Revista Mexicana de Astronomía y Astrofísica Serie de Conferencias, 60, 148-163, (2026)

"XVII LARIM", Montevideo, Uruguay, November 27 - December 1, 2023.Volume Editors: Gonzalo Tancredi, Cecilia Mateu & Juan José Downes

Ylgr stellar stream elemental abundances

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https://doi.org/10.22201/ia.14052059p.2026.60.122

Stellar streams are spectacular evidence of satellite disruption, which might originate from globular clusters (GCs) or massive mergers like Sagittarius, Kraken, Sequoia, or Gaia-Sausage-Enceladus (GSE). However, the elemental abundances properties of these objects have been poorly studied. We have obtained near-IR (H-band) high-resolution (R=45000) spectra for four stars in the Ylgr stellar stream with IGRINS/GEMINI spectrograph to obtain elemental chemical abundances for the first time for this stream. Ylgr is a metal-poor group of stars with $\langle[\mathrm{Fe/H}]\rangle = -1.87$. Additionally, it exhibits depleted carbon and aluminum abundances with respect to the solar values. Despite the small sample, the abundance patterns in the Al-Si, Al-Mg, Ce-Al and Si-Mg planes show a behavior more similar to that of the GSE dwarf galaxy than to clusters. This outcome could indicate a dwarf galaxy progenitor for the Ylgr stellar stream.

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Revised distances for blue horizontal-branch stars based on SDSS photometry

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https://doi.org/10.22201/ia.14052059p.2026.60.123

Stars in the helium-burning phase form a horizontal structure on the colour-magnitude diagram. As they exhibit approximately constant luminosities, the so-called "horizontal-branch stars" can be used as standard candles. In this project, we work with the blue horizontal-branch (BHB) stars, the most metal-poor population in this evolutionary stage, which are excellent objects to explore the outermost regions of the Galaxy. About 5700 BHB stars were found in the sixteenth data release of the Sloan Digital Sky Survey catalogue, selected by photometric and spectroscopic data, and individual probabilities of being a BHB star were assigned based on surface gravity distributions. To determine the photometric distances, we reanalyzed the relation for their absolute magnitude using the *ugriz* system and Gaia distances for globular clusters. We proposed a relation using the colour $(u - r)_0$, besides $(g - r)_0$, to estimate the distances. These new simpler relations present reasonable improvements over previously available ones, especially for stars beyond ∼40 kpc from the Sun. From the distances obtained, inferred ages and the kinematic information available for the BHB stars, we aim to explore the streams found in the Galactic halo and learn more about the formation history of the Galaxy.

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Revista Mexicana de Astronomía y Astrofísica Serie de Conferencias, 60, 148-163, (2026)

"XVII LARIM", Montevideo, Uruguay, November 27 - December 1, 2023.Volume Editors: Gonzalo Tancredi, Cecilia Mateu & Juan José Downes

The nature of the enigmatic highly-variable high-mass young stellar object Mol 1: What we know

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https://doi.org/10.22201/ia.14052059p.2026.60.124

Since the discovery (Tapia et al. MNRAS 485, 764, 2019) as a high-mass Class I young stellar object (HMYSO) with large amplitude light variations, Mol 12 (IRAS05373+2349) has been observed extensively. It is at a distance of 1.59 kpc, as determined by VLBI parallax to an associated water maser. This is consistent with a more uncertain Gaia DR3 determination. It is reddened by $A_V > 16$ and has a total luminosity of $1.74 \times 10^3 L_\odot$. SED fitting provides likely stellar, disc, and envelope parameters. Mol 12 drives a bipolar CO outflow that excites a number of nearby shocked knots of molecular hydrogen emission. Light curves of Mol 12 spanning several decades, from red to mid-infrared wavelengths, show a capricious behaviour. It exhibits chaotic variations of more than 5 magnitudes in the J band (1.25 μm), with colour changes that suggest the occurrence of a series of eclipses by dust structures, presumably outliers of the protoplanetary disc. These cause up to 25 V-band magnitudes of extra extinction, in addition to possible changes in accretion luminosity. Medium-resolution spectra from 0.6 to 2.3 μm show numerous emission atomic lines, including C I, N I, Ca II, Mg I, Si I, Fe I, and Fe II, likely originating from the inner zones of the disc. Notably, we detected the He I 1.0830 μm line with a complex P-Cygni profile, indicating the presence of strong inner disc winds accompanied with high accretion. No photospheric absorption lines were found. Strong first overtone CO emission band-heads were detected at 2.3 μm, probably arising in the inner disc. These features, plus the derived total luminosity combined with the presence of associated compact HII region and water maser, lead us to propose that Mol 12 is a Herbig Be star at its earliest phases of detectable life. The observed irregular eclipses are probably caused by dusty fragments of remnant disc material, yet to be modeled. We note that Mol 12 has many of the observed peculiarities with the less luminous T Tauri star RW Aur A.

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Variability in B supergiant stars: a theoretical and photometric approach to pulsation modes and detection of binary systems

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https://doi.org/10.22201/ia.14052059p.2026.60.125

B supergiant stars evolve from O-type stars, however, there is still much uncertainty about their evolution after they leave the main sequence. The asteroseismological study of light curves of massive supergiant stars has revealed that they all pulsate in specific modes, defining regions of instability at the top of the HR diagram. Studying pulsating stars in binary systems is essential for exploring the internal structure of stars and verifying evolutionary models, as they allow the masses of each component to be measured accurately and independently. However, detecting binary systems among evolved B stars is challenging, either because of observational bias or, perhaps, due to the intrinsic variability of the more evolved primary component, leading to light curves and spectra variations. To improve our knowledge of these phenomena, light curves of a sample of massive stars, with L/M ratio ≥ 4, observed with the TESS satellite were studied to determine their periods and quasi-periods, which could be associated with pulsation, binarity, or both. In addition, the pulsation modes were studied based on a linear non-adiabatic model and compared with the observationally detected frequencies, to estimate a theoretical mass for these stars and address the mass discrepancy problem. To obtain a detailed description of the periodic behavior of the signals, two complementary tools were used: the Lomb-Scargle periodogram and the Weighted Wavelet Z-Transform.

