations where winds evolve in a turbulent ISM, then inject an SN and study the dust destruction by its forward shock.

#### **POSTER IDa016**

##### **Triple central star of PN K 1-6 and its puzzling variability**

**Jaroslav Merc**, David Jones, Ana Escorza, Henri M. J. Boffin, Paulina Sowicka

K 1-6, identified as a planetary nebula (PN) candidate by Czech astronomer Kohoutek in the 1960s, remained largely unstudied since then due to its faintness. Gaia DR3 data allowed us to confirm the hierarchical triple nature of its central star. While triple evolution is often invoked to explain morphologies of many PNe, direct evidence remains very rare. Motivated by the peculiar variability of the system, we also present new multi-color photometry from our own follow-up, ground-based surveys, and TESS, along with multi-epoch NOT and TNG spectroscopy.

## POSTER IDa018

### Detection of $\text{CH}^+$ in the O-rich planetary nebula NGC 6302

**Charmi Bhatt**, Jan Cami, Els Peeters, Nicholas Clark, Paula Moraga Baez, Kevin Volk, Greg C. Sloan, Mikako Matsuura, Joel Kastner, Bruce Balick, Harriet L. Dinerstein, Kay Justtanont, Olivia Jones, Raghvendra Sahai, Kathleen E. Kraemer, Isabel Aleman, Michael J. Barlow, Jeronimo Bernard, Joris Blommaert, Alexander Csukai, Naomi Hirano, Francisca Kemper, J. Martin Laming, Eric Lagadec, Franck Molster, Anita M.S. Richards, Nick C. Sterling, Jeremy R. Walsh, Peter A.M. van Hoof, Nicholas J. Wright, L.B.F.M. Waters, Albert A. Zijlstra

We present the discovery of the methyl cation ( $\text{CH}^+$ ) in JWST MIRI/MRS observations of the O-rich planetary nebula NGC 6302.  $\text{CH}^+$ , which is a key driver of organic chemistry in irradiated astrophysical environments, is detected for the first time in a planetary nebula. In NGC 6302, the  $\text{CH}^+$  emission is bright along the dusty torus and a bubble. Comparing its spatial distribution with that of  $^{12}\text{CO}$ ,  $\text{H}_2$ ,  $\text{HI}$ ,  $\text{HCO}^+$ , and PAHs shows that UV irradiation is key to the formation of  $\text{CH}^+$ , which itself is only the first step to drive a rich carbon chemistry in irradiated O-rich environments.

## POSTER IDa019

### JWST Observations of Tc 1: Tracing Fullerene-Linked Dust Variability

**Simon Van Schuylenbergh**, Jan Cami, Els Peeters, Morgan Giese, Charmi Bhatt, Dries Van De Putte, Cedric Baerts, Michael J. Barlow, Jeronimo Bernard-Salas, Alessandra Candian, Bryan Changala, Nick Cox, Harriet Dinerstein, Vincent Esposito, Aníbal García Hernández, Marco Antonio Gómez Muñoz, Kay Justtanont, Kathleen E. Kraemer, Eric Lagadec, Arturo Manchado, Ana Monreal Ibero, Raghvendra Sahai, Ameek Sidhu, Greg Sloan, Nicholas C. Sterling, A.G.G.M. Tielens, Jeremy Richard Walsh, Roger Wesson, Joshua Cole Whitman, Albert Zijlstra

JWST MIRI/MRS observations of the planetary nebula Tc 1 - a benchmark fullerene source - reveal important new details about the peculiar mid-IR dust emission shared by all fullerene PNe. These include four broad “plateau”-like emission with substructure between 6 and 30 micron. We present a combined spectral and spatial analysis of these dust features and find that their strength and, in some cases, also their shape vary throughout the field of view. Analysis of these variations yields important clues to the formation and excitation of  $\text{C}_{60}$ , and to evolutionary events that are crucial to explain these unique environments.

## POSTER IDa022

## DROPPED!

### Molecular line variability of three post-AGB stars in the YJH bands

Aija Grankina, Kārlis Puķītis

Stellar wind in the beginning of the post-asymptotic giant branch phase determines evolutionary rate of the star and contributes to shaping of the subsequent planetary nebula. This wind can be probed by molecular vibration-rotation lines, such as CO features in the near-infrared. We have observed YJH-band high-resolution spectra of IRAS 22272+5435, IRAS 20229+6208, and IRAS 20000+3239. Molecular lines are found to significantly vary in intensity, shape, and radial velocity during the pulsation period. Also, change between absorption and emission is observed, and it appears to be dependent on the pulsation phase.

