First Name	Last Name	Afiliation	Title	Abstract
Hans	Van Winckel	Institute of Astronomy, Department Physics and Astronomy, KU Leuven, Celestijnenlaan 200D, B-3001 Leuven, Belgium	Binary evolution labs: discs and jets in post-AGB binaries	In the last decades we could combine the power of long-term spectral monitoring with the power of topical high-spatial resolution interferometric imaging experiments. We could dissect a number of post-AGB binaries and resolve their specific building blocks. In this contribution, I will synthesize the main results and focus on the common properties of these interacting binaries. We know about 90 Galactic systems and common ingredients are: a wide and often eccentric orbit, a circumbinary disc of gas en dust, a jet-launching companion with an accretion discs. Insight in the physical interplay between these ingredients is needed to understand how these systems evolve and how they avoided spiralling-in, despite their orbits being too short to accommodate an AGB star. Post-AGB binaries present an ideal space laboratory to study binary evolution.
Akke	Corporaal	KU Leuven	An interferometric multi-wavelength approach to study post-AGB binary discs	Stable, compact circumbinary discs are found around post-asymptotic giant branch (post-AGB) binary systems. Mass-transfer episodes are expected to have happened between the former AGB star and its unevolved companion. This mass transfer has likely been through a common-envelope interaction, but the exact interaction process is still poorly constrained. The discrepancy between the observed orbital periods of these binaries and the theoretical estimates is not understood yet. Disc-binary interactions likely play a role in this. By studying these discs with optical interferometry, we can probe the infrared emission from the inner regions of the disc, gaining insight into both the interaction between the disc and the central stars and the physical processes happening in the inner regions of the disc. In this talk, I will present the results of a study where we combined, for the first time, all three current VLTI instruments (PIONIER, GRAVITY, and MATISSE). This paves the way to a new era of multi-wavelength optical interferometry. With such observations, it is not only possible to study the structure, evolution, and disc-binary interactions of circumbinary discs around post-AGB binaries, but also to assess the physical processes in other circumstellar disc systems.
Guillermo	Garcia-Segura	Instituto de Astronomia, Universidad Nacional Autonoma de Mexico	Common Envelope Shaping of Planetary Nebulae	In this talk, we compute the outcome of CE evolution events. In the first part of the talk, we explore the direct formation of planetary nebulae assuming a line-driven wind from a hot core. In the second part, we study the importance of the circumbinary disk and explore a first insight with magnetic solutions. In the third part of the talk, we solve the launching of magnetic winds and jets from the circumbinary disk and explore the formation of proto-planetary nebulae.
Henri	Boffin	ESO	Planetary Nebulae as constraints to the Common Envelope process	Although planetary nebulae are often considered to be the swan song of low- and intermediate-mass stars, It Is now thought that binarity (with a stellar, substellar or even planetary companion) plays a fundamental role in their formation. It is thus well established that at least 20% of all planetary nebulae harbour a close, post-common envelope (CE) binary - a fraction which is 4 times higher than what we expect naively. I will present our latest results about the post-CE planetary nebulae, including those obtained thanks to Gaia, and show how these, coming just out of the CE oven, can be used to constrain the CE process.

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Javier	Alcolea	OAN (IGN/CNIG, Spain)	Deciphering the structure of the central regions of M1-92	M1-92 is a prototypical bipolar pPNe. Previous studies in CO show that the present dynamics is dominated by a clear velocity gradient, suggesting that it is the result of a very energetic and brief ejection, similar to those expected in common envelope events. Here we present the results of 0"5 resolution interferometric observations of several lines of SO, a molecule that is a good probe of dense gas, and whose abundance is expected to increase in the presence of shocks. Using the well known rotational-diagram formalism, and taking advance of the high degree of symmetry of the nebula, we have been able to derive a 3D picture of the excitation temperature of the lines, and of the SO density. We find that SO emission is restricted to the equatorial structure dividing the two bipolar lobes. Temperatures are in the range of 5 K at the outskirts, to 45 K towards the centre of the structure, in agreement with previous works. Densities are between 1.3e-2 to 2.0e-1 SO molecules per cubic cm. Highest SO concentration is found located at a central unresolved condensation, and at a torus with a radius of 6.5e16 cm.
Miguel	Santander-García	Observatorio Astronómico Nacional (OAN-IGN)	Lessons from the ionised and molecular mass of post-CE PNe	Close binarity is widely invoked to help eject axisymmetric planetary nebulae (PNe), after a brief common envelope (CE) phase. Evolution of the primary would be interrupted abruptly, its still quite massive envelope being fully ejected to form the PN, which should be more massive than a PN coming from the same star, were it single. We test this hypothesis by investigating the ionised and molecular masses of a sample consisting of 18 post-CE PNe, roughly one third of their known total population, and comparing them to a large sample of regular PNe (not known to host close-binaries). We find that post-CE PNe arising from Single-Degenerate (SD) systems are just as massive, on average, as regular PNe, whereas post-CE PNe systems arising from Double-Degenerate (DD) systems are considerably more massive, and show substantially larger linear momenta and kinetic energy than the rest. Reconstruction of the CE of four objects further suggests that the mass of SD nebulae actually amounts to a very small fraction of the envelope of their progenitor stars. This leads to the uncomfortable question of where the rest of the envelope is, raising serious doubts on our understanding of these intriguing objects.
Nicholas	Chornay	IoA, University of Cambridge	Candidate close binary central stars of planetary nebulae identified with Gaia	Close binary central stars of planetary nebulae offer a crucial window into common envelope evolution with the parameters of such systems providing key theoretical constraints. However only about 100 such systems are known, and far fewer are well characterized, with uniform surveys such as OGLE and Kepler largely focused on distant, faint objects towards the Galactic bulge. Gaiaâ€™s precise photometry and repeated scanning make it a powerful tool for detecting variability across the whole sky; including variability indicative of close binary systems - whether due to irradiation, eclipses, or tidal distortion effects. We show that with Gaia data we are able to recover most of the known close binary PN central star population by using Gaiaâ€™s photometric uncertainty as a proxy for variability. Not only that - we also uncover many new candidate variables which are potential close binary central stars. Care must be taken to ensure that the variability is genuine, particularly for extended, bright objects such as PNe. We discuss our method and our approaches to deriving a clean sample. We also present new results from applying our method to Gaia EDR3 as well as the first outcomes of our ground-based follow-up campaign.
Jingyao	Zhu	Columbia University	AMR Simulations Probing the Role of Recombination Energy in Common Envelope Evolution	We examine the hypothesis that recombination energy can assist in common envelope ejection. We present 3D adaptive mesh refinement (AMR) simulations of common envelopes with an equation of state that includes hydrogen and helium partial ionization, considering a 1.4 Mâ˜‰ red giant primary star and white dwarf companions of masses 0.36, 0.6, and 1.1 Mâ˜‰. At the highest resolution, these simulations resolve sub-solar radius sized stellar cores and outer envelopes down to 10-9 g cm-3, capturing over a factor of 40 orbital inspiral at the end stages. A Lagrangian tracer fluid is introduced in our simulations to connect the relative locations of partial ionization zones and material unbinding. We discuss the effect of core resolution, hydrogen and helium partial ionization, and companion mass on the outcome of the common envelope phase.