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Revista Mexicana de Astronomía y Astrofísica Serie de Conferencias, 60, 148-163, (2026)

"XVII LARIM", Montevideo, Uruguay, November 27 - December 1, 2023.Volume Editors: Gonzalo Tancredi, Cecilia Mateu & Juan José Downes

Exploring the uncertainties in mixing processes of low-mass stars: preliminary results

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https://doi.org/10.22201/ia.14052059p.2026.60.126

During the many phases of stellar evolution many different convective zones develop and alter the chemical stratification of the star. Mixing Length Theory (MLT) is commonly used in astrophysics to treat convection and this theory only takes into account convective motions arising from adiabatic perturbations, and usually neglects the impact of chemical gradients (i.e. it usually adopts the Schwarzschild instability criterion). Grossmann et al. proposed a more general theory of convection (from now on GNA) in which the impact both of chemical gradients and thermal diffusion is taken into account. This implies that besides the standard thermally driven convection other regimes, such as, chemically driven convection (Rayleigh–Taylor convection), fingering convection (thermohaline mixing), and semiconvection arise.

Both at the end of helium core burning and during the thermal pulses in the Asymptotic Giant Branch (AGB) a process of stratification takes place in which heavier mixtures are left lying on top of lighter ones. This stratified chemical structure should be unstable either to Rayleigh-Taylor instabilities or the much slower fingering convection.

In this work we explore this mixing processes in stellar models of $3M_{\odot}$ and $1M_{\odot}$ considering both MLT and GNA convection theories. Our work shows that mixing processes induced by negative mean molecular weight gradients, are able to iron out carbon-oxygen (CO) chemical profiles both in the inner and outer CO-core. This happens before the star reaches the end of the AGB. In future works we will expand this exploratory works and assess the impact of these processes on the oscillation frequencies of pulsating pre-white dwarfs.

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Dense gas kinematics in the massive G351.77 protocluster: ALMA-IMF large program observations of N_2H^+

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https://doi.org/10.22201/ia.14052059p.2026.60.127

From the ALMA-IMF Large Program (LP) we got access to the massive filamentary protocluster's observations G351.77, located ~ 2 kpc. We accessed to N_2H^+ line emission of the dense gas, down to ~ 2 kAU resolution. Our main data consists of ALMA observations in the 3 mm spectral band, N_2H^+ line with 7M and 12M arrays, and Total Power (TP) antennas. Moreover, we have used additional data from the LP, such as core catalogs derived from the 1.3 mm band, spectral line fits kinematics of DCN, integrated intensity and mean velocity of H_2CO, and H_2 column density map. To recover the emission, the 7M and 12M arrays were both combined and reduced to then be feathered with TP. The N_2H^+ hyperfine line profile is modeled with PySpecKit, fitting two velocity components, obtaining excitation temperature, optical depth, centroid velocity and line width for each component. In combination with optical depth and the H_2 column density map, we estimated the N_2H^+ relative abundance $\sim (1.66 \pm 0.46) \times 10^{-10}$. Measuring a total H_2 mass $\sim 1660 \pm 460$ $M_{\odot}$. By examining the Position-Velocity diagrams (PV) at small scales, we observe clear infall signatures (V-shapes) associated with 1.3 mm cores. The most prominent V-shape has an average of mass inflow rate $\sim (4.08 \pm 1.62) \times 10^{-4}$ $M_{\odot}$/yr, and an average timescale $\sim 21 \pm 1.7$ kyr. The PV on large scales shows two clear filamentary structures in N_2H^+ separated both in space and velocity. H_2CO and DCN cover most central regions, where there is no N_2H^+ emission. They provide additional information on the central part of the protocluster, whose PV shows signatures of rotation and infall, being consistent with the N_2H^+ velocities of the PV at large scales.

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Revista Mexicana de Astronomía y Astrofísica Serie de Conferencias, 60, 148-163, (2026)

Dynamos in partially convective M dwarfs

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https://doi.org/10.22201/ia.14052059p.2026.60.128

M dwarfs are low-mass main-sequence stars, which are the most common type of star in the galaxy. It is well known that they have significant magnetic activity but the mechanism that controls this is still unclear. M dwarfs more massive than 0.35 $M_\odot$ are partially convective, and this transition marks an important change in stellar structure that can affect the production and storage of internal magnetic fields. The aim of this work is to test a new computational model for the dynamo of partially convective M dwarfs. This model consists of three-dimensional magnetohydrodynamical (MHD) numerical simulations using the star-in-a-box model, where we consider a star of radius R in a Cartesian cube of size $(2.2R)^3$. Within this model, we change the magnetic boundary condition to see how this affects the dynamo and also explore different rotation rates. Up to now, we have observed clear cycles in three of our simulations with different rotation rates, while the others have dynamos that are quasi-static. In addition, we present an exceptional case where the magnetic field disappears and reappears. Furthermore, we found that $P_{\rm rot}/P_{\rm cyc} \propto {\rm Co}^\beta$ with $\beta = -1.15 \pm 0.17$ that is consistent with earlier studies where $\beta < 0$ was found for global simulations of solar-type stars.

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Core dynamo simulations of A-type stars

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https://doi.org/10.22201/ia.14052059p.2026.60.129

Early-type stars have convective cores due to a steep temperature gradient produced by the CNO cycle. One of the subclasses of these stars is the chemically peculiar Ap and Bp stars, which host large-scale magnetic fields in the range of 200 G to 34 kG. Two of the hypotheses to explain these fields are the fossil field theory and the core dynamo theory. We performed 3D numerical simulations of a $2M_\odot$ A-type star with a convective core of roughly 20% of the stellar radius surrounded by a radiative envelope, using the star-in-a-box model as a way to explore magnetic fields driven by convection in the core of the star. The non-ideal fully compressible magnetohydrodynamics equations were solved using the Pencil Code. We explored rotation periods from 8 to 20 days, and these simulations were divided into two sets: Whole star models and a zoom set, where 50% of the radius is retained. Both sets allow us to have a better understanding of the core dynamo, differential rotation, and also the magnetism at the surface of the star. We conclude that the core is able to host very strong hemispheric dynamos, with toroidal magnetic fields up to 200 kG. Nevertheless, only a very small fraction of the magnetic energy is able to reach the surface, which is not enough to explain the observations.