### POSTER IDa023

#### **The asymmetric and puzzling recent mass ejections of Mira A**

[Theo Khouri](#), David Raudales Oseguera, Wouter Vlemmings, Daniel Tafoya, Hans Olofsson, Claudia Paladini, Matthias Maercker, Taïssa Danilovich, Maryam Saberi, Prasanta Gorai

I will present observations acquired over eight years of light polarized through scattering off dust and of molecular emission, which reveal a recent ejection of matter in the close vicinity of Mira A evolving in real time. The ejected material is confined to two high-gas-density lobes. Dust is well traced in one of the lobes and is seen to be mostly confined to a shell surrounding the gas lobe. The measured ejected gas mass and the distribution of the dust with respect to the gas make this event puzzling under the light of the current mass-loss paradigm of AGB stars.

### POSTER IDa025

#### **3D Physical Structure of the H-deficient Ejecta of the Born-Again Planetary Nebulae A 30 and A 78**

[Borja Montoro Molina](#), Martín A Guerrero, Jesús A. Toalá, Edgar I Santamaría

The planetary nebulae (PNe) A 30 and A 78 are among the best-studied born-again PNe, objects whose central stars experienced a very late thermal pulse (VLTP). However, the morpho-kinematic evolution of the central ejecta, responsible for the observed "disk-jet" structures, remains unclear. New high-resolution GTC 10.4m MEGARA observations provided radial velocities for all knots. Combined with their proper motions in the sky plane available in the literature, this offers a unique opportunity to determine the inclination and true space velocity of each knot without geometrical assumptions, enabling the first fully assumption-free 3D model of ejecta in a born-again PN.

### POSTER IDa029

#### **Structure-Dependent Common Envelopes Have Observable Lightcurves**

Emily Wilson, [Jason Nordhaus](#), Nikki Noughani

The outcomes of common envelope events (CEEs) of binary stars have been found to be dependent on the internal structure of the primary star at the time of engulfment. When convection is included in 1-dimensional models of CEEs, ejection is delayed allowing for the formation of short-period binaries, which match observations of populations of double white dwarfs and Wolf-Rayet binaries. The energy of the inspiraling companion, which is transported by convection, may produce observable and distinct light-curves allowing for early detection of CEEs and subsequent outflows.

## **POSTER IDa040**

### **The Rise and Fall of HuBi 1**

**Zhengjie Tian**, Quentin Andrew Parker, Seyed-Abdolreza Sadjadi

HuBi 1 is a born-again PNe that underwent a very late thermal pulse (VLTP). The previous research suggests it experienced a rapid brightness decline over five decades, mostly attributable to dust obscuration formed through VLTP. Furthermore, VLTP-born-again objects experience a brightening phase due to the expansion of the star driven by the He-shell flash before the formation of the dust. In this study, we present the most comprehensive light curve data of HuBi 1, which reveals a brightening process first time. Through this, we reconstructed the evolutionary history of HuBi 1 and estimated its dust mass.

## **POSTER IDa043**

### **Decoding the Complex Structure of NGC 2371: A Morpho-Kinematic Approach**

**Roberto Vázquez**, Jesús A. Toalá, Sandra A. Ayala, María E. Contreras, Marco A. Gómez Muñoz, Pedro F. Guillén, Luis F. Miranda, Lorenzo Olguin, Gerardo Ramos-Larios, Laurence Sabin, Federico Soto-Badilla

We present a detailed morpho-kinematic study of the planetary nebula NGC 2371 based on high-resolution spectra obtained with the Manchester Echelle Spectrograph at SPM (Mexico). Using the ShapeX software, we constructed a 3D model that reproduces the main structural components observed in [O III] and [N II] emission lines, including an elliptical barrel, extended bipolar lobes, and asymmetric jet-like knots. Our results reveal complex spatio-kinematic features with distinct velocity fields and suggest an evolutionary scenario involving successive ejection episodes. This work highlights the potential role of binary interaction and environmental conditions in shaping the observed morphology.