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“XVII LARIM”, Montevideo, Uruguay, November 27 - December 1, 2023.Volume Editors: Gonzalo Tancredi, Cecilia Mateu & Juan José Downes

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"XVII LARIM", Montevideo, Uruguay, November 27 - December 1, 2023.Volume Editors: Gonzalo Tancredi, Cecilia Mateu & Juan José Downes

Evolution in low mass close binaries with a black hole: the cases of V404 Cygni and V381 Normae

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https://doi.org/10.22201/ia.14052059p.2026.60.130

When the components of a binary system are close enough, one can fill its Roche lobe and start transferring mass to the companion. These mass transfer episodes affect the whole evolution of the star, being a completely different situation as if it were isolated. In this work, we study two systems with these characteristics, with the particularity that the accreting object is a black hole (BH) on both. We chose V404 Cyg as one of our study targets due to its well-measured fundamental parameters, including mass transfer rates and theoretical estimations, along with an observational estimation of the BH spin parameter, which is notably high. On the other hand, we also investigated V308 Normae, a system with similar known parameters that stands out as the only system with a moderate and highly confident BH spin parameter, measured consistently using different techniques. With the help of our binary evolution code, we developed evolutionary models to obtain a progenitor for each system, considering the initial moment when the star is on the zero-age main sequence, and the BH is already formed. These models allow us not only to study the entire evolution of the donor star for each system but also to derive constraints on mass transfer episodes, orbital evolution, and changes in the BH spin due to accretion.

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A LAMOST spectroscopic study of T Tauri Stars in the Orion OB1a sub-association

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https://doi.org/10.22201/ia.14052059p.2026.60.131

We present a spectroscopic analysis of T Tauri stars (TTS) observed with the wide-field multi-fiber spectrograph LAMOST in the substellar associations Ori OB1a located in the Orion Star-Forming Complex. Based on GAIA-DR3 data, we selected stars with proper motions and parallaxes expected for TTS belonging to the young association. We perform a spectroscopic analysis to obtain spectral types and measure equivalent widths of Li I and Hα to confirm the youth of the stars and estimate the accretion status. We also estimate extinctions, masses, and ages for the studied sample. Out of 342 TTS with spectroscopic and kinematic properties to be members of the sub-association, 12 are reported here for the first time. Finally, we detect four stellar kinematic groups located at different distances, two in the north field and two in the south field. These groups also show different proper motions. This suggests that the star-forming scenario in this region is more complex than the traditional spatial-temporal scenario, in which a generation of stars triggers the formation of a new spatially differentiated generation of stars. This work was published in the Astronomical Journal (Bibcode: 2023AJ....165..205H).

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Revista Mexicana de Astronomía y Astrofísica Serie de Conferencias, 60, 148-163, (2026)

"XVII LARIM", Montevideo, Uruguay, November 27 - December 1, 2023.Volume Editors: Gonzalo Tancredi, Cecilia Mateu & Juan José Downes

O Vz stars in low-metallicity environments in the Magellanic Clouds

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https://doi.org/10.22201/ia.14052059p.2026.60.132

Massive stars are powerful "cosmic engines" that modify the morphology, chemistry and dynamics of their host galaxies, playing a fundamental role in the Universe. They are found in distant and highly extinguished regions, so our understanding of their formation and evolution is still limited. The morphological and quantitative study of their optical spectra is a powerful tool for determining their properties. In this work, we focus on stars of the O Vz class, identified by presenting a He II λ 4686 absorption much stronger than expected. It has been suggested that these objects are on, or very close to, the Zero-Age Main Sequence (ZAMS), so studying them can provide key information about the massive star formation process.

The "z phenomenon" has been investigated in the Galaxy, but there are no systematic studies in environments with different metallicity. Using high and intermediate-resolution optical spectra obtained at the VLT and LCO observatories (Chile), we are carrying out a comparative study of O Vz stars belonging to two star-forming regions in the Magellanic Clouds: 30 Doradus in the LMC and NGC 346 in the SMC, along with a star-forming region in the Milky Way: NGC 3603. Here, we present the preliminary results of our analysis, which provide clues about the role of metallicity and other parameters in the development of the z spectral feature.

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Exploring the hierarchical formation of the Milky Way with hypervelocity stars

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https://doi.org/10.22201/ia.14052059p.2026.60.133

The exploration of the outer halo of the Milky Way, through wide-sky photometric and spectroscopic surveys, has unequivocally confirmed that our Galaxy has formed as a result of the continuous merger of protogalactic fragments, aligning with predictions from cosmological Lambda-Cold Dark Matter simulations. Here, we discuss the hypervelocity stars, considered potential remnants of past accretion events, with velocities exceeding the local escape speed. Alternatively, hypervelocity stars may arise from binary system disruptions during close encounters with the supermassive black hole at the center of the Milky Way. Thanks to the invaluable data provided by Gaia, we have successfully identified stars exhibiting a high likelihood of belonging to this intriguing stellar family. Follow-up VLT spectroscopy has allowed us to estimate their total velocities, which, in certain cases, reach values of up to 1200 km/s. By reconstructing their past orbits, we have uncovered evidence suggesting that some of these stars might have originated within a now-disrupted dwarf galaxy or experienced another violent event far from the Galactic center.

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New evidence for a black hole in the X-ray binary system Swift J1910.2−0546

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https://doi.org/10.22201/ia.14052059p.2026.60.134

Swift J1910.2−0546 is a transient X-ray binary discovered in 2012 when the system was detected in an outburst episode. During that state, it showed the typical behaviour found in systems harbouring black holes although the nature of the compact object has not been established since. In this contribution, we show a comprehensive study of *Swift* J1910.2−0546 using optical outburst (obtained with the INT and NOT) and quiescence data (obtained with GTC and VLT), obtaining that the donor star is later than $\sim$G2 V. We also establish constraints to the orbital period (< 8.7 h) and distance (> 4.6 kpc) which, together with the lack of double peak emission lines (suggesting an inclination < 35 deg) and the radial velocity estimates obtained from the Hα line in quiescence, support the presence of a black hole in the system.

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Revista Mexicana de Astronomía y Astrofísica Serie de Conferencias, 60, 148-163, (2026)

"XVII LARIM", Montevideo, Uruguay, November 27 - December 1, 2023.Volume Editors: Gonzalo Tancredi, Cecilia Mateu & Juan José Downes

The own survey: What we can tell about massive binaries after 18 years of systematic observations

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https://doi.org/10.22201/ia.14052059p.2026.60.135

The OWN Survey (Barbá et al. 2017, IAUS, 329, 89) is a high- resolution spectroscopic survey of Galactic massive stars accessible from the Southern hemisphere. It has been carried out since 2005, using echelle spec- trographs at 2-m class telescopes in Chile and Ar- gentina. More than two hundred stars of types O and WN have been monitored to assess their multi- plicity status through the systematic study of their radial velocities. About two thirds of the sample were found to show RV variations. The main result of the OWN is the discovery of more than 60 multiple systems (37 SB2, 19 SB1 and 6 SB3), effectively doubling the volume of knowl- edge previously existing about massive stars multi- plicity. The RV orbits of many of them were accurately determined. Additionally the detection of spectroscopic variability in some objects has allowed insights into magnetic fields, circumstellar material and interactions between components. Individual key objects were thoroughly studied. Remarkable examples are the ZAMS triple system Herschel 36A (Campillay et al. 2019, MNRAS, 484, 2137), the long period binary HD 54662 (Barbá et al. 2020, MNRAS, 494, 3937) and WR21a (Barbá et al. 2022, MNRAS, 516, 1149), which is one of the most massive stars in the Milky Way. Thanks to the contribution of the OWN Survey, a significant pool of spectroscopic orbits is now available for statistical analysis. The distribution of orbital elements (period, eccentricity, and mass ratio) for different luminosity classes is be- ing investigated, shedding light on the formation and evolution of these systems (Gamen et al. in prep.).

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Cepheid pulsation mode identification via unsupervised machine learning

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https://doi.org/10.22201/ia.14052059p.2026.60.136

In this work we aim to determine the pulsation mode of a Cepheid variable star, only considering extinction and distance-free features of its light curve, and without the use of Fourier parameters, as is custom in the literature. We developed a set of features calculated by a continuous model of the light curve, namely the phases and curvature of the extrema points, the phases and values of the derivative extrema, the phases of the rising and falling branches, the amplitude, and the period. These features are meant to be used on a clustering algorithm in order to identify the pulsation modes.

As our test case, and motivated by the importance of the Magellanic Cepheids in the calibration of the extragalactic distance ladder, we calculated these features on the Galactic and LMC Cepheids from the OGLE Catalog of Variable Stars, from both version III and IV, totaling to 12482 objects. We then fed the feature dataset to the HDBSCAN algorithm, playing with the minimum cluster size, and using the Chebyshev metric. The desired level of detail was achieved with a minimum cluster size of 5, and a hybrid ϵ hyperparameter of 0.047, giving a 29% of data being classified as noise.

Our clustering correctly separated the fundamental, first, and second overtones on the Classical Cepheids, along with the anomalous and type II Cepheid types. There is some confusion, however, between the WVir and fundamental Cepheids, and general mixing among the type II subclasses. Moreover, the clustering algorithm identified different substructures within the established fundamental and first overtone modes. These could be a hint to a richer morphology of the classical Cepheid light curves, perhaps related to the Hertzprung progression, that will be explored in future research.

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Revista Mexicana de Astronomía y Astrofísica Serie de Conferencias, 60, 148-163, (2026)

"XVII LARIM", Montevideo, Uruguay, November 27 - December 1, 2023.Volume Editors: Gonzalo Tancredi, Cecilia Mateu & Juan José Downes

Determination of fundamental parameters of Wolf-Rayet stars in eclipsing binary systems

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https://doi.org/10.22201/ia.14052059p.2026.60.137

Despite the essential role of massive stars in the evolution of the Universe, our understanding remains incomplete, particularly concerning mass loss and its influence on post-main-sequence evolution. Recognizing binary stars as ideal benchmarks for determining stellar parameters, we focused on two WR+O systems, WR 62a and WR 68a, identified as double eclipsing systems through TESS photometry. Notably, the light curve of these binaries presents a challenge to the classical modeling of photospheric eclipses, as demonstrated by the limitations of the PHysics Of Eclipsing Binaries (PHOEBE) code.

To address this, we extended our approach by incorporating a model of Thomson scattering for atmospheric eclipses, complementing PHOEBE. Furthermore, a custom light curve synthesis algorithm was employed to account for binaries with extended atmospheres. This comprehensive methodology, integrating TESS data and radial velocity curves, significantly improves parameter precision, facilitating the analysis of the masses and radii of the WR and O components within the framework of massive stellar evolution.

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Internal structure of open clusters with close companions

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https://doi.org/10.22201/ia.14052059p.2026.60.138

Our project aims to analyze the alteration and evolution of the internal structure of open clusters that are part of a binary or multiple systems. For this, we have assembled a homogeneous sample of open clusters, comprising both single and multiple systems, with membership probabilities of stars within these clusters obtained from previous catalogs, using Gaia astrometric and photometric databases. To quantify the structural parameters of the clusters in our sample, we employ the "minimum spanning tree" technique, which allows us to gain valuable insights into the cluster's internal structure. As the main results, we found the Q value is more affected by the dynamic state of multiple open clusters than by single ones. This could explained as the gravitational interaction between the linked clusters amplifies the effects of dynamic evolution. These mainly affect its peripheral regions and appreciably less its central regions. On the other hand, it does not significantly affect the most massive stars. The employed simulations indicate that a low fractal dimension tends to result in the creation of multiple components. It is highly likely that most of these systems are identified as binary ones, but they could be triple or even multiple systems. Finally, the average Q parameter of the entire binary/multiple systems is lower than the parameters of each component. This suggests that they do not inherit the original fractal dimension value.