## **POSTER IDa048**

### **Deep and large-scale images of extended PNe in the J-ALFIN framework**

**Faezeh Bijarchian**, Martin A Guerrero and the J-ALFIN Consortium

Mapping the most evolved PNe and their largest scale structures provides us the means to assess the time-scale and spatial-scale of their dispersal in the Galaxy. We present here the project J-ALFIN aimed at the acquisition of deep, large field-of-view images of PNe and its preliminary results. J-ALFIN is expected to allow us to investigate the late stages of the feedback of PNe to the ISM.

**POSTER IDa049****Discovery of an exotic red supergiant in the massive stellar cluster RSGC2**

**Mark Siebert**, Elvire De Beck, Guillermo Quintana-Lacaci, Wouter Vlemmings

In surveying the mass loss properties of RSGs in the massive cluster RSGC2 with ALMA, we uncovered a surprising outflow toward one source: DFK52. Through CO and continuum mapping, we find that this RSG harbors an extremely large outflow ( $\sim 100,000$  au diameter), which shows complex structures in its molecular and dust distributions. The size of the circumstellar medium is unprecedented even when compared with other extreme RSGs, and the star's smaller luminosity requires a unique ejection mechanism. We suggest that DFK52 underwent a dramatic asymmetric mass loss event  $\sim 4000$  years ago, however the exact nature of this event remains unknown.

**POSTER IDa053****H<sub>2</sub>O and SiO masers survey toward very young proto Planetary Nebulae.**

**Jean Francois Desmurs**

We will present the results of a pilot study of silicon monoxide (SiO) maser lines at 43 GHz (including the  $v=0, 1, 2, 3, 4$ ,  $J=1-0$  lines of the isotopes  $^{28}\text{SiO}$ ,  $^{29}\text{SiO}$ , and  $^{30}\text{SiO}$ ). These lines were observed simultaneously with the water maser at 22 GHz. Our source catalog includes 43 proto-planetary nebulae that have been detected in recent years, as well as other young planetary nebulae.

**POSTER IDa054****Diagnostics for Nebula Identification using Machine Learning**

**Maria Kopsacheili**, Konstantinos Bouvis, Lydia Konstantinou, Stavros Akas, Panayotis Boumis

Nebulae, such as H II regions, planetary nebulae (PNe), and supernova remnants (SNRs) are key to understanding galactic evolution through their feedback on the interstellar medium (ISM). In 2020, model-based diagnostics were developed to distinguish SNRs from H II regions. Applied to IFU data, these techniques revealed hundreds of new SNRs. In this poster, we present the diagnostic methods and the newly identified SNRs. We also introduce extended diagnostics that now include PNe and account for a wider range of physical conditions, improving the classification of emission nebulae using machine-learning techniques.

### POSTER IDa056

#### **Stellar Remnants and Their Environments: A Multi-Faceted Approach to Late Stellar Evolution**

Marissa Botello Nava, Diego Ochoa , Iridian Castrejon, Daniel Mera Valverde, Amairani Leon Garcia, Ana Vanessa Gonzalez Campista, Gustavo García, [Laurence Sabin](#)

We present ongoing research by postgraduate students at the Institute of Astronomy, UNAM (Ensenada), on late stellar evolution. The projects focus on exoplanets, planetary nebulae, symbiotic stars, and post-AGB objects. Efforts include developing pipelines to detect WDs transiting exoplanets and low-activity accreting symbiotic stars, uncovering new PNe, analyzing under-observed fields to unveil cataclysmic variables, applying machine learning techniques to classify post-AGB stars, and studying dust in symbiotic systems. ICFs and chemical abundances calculation methods are also being tested. These investigations aim to improve detection techniques and deepen our understanding of stellar remnants and their environments.

### POSTER IDa073

#### **Possible correlations between morphology, kinematics, and physical-chemical conditions in bubble-like planetary nebulae**

[Federico Soto-Badilla](#), R. Vázquez

This project analyzes 12 poorly studied planetary nebulae with bubble-like morphologies using long-slit spectroscopy and imaging. High-dispersion spectra provide kinematic parameters and 3D morpho-kinematic models, while low-dispersion data yield spatially resolved physical and chemical properties. The goal is to explore correlations between morphology, kinematics, and physical-chemical conditions. Observations were conducted with MEZCAL and Boller & Chivens spectrographs at the San Pedro Mártir astronomical observatory, México. Future work includes direct imaging, multi-wavelength data analysis, and potential integration of magneto-hydrodynamic. The results will enhance our understanding of the shaping processes and late stellar evolution stages.