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Revista Mexicana de Astronomía y Astrofísica Serie de Conferencias, 60, 148-163, (2026)

"XVII LARIM", Montevideo, Uruguay, November 27 - December 1, 2023.Volume Editors: Gonzalo Tancredi, Cecilia Mateu & Juan José Downes

Unveiling the evolutionary states of B supergiant stars

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https://doi.org/10.22201/ia.14052059p.2026.60.139

Massive stars are the cornerstone for the chemical evolution of the interstellar medium through feedback from their winds and supernova explosions. Through a synergy between asteroseismology, evolutionary modeling, and spectroscopic analysis, new insight into the evolutionary stage of three well-known B supergiant stars was achieved: HD 42087 (PU Gem), HD 52089 (ϵ CMa), and HD 58350 (η CMa). For our analysis, we used the 2-min cadence TESS data to study the photometric variability and obtained new spectroscopic observations at the CASLEO observatory. We used non-LTE radiative transfer models calculated with CMFGEN. These models were included in the iterative spectral analysis pipeline XTGRID to determine their CNO abundances and their stellar and wind parameters, which were later compared with Geneva evolutionary tracks. Based on the abundance ratio alone, we found that all our stars are more consistent with a pre-RSG stage. However, stellar evolution models confirm this stage only for HD 42087 and HD 52089, considering their derived T_{eff}, L and M, while predicting HD 58350 to be at the post-RSG stage. The results underscore the need to study large samples of B supergiants homogeneously and to review processes involved during the evolution of massive stars, such as mass loss via stellar oscillations.

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Exploring star cluster through eclipsing binary members

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https://doi.org/10.22201/ia.14052059p.2026.60.140

Binary stars constitute approximately 70% of stellar populations. Particularly, those within star clusters play a crucial role in understanding various aspects of stellar astrophysics. In this study, we conducted an extensive investigation of eclipsing binary (EB) candidates in a specific near-infrared window in the southern part of the disk of the VVV Survey. Our primary focus is to explore the potential membership of these binaries within star clusters in the same region. By analyzing Gaia DR3 and VVV databases, we thoroughly examined two open clusters, Teutsch 77 and Ruprecht 97, each associated with two EBs in total, among the VVV and ASASSN dataset. We modeled with PHOEBE code the light curves, in the V magnitude, of the two new ASASSN binaries. We analyze the kinematics and photometry of the studied open clusters, aiming to uncover any possible connections with the identified EBs. This work presents our preliminary findings on cluster membership and characterizations, providing crucial insights into the intricate interplay between binary systems and star clusters.

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Revista Mexicana de Astronomía y Astrofísica Serie de Conferencias, 60, 148-163, (2026)

Atlas of massive galactic O-type spectral standards in the near-infrared

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https://doi.org/10.22201/ia.14052059p.2026.60.141

The study of spectral morphology is a powerful tool for understanding the fundamental properties of stars. The spectral classification scheme for O stars has been revised in the context of the Galactic O-Star Spectroscopic Survey and a new set of spectral standard stars has been proposed. Since the vast majority of the Galactic O stars are visible only in the infrared due to large interstellar absorption in the optical, it is necessary to extend this work towards those wavelengths.

We are working on the construction of an atlas of Massive Galactic O-type Spectral Standards in the near-infrared (MaGOSS in the NIR), observing the standards, defined in the last installment of the Galactic O-Star Spectroscopic Survey, with high-quality spectra in the wavelength range between 0.85 μm and 2.5 μm.

We present here an advance of the Atlas of MaGOSS in the NIR, which includes spectra of a sequence of dwarf, giant and supergiant stars. We analyze this data set to establish some spectral characteristics of such stars, with the aim of defining classification criteria in the near-infrared range, such as the ratios HeI λ1.700 μm/HeII λ1.692 μm, HeI λ1.031 μm/HeII λ1.042 μm, and HeI λ2.112 μm/HeII λ2.189 μm.

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Supernova light curves with the HSH telescope at CASLEO

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https://doi.org/10.22201/ia.14052059p.2026.60.142

The early-time light curves of Supernovae (SNe) are crucial to know the properties of their progenitors, such as radius and density profile. For this purpose, observations are fundamental to obtain images as soon as possible. In this work, we present the first observing campaign by the SOS (Supernova Observations and Simulations) group using the 60 cm Helen Sawyer Hogg (HSH) telescope at CASLEO, Argentina. The campaign had the following goals: test the capabilities of the instrument to perform very early follow-up observations of SNe ; obtain photometry of transients within hours/days from discovery; and obtain *BVRI* light curves of selected SNe.

The campaign lasted 37 consecutive nights, where 70 transients were observed. From these, 27 (∼39%) were confirmed as SNe, being 17 Type Ia, 2 Type Ib/c, 2 Type Ic and 6 Type II. For 5 of them, the SOS group made 3 announcements with the early discovery confirmations. The mean delay between discovery and our first observation was 31 hours. The average image quality at FWHM was 3.4 arcsec, and this may have been affected by seeing, focus and tracking problems. In addition, by the analysis of the light curves of 3 Type Ia SNe of our sample that had more than 15 epochs, we estimated the Δm_{15} parameter, the distance to their host galaxy and the reddening of the host. The luminosity distances agreed within ∼13% with those based on the redshift.