### POSTER IDa078

#### **Investigating the knots in the Balmer-dominated LMC supernova remnant 0509-68.7 using MUSE/IFS**

Theodossiou Sofia, Boumis Panos, Akras Stavros, Kopsacheili Maria, Bouvis Konstantinos, Konstantinou Lydia

Using MUSE/IFS data, we investigate the nature and optical characteristics of the Type-Ia Balmer-dominated LMC SNR0509-68.7. Based on the knots, we identified 119 emission lines, where we detected high ionization coronal Fe lines ([Fe VII], [Fe XIV]) that reveal a previous position of the reverse shock-front. We constructed emission line maps, showing that [O I] and [O III], seemingly associated with the shell, have a pre-shock origin. We derived  $n_e=4000\text{--}10^6\text{ cm}^{-3}$  and  $T_e=6000\text{--}13000\text{ K}$ , using [S II] 6716/6731 or [Fe III] 4881/4931, and [O I] 5755/(6300+6364), respectively. Using diagnostic diagrams, we conclude that the knots radiate due to the ionization of the circumstellar matter by multiple shock-waves that followed the explosion.

### POSTER IDa083

#### **Timeline of knowledge about low-ionization structures in planetary nebulae.**

**Lydia Konstantinou**, Konstantinos Bouvis, Denise Gonçalves, Stavros Akras, Gerardo Ramos-Larios, Isabel Aleman, Panos Boumis, Mari Belen

Since the first Hubble Space Telescope images, planetary nebulae (PNe) have been known to possess small-scale structures, which challenge the wind-interaction model of formation. These microstructures, also known as LISs, exhibit enhanced emission lines from low-ionization species (LISs), such as [N II]  $\lambda 6584$ , [S II]  $\lambda\lambda 6716/31$ , and [O I]  $\lambda\lambda 6300/63$ . LISs are also characterized by electron densities equal to or lower than their surrounding medium, which was perplexing to understand their nature. State-of-the-art instruments and recent observations have unveiled new insights into LISs, prompting a comprehensive analysis in different mass components and across various spectral ranges.

### POSTER IDa091

#### **The influence of central star in the slope of the ionization tendency of planetary nebulae**

**Daniela Barria**, Kiara Angel

The investigation of gaseous nebulae is often based extensively on diagnostic diagrams. The special physics of these lines allows studying the properties of the photo-ionizing radiation field as well as the nebular plasma. Diagnostic diagrams are usually used for the investigation of planetary nebulae as a total. Here, we investigated the extension of such properties towards spatially resolved 2D diagnostic diagrams (DDs) at 15 symmetric and asymmetric PNe, using HST/WFPC2 narrow band images. Extended 2D ( $H\alpha$ /[S II]) vs. ( $H\alpha$ /[N II]) DDs were used to estimate the gradient of the main ionization tendency and thus investigate its connection to the central stars.

### POSTER IDa094

#### **The Art of Shaping Carbon: Tc 1 as a Laboratory for Fullerene Chemistry**

**Jan Cami**, Jeremy Walsh, Morgan Giese, Simon Van Schuylenbergh, Charmi Bhatt, Dries Van de Putte, Els Peeters, Michael J. Barlow, Jeronimo Bernard-Salas, Alessandra Candian, Bryan Changala, Nick L.J. Cox, Harriet Dinerstein, Anibal Garcia-Hernandez, Marco Antonio Gomez-Munoz, Kay Justtanont, Kathleen E. Kraemer, Eric Lagadec, Arturo Manchado, Ana Monreal Ibero, Raghvendra Sahai, Ameet Sidhu, Greg Sloan, Nicholas C. Sterling, Roger Wesson, Joshua Cole Whitman, Albert Zijlstra, Isabel Aleman

Tc 1 is the archetype of fullerene-rich planetary nebulae, offering a unique window into the environments where fullerenes form and are excited. We present a spatially resolved, multi-wavelength study combining VLT/MUSE, Gemini, and JWST/MIRI observations. From the optical atomic lines, we derive the physical conditions and extinction structure across the nebula. All datasets reveal a consistent morphology: a seemingly round nebula with an inner horseshoe-shaped region, a ring where  $C_{60}$  emission peaks, embedded low-ionization structures, and a faint, highly structured outer halo. The origin of these features –and their relation to the peculiar chemistry of this source– remains unclear.