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“XVII LARIM”, Montevideo, Uruguay, November 27 - December 1, 2023.Volume Editors: Gonzalo Tancredi, Cecilia Mateu & Juan José Downes

Revista Mexicana de Astronomía y Astrofísica Serie de Conferencias, 60, 148-163, (2026)

"XVII LARIM", Montevideo, Uruguay, November 27 - December 1, 2023.Volume Editors: Gonzalo Tancredi, Cecilia Mateu & Juan José Downes

The IMF in Orion OB1b from $0.05M_\odot$ to $8M_\odot$ using public surveys

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https://doi.org/10.22201/ia.14052059p.2026.60.143

The initial mass function (IMF) is one of the main results of the star formation process and a fundamental quantity for many branches of astrophysics. The Orion complex is one of the most studied star-forming regions composed of several sub-regions including stars and brown dwarfs in a wide mass range, with ages spanning from $\sim$ 1 to $\sim$ 10 Myr and distances around 400 pc. Particularly, the slightly evolved populations such as 25 Ori in Orion OB1a, σ Ori in Orion OB1b and Collinder 69 in λ Ori also show low extinctions which makes them a perfect laboratory for robust determinations of the IMF from massive stars down to the planetary mass domain. In this work, we determine the system IMF of stellar and sub-stellar overdensities belonging to the Orion OB1b sub-region in a mass range from $0.05M_\odot$ to $8M_\odot$. The candidate members were selected independently for different stellar mass ranges according to their distribution in color-magnitude diagrams and/or kinematics diagrams made based on Pan-STARRS DR1 photometry and Gaia DR3 photometry, proper motions, parallaxes and radial velocities. Additionally, we corrected the resulting distributions by the expected contamination from field stars and the biases affecting the observable quantities, using spectroscopically confirmed members from the literature as a control sample. We present the comparison of the resulting IMF with those previously known for other Orion sub-regions, focusing on the similarities of the IMF in the solar neighborhood and the predictions from low-mass stars and brown dwarf formation models.

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Project SOL (Solar Origin and Life): Detailed characterization of candidates at ZAMS and Subgiant stages

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https://doi.org/10.22201/ia.14052059p.2026.60.144

The solar situation in the galactic neighborhood is not well understood, especially when we compare its physical properties (atmospheric parameters, evolutionary parameters, chemical composition, magnetic activity, among others) with those of nearby stars. Thereby, we still can not fully understand if the Sun is a typical star or not. This happens because recent results in the literature support both hypotheses. Therefore, this work aims to identify and characterize stars with evolutionary tracks similar to the Sun (solar mass and metallicity) that could represent it at the ZAMS and subgiant stages. Thus, we performed a precise spectroscopic analysis of the candidates using high resolution (R $\approx$ 35000 - 115000) and signal-to-noise (S/N $\geq$ 150) spectra obtained with modern instruments on different telescopes around the world. We adopted the classical spectroscopic method, which uses equivalent widths of Fe I and Fe II lines and is based on the excitation and ionization equilibria. Additionally, we derived mass, radius, luminosity and age, using theoretical evolutionary tracks and isochrones, and kinematic parameters for all stars in our sample. We also performed age estimates through 2 additional independent methods and we present the chromospheric activity levels of our candidates. From these, we identified 2 candidates (HD 13531 and HD 61033) and 1 candidate (HD 148577) capable of representing the Sun at the ZAMS and subgiant stages, respectively. Moreover, 2 stars (HD 64114 and HD 197210) could be interesting for studying the Sun with $\approx$ 2 Gyr, when the Earth's atmosphere started having a significant amount of oxygen. Although our sample is not big enough for us to answer if the Sun is typical or not, it shows we are able to identify stars similar to our own at different evolutionary stages, which is very important for the search for exoplanets and habitability studies.

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Revista Mexicana de Astronomía y Astrofísica Serie de Conferencias, 60, 148-163, (2026)

"XVII LARIM", Montevideo, Uruguay, November 27 - December 1, 2023.Volume Editors: Gonzalo Tancredi, Cecilia Mateu & Juan José Downes

Studying supernovae associated with long gamma-ray bursts

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https://doi.org/10.22201/ia.14052059p.2026.60.145

The origin of stellar explosions associated with long-duration gamma-ray bursts (GRB SNe) is an intriguing open topic in the field of stellar astrophysics of massive stars. In all cases, these supernovae (SNe) were classified as type Ic-BL, indicating Hydrogen and Helium deficiency, and showing broad lines in their spectra. This last characteristic is indicative of high velocities and energies. In this work we thoroughly analyze the physical properties of a selected sample of GRB SNe, contrasting them with those derived for other groups of SNe. The use of varying methods in previous studies to calculate bolometric luminosities hindered comparisons between objects. To ensure comparability, we standardized the calculation method for bolometric luminosities in our sample. Subsequently, we model the objects using a hydrodynamic code and derive their physical parameters. To conclude, we compare our results with those obtained for stripped-envelope SNe and SNe Ic-BL lacking a detected GRB available in the literature. Our findings reveal the existence of two possible solutions: low-mass models or high-mass models, the latter necessitating larger compact remnants consistent with black hole formation. Both solutions require the common characteristic of a small ejected mass to reproduce the observations.

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Inferring the production rate of intermediate-age RR Lyrae stars using Magellanic Clusters

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https://doi.org/10.22201/ia.14052059p.2026.60.146

RR Lyrae stars (RRLs) are vital in establishing the cosmic distance ladder due to the relations they follow between their luminosities, metallicities, and pulsation periods. RRLs have been historically considered as tracers of old populations (older than 10 Gyr). However, recent studies in the field of the Milky Way and Magellanic Clouds suggest the existence of RRLs in intermediate-age populations (1-8 Gyr), challenging our understanding as they cannot be accounted for by stellar evolution models of isolated stars, making binary evolution the prime suspect to explain their existence. Our goal is to look for direct evidence of the existence of these stars by looking for RRLs in intermediate-age clusters. To this aim, we establish an inference model intended to estimate the membership probability of RRLs from the Gaia DR3 and OGLE catalogs to massive intermediate-age stellar clusters in the Large and Small Magellanic Clouds. Because the expected rate of production of these stars in any individual cluster is expected to be small, we combine the data for many clusters to infer the production rate of RRLs per unit mass in a given age range. We obtain a production rate of $\sim$10 RRLs per $10^5\ M_\odot$ for old clusters (>8 Gyr), in accordance with observations in Milky Way globular clusters, and infer a rate of $\leq$ 2 RRLs per $10^5\ M_\odot$ for intermediate-age (1-8 Gyr) clusters. Our method also allows us to build a list of RRLs with a high membership probability to intermediate-age clusters, which will require spectroscopic follow-up to confirm their membership to the clusters.

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Revista Mexicana de Astronomía y Astrofísica Serie de Conferencias, 60, 148-163, (2026)

"XVII LARIM", Montevideo, Uruguay, November 27 - December 1, 2023.Volume Editors: Gonzalo Tancredi, Cecilia Mateu & Juan José Downes

Close binary systems: evolution and environment

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https://doi.org/10.22201/ia.14052059p.2026.60.147

Binary stars are very important in Astronomy. In some cases, it is possible to access, with good precision, the fundamental parameter that determines the evolution of an isolated star: its mass. In close binary systems, if close enough to each other, the evolution of the components changes completely compared to what each of them would have had in isolation, because mass loss may occur by Roche lobe overflow. Examples of objects due to binary evolution are low-mass helium white dwarfs, type Ia supernova progenitors, cataclysmic variables, black widows and redbacks families, blue and yellow stragglers. In addition to the two stellar components, there is another fundamental actor: the accretion disk. Accretion disks have been studied for decades. However, the complexity of the physical processes that occur in it means that we still have a lot to explore. In this poster, we will make a brief description of the evolution of close binary systems composed of a low-mass normal star and a neutron star, using models obtained from our binary evolution code. We show the method we use to search for a possible progenitor of PSR J1622-0315, a redback whose characteristic parameters have been recently determined. Subsequently, we describe the thin disk treatment ("alpha disk"), where it is possible to decouple the vertical from the radial treatment (where temporal evolution is found). We present our first results and discuss the steps to follow to study the effect of neutron star irradiation on the accretion disk.

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Ca triplet metallicities and velocities for 12 globular clusters toward the galactic bulge

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https://doi.org/10.22201/ia.14052059p.2026.60.148

We used near infrared low resolution spectroscopy with the FORS2 instrument on the VLT to measure the equivalent widths of the CaII triplet (CaT) lines for a number of stars per cluster. We derived radial velocities, ascertained membership, and applied known calibrations to determine metallicities for cluster members, for a mean of 11 members per cluster. We derive mean cluster RV values to 3 km/s, and mean metallicities to 0.05 dex. We find general good agreement with previous determinations for both metallicity and velocity. On average, our metallicities are 0.07 dex more metal rich than those of Harris (2010, arXiv:1012.3224), with a standard deviation of the difference of 0.25 dex. Our sample has metallicities between -0.21 and -1.64, and the values are distributed between the traditional metal rich BGC peak near [Fe/H] -0.5 and a more metal-poor peak around [Fe/H] -1.1, which has recently been identified. These latter are candidates for the oldest GCs in the Galaxy, if blue horizontal branches are present, and include BH 261, NGC 6401, NGC 6540, NGC 6642, and Terzan 9. Finally, Terzan 10 is even more metal poor. However, dynamically, Terzan 10 is likely an intruder from the halo, possibly associated with the Gaia-Enceladus or Kraken accretion events. Terzan 10 is also confirmed as an Oosterhoff type II GC based on our results.

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Revista Mexicana de Astronomía y Astrofísica Serie de Conferencias, 60, 148-163, (2026)

"XVII LARIM", Montevideo, Uruguay, November 27 - December 1, 2023.Volume Editors: Gonzalo Tancredi, Cecilia Mateu & Juan José Downes

Recharacterization of open clusters in optical and near-infrared wavelengths using machine learning methods

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https://doi.org/10.22201/ia.14052059p.2026.60.149

In recent years, there has been a major revolution in the open clusters field. With the numerous attempts to characterize them using different techniques and clustering models in the optical and infrared domain, we currently have a mixture of results that make it challenging to analyze the true structure of certain clusters and understand their evolutionary history. We propose implementing a single method, an artificial neural network, with members from different methodologies and wavelengths. Initially, we selected one cluster: NGC6259 using optical/infrared photometric and astrometric data from Gaia DR3 and VVV/VIRAC2 surveys. The selected cluster has a particular "blob" in the reddest part of its stellar sequence. After re-identification, I will present the preliminary results on the revisited cluster sequence on different parameter spaces, its radial velocity and distance distributions, age assessment, and cluster radial profile. Complementary, with the study of the available spectroscopic information of some of the cluster members, we expect to shed light on the real nature of the "blob" on the cluster sequence. In this contribution, I will also discuss how the results contribute to the possibility of establishing a cluster membership assessment that mixes different machine learning methods.

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Small-scale substructures in Taurus transition disks around low mass stars

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https://doi.org/10.22201/ia.14052059p.2026.60.150

The process of planet formation and disk evolution leaves an imprint on the material that surrounds a young star. Imaging from at high spatial resolution has revealed that most protoplanetary disks host small-scale (few au) substructures. While rings and gaps are very frequent, asymmetric features and spiral arms are also present. At low-resolution annular features are detected in disks around young stars with a wide range of stellar properties, from very low mass stars to Herbig AeBe stars, suggesting that rings and gaps may be ubiquitous and comprise key processes of the star/disk evolution. The analysis of high-contrast rings shows that these prominent rings are consistent with dust trapping, enabling the accumulation of dust grains in these regions and favoring their growth towards planetesimals. Therefore, small-scale substructures in disks play a crucial part in the planet formation process. Our methodology consists on using deep (20 μJy/beam) - high spatial resolution (down to 42 mas) - dust continuum observations at 1.3 mm with ALMA to target 5 transition disks located in the young, nearby, Taurus star-forming region. So far, we have found evidence for small-scale substructures in the outer disk rings of the sample made up solely of disks around low-mass stars. Fitting the visibilities we have measured the shape location, width, contrast, and optical depth of the outer disk features, including non-axisymmetric structures such as spirals and arcs. Our aim is to compare these properties to that of known substructures in higher mass stars and constrain the degree of dust trapping in rings or asymmetric features associated with signatures of planet formation for a wide range of stellar parameters.