## **POSTER IDa095**

### **3D visualization of nebular remnants**

Edgar I Santamaría, [Martín A Guerrero](#), Jesus A Toala, Laurence Sabin

The 3D visualization of nebular remnants provides critical insights into their complex morphological structures, chemical composition, and dynamical evolution. Unlike traditional 2D imaging, it enables analyzing the spatial distribution of gas and dust with higher precision, advancing our understanding of mass ejecta and their interactions with the ISM. This study employs advanced computational techniques, including volumetric rendering, to generate immersive 3D representations of nebular remnants (e.g., nova shells or PNe) from integral field unit (IFU) spectroscopy data. 3D visualization enhances the interpretation of kinematic features, asymmetries, and emission-line structures, offering a powerful tool for analyzing spectral data cubes.

## **POSTER IDa097**

### **Exploring the occurrence of intermediate neutron-capture process in very late thermal pulses. Preliminary results**

Tiara Battich, [Marcelo M Miller Bertolami](#)

Stellar evolution computations predict the occurrence of thermal pulses after departure from the AGB in a sizable minority of simulations. These "late" thermal pulses are among the most successful evolutionary channels for explaining the properties of C-rich, H-deficient CSPNe. A subgroup of these events—very late thermal pulses (VLTPs)—leads to violent H burning in the hot He- and C-rich interior. These conditions are qualitatively similar to those required for the occurrence of the intermediate neutron-capture process. We use the recently developed Astrophysical Nucleosynthesis Tool (ANT) to explore the formation of trans-iron elements in VLTPs.

## **POSTER IDa098**

### **Pulsational instabilities in post-AGB stars: initial exploratory calculations of variable pPNe central stars**

Alejandro Córscico, [Marcelo M Miller Bertolami](#), Bruce Hrivnak

The central stars of pre-Planetary Nebulae (pPNe) are transitional objects (F3–G8) with masses in the range  $0.5\text{--}0.8\text{ M}_{\odot}$ , classified as luminosity class I and II. They correspond to a very short evolutionary stage (timescales of 10–1000 years) immediately after the Asymptotic Giant Branch (AGB) phase and before the Planetary Nebula phase. Some central stars of pPNe exhibit brightness variations with periods in the range of  $\sim 35\text{--}150$  days, which are suspected to be due to radial pulsations. We present the first results of adiabatic radial pulsation calculations of variable pPNe central stars and compare them with observations.

**POSTER IDa100**

**X-ray and Optical Observations of RV Tau Variable Stars**

Rodolfo Montez, Jr, Nick Graber, Rachel Nere, Laura Vega

RV Tau variable stars (RVTs) are cool luminous stars with characteristic pulsations believed to lie between the post-AGB and PN phases. A 10 MK plasma detected from RVT U Mon revealed the potential complex relationship to binary stellar evolution, leading us to wonder how common X-ray emission might be from RVTs. We studied new and serendipitous X-ray observations of RVTs and verified/refuted some classifications using optical observations from the All Sky Automated Survey for Supernova (ASAS-SN). From the resulting confirmed sample, we were able to draw stronger conclusions on the lack of X-ray emission detected from RVTs

**POSTER IDa101**

**Classification of Galactic PNe Using the HASH Database and ML Techniques**

Aleyna Demirci, Nurullah Erzincan, Nazim Aksaker, Aysun Akyüz, Quentin A. Parker

We present a classification study of 149 Galactic planetary nebula (PN) candidates using spectral data from the HASH database. Emission lines were measured with the ALFA code, and both classical diagnostic diagrams (SMB, BPT) and a supervised machine learning model (CatBoost) were applied to distinguish PNe from H II regions and supernova remnants. The ML model, trained on 103 labeled sources and enhanced by SMOTE, achieved high classification accuracy. This hybrid approach enhances the reliability of PN identification and contributes to refining the Galactic PN census.

**POSTER IDa102**

**DROPPED!**

**Emerging planetary nebulae within 3D spiral patterns in circular and elliptical orbits**

Verónica Lora

We present 3D radiation-hydrodynamic simulations of the formation of planetary nebulae emerging from 3D spiral patterns. These structures form as a consequence of the distortions on the geometry of the intrinsically isotropic wind of an AGB star produced by a companion star in a circular and elliptical orbits. By adopting a phase of jet ejections between the AGB and post-AGB stages, we are able to recover the morphologies of proto-PNe and PNe that exhibit ring-like structures in their haloes.