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Revista Mexicana de Astronomía y Astrofísica Serie de Conferencias, 60, 148-163, (2026)

"XVII LARIM", Montevideo, Uruguay, November 27 - December 1, 2023.Volume Editors: Gonzalo Tancredi, Cecilia Mateu & Juan José Downes

Uncovering variable stars in Ultra Faint Dwarves without filter

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https://doi.org/10.22201/ia.14052059p.2026.60.151

Several satellites of our Milky Way have been discovered in the last decades. Most of them could not be found before due to their extremely low luminosity, now known as Dwarf Spheroidals (dSphs) and Ultra faint dwarfs (UFDs). These systems are most dominated by dark matter, and they are key to explore a large variety of topics. Unfortunately, most UFDs are not suitable for extensive analysis due to the scarcity of bright stars. The available color-magnitude diagrams (CMD) of these systems are poorly populated and do not reach the sub-giant branch level in most cases. Their key parameters are thus derived from isochrone fits that are uncertain and degenerate in the three input parameters of age, metallicity, and distance. Our principal aim is to detect RR-Lyrae variable stars, which have been found in all dSphs studied so far. In fact, their well-known period-luminosity relation makes them ideal distance indicators for old stellar populations. The discovery of even one such star would fix the distance much better than what can be done through isochrone fit, improving measures such as luminosity and size, and allowing a better estimate of age and metallicity, among other benefits. We are probing a new method to detect the RR-Lyrae stars of the UFDs that is to observe them directly, without any filter. Our aim is to successfully deal with all the issues that involve using this method to detect variable stars, such as the lack of standard stars, leading to magnitude dependencies in color and/or airmass, among others. If we are successful, we will be able to find variable stars in UFDs using only a 1-m telescope, giving new life to these increasingly forgotten telescopes. Using only images from the 1-meter Swope telescope (LCO) we found in Reticulum II a variable star already identified by the Gaia survey. Now we are studying Grus II to find similar results.

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TESS survey for magnetic white dwarfs in symbiotic binaries

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https://doi.org/10.22201/ia.14052059p.2026.60.152

Symbiotic stars are a subclass of interacting binary systems where a compact object, typically a white dwarf (WD) or a neutron star, accretes material from an evolved giant. Accretion can occur through two primary mechanisms: wind accretion or Roche lobe overflow. Wind accretion is the dominant mechanism in most symbiotic stars, but in a small fraction of symbiotic stars, Roche lobe overflow can also occur. Typical orbital periods of symbiotic stars are observed over relatively long timescales ranging from hundreds of days to decades. Shorter time-scale variability is also observed in these systems. This short- term variability in symbiotics is related to the accretion process and the formation of the accretion disk, whichis crucial for understanding the evolution of these systems. The detection of periodic modulations in the optical light curves of symbiotic binaries provides evidence for the presence of magnetic white dwarfs, which plays an important role in the accretion process by truncating the accretion disk and regulating the accretion flow. We propose to do a survey with TESS of symbiotic systems to find new candidate magnetic WD in symbiotics.

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Revista Mexicana de Astronomía y Astrofísica Serie de Conferencias, 60, 148-163, (2026)

"XVII LARIM", Montevideo, Uruguay, November 27 - December 1, 2023.Volume Editors: Gonzalo Tancredi, Cecilia Mateu & Juan José Downes

The XshootU Stellar Library: Hot low metallicity stars

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https://doi.org/10.22201/ia.14052059p.2026.60.153

Stellar spectral libraries are one of the main ingredients of stellar population models. They can be either empirical or theoretical. Empirical libraries are based on observations, meaning that all features in models generated with them will be real. The disadvantage is that it will always be limited by the stars we can observe. Theoretical libraries do not have this setback and stellar spectra can be generated with any atmospheric parameters desired. However, models are based on approximations and simplifications, and therefore not quite yet able to reproduce all features of real stellar spectra. That is why, despite the existence of several empirical libraries, there are still efforts to push their boundaries. One of the major deficiencies of the empirical libraries available today is the coverage of hot/young stars and low metallicity. In this work, we present the XShootU stellar library, the most recent effort to try to fill this gap. The ULLYSES program (HST) generated a UV spectroscopic library of 160 massive stars in the LMC and the SMC, uniformly sampling the parameter space of spectral type and luminosity class for massive OB stars. In parallel to ULLYSES, XShootU is collecting high S/N spectra with R$\sim$10,000 over the spectral range from 300 nm to 2.5 microns of these stars. This will vastly extend the power of ULLYSES spectra by merging the UV, optical, and NIR. ULLYSES + XShootU is by far the most complete, highest-S/N, and highest resolution library of hot, massive stars with the broadest spectral coverage. In combination with other stellar libraries available in the literature, XshootU will allow self-consistent population synthesis models of systems hosting both young and old stars.

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The morpho-kinematic structure of the Thor's Helmet Nebula

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https://doi.org/10.22201/ia.14052059p.2026.60.154

Around some Wolf-Rayet (WR) stars we found gas and dust whose presence is associated directly with the central star. Often, these materials present patterns and structures in a variety of shapes (Toala et. al. 2015; A&A, 578, A66). In this context, an object with striking features is NGC 2359 (Thor's Helmet), whose complex and intricate filamentary sharp structure, is composed of a large shell of gas and dust that surrounds the central star. In order to obtain important insights into their dynamic formation and structure we have obtained high dispersion spectroscopy of the main nebula to investigate the kinematics and the complex processes that occur in the final stages of this massive star life. We present a morpho-kinematic study of the WR nebula NGC 2359 around the WR7 star through high-resolution Manchester Echelle Spectrograph (MES) observations using the 2.1m telescope at the Observatorio Astronómico Nacional (OAN) Mexico. A total of 26 long-slit positions were used. The long-slit high-dispersion optical spectroscopy of NGC 2359 was acquired in 2020, 2021 and 2022 using filters covering the spectral range that includes the Hα, [N II] and [O III] lines. We found that the kinematics of this WR nebulae are highly complex, with a variety of structures and velocities. The nucleus of NGC 2359 resembles an interstellar bubble, produced from the interaction between a fast wind originated from a massive WR central star that is surrounded by an enormous HII region (Sharpless 298) within a molecular cloud. The wind is responsible for compress the medium, producing the bubble of gas around the star. We found that our initial shape model resembles that for a cloud-cloud collision. The O-type central star will evolve into the WR star with a wind-blown bubble such as NGC 2359.

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