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Emily	Wilson	Rochester Institute of Technology	Convection as a key ingredient in common envelope evolution	The ejection efficiency of the common envelope (CE) phase of binary stellar evolution, α_{CE} and the predicted final separations of these same systems are closely linked. Rather than using a constant ejection efficiency, we consider one that is dependent on the internal structure of the CE. Specifically, we examine the effects of convection and radiative losses on α_{CE} and the final separations of systems which undergo a CE phase. As the companion deposits energy into the CE during inspiral, the energy can get carried by convective eddies to an optically thin surface of the primary where it can be lost from the system via radiation. This allows the companion to inspiral deeper into the CE before energy can be tapped to drive ejection. The predicted final separations given radiative losses via convection are consistent with M-dwarf+WD populations and known double white dwarf (DWD) systems.
Morgan	MacLeod	Harvard University	Tides and the possibility for the eccentric onset of common envelope phases	As a pair or multiple system of stars evolves toward mass exchange, the actions of tides, stellar, and orbital evolution combine to determine the state of the orbit at the time when mass transfer begins. I will talk about cases in which the tidal dissipation is slow relative to the system evolution, leading to mass exchange and common envelope phases that begin with asynchronous rotation, dynamical tidal oscillations, and eccentric orbits. I will discuss how tidal dissipation acts as tides grow to highly-nonlinear amplitudes and mass exchange begins.
Logan	Prust	University of Wisconsin-Milwaukee	Moving Boundary Conditions in Common Envelope Evolution	In this talk, I discuss the application of 3-D numerical simulations to the problem of CEE using the moving-mesh code MANGA. All CEE simulations to date have modeled the companion object as a dark matter particle, which interacts only gravitationally with the gas. However, the accuracy of this approximation is unclear. As material accretes onto the companion or just passes by it, it can create a shock, and this shock can backreact on the material. Because of the great density contrast between the companion star and the extended envelope of the primary, the surface of the companion can instead be treated as a hard boundary. To this end, I describe the implementation of moving boundary conditions into MANGA and their application to simulations of CEE. I find that the orbital mechanics of the spiral-in phase are affected by the size of the companion, while the energetics remain relatively untouched. This suggests that hydrodynamic interactions between the companion and envelope affect the transport of angular momentum.
Iminhaji	Ablimit	NAOC (National Astronomical Observatories, Chinese Academy of Science)	Possible important outcomes related with core mergers inside the common envelope from white dwarf binaries	The common envelope phase (CE) in the binary stellar evolution has been studied as one crucial phase to form various transients and special objects. In this talk, I will introduce my recent two works which showed very important outcomes from core mergers inside the CE of white dwarf (WD) binaries. In the first part, I investigate stellar core mergers between CO WDs and cores of hydrogen-rich or helium-rich non-degenerate stars during the CE phase as origins for peculiar type Ia supernovae (SNe) and type II SNe with the framework of the core-merger detonation model. In the second part, I propose a new formation channel for the formation of black holes (BHs) and peculiar NSs (specifically, magnetars and Thorne-Zytkow objects [TZOs]), so-called as the core merger-induced collapse (CMIC) model which involves the merger inside a CE phase of an ONeMg WD and the core of a hydrogen-rich or helium-rich non-degenerate star. I also demonstrate that the central NS objects (e.g., pulsars and TZOs etc.) formed through CMIC could eventually become BHs. I also discuss how these objects born through the CMIC migh be related with peculiar SNe and fast radio bursts.

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Miguel	Gonzalez-Bolivar	Macquarie University	Common envelope evolution with a thermally pulsing AGB star donor.	Common envelope evolution (CEE) is one of the least understood process in Astrophysics. CEE occurs when, in a binary stellar system, the primary star evolves and overflows its Roche lobe. This can happen via physical expansion of the star or through contraction of the Roche lobe. This, in turn, starts a mass transfer phase between the binary components, and therefore, transport of angular moment. In this point the gas of the primary covers both stars and form the common envelope. In this work we put a 2 solar mass primary star on the AGB thermal pulse phase in orbit with a 0.6 solar mass companion at Roche Lobe Overflow and allowed them evolve until the core separation reached 30 solar radius. This work explores an unknown region in the energy space parameter that previous works have not been reached. We found that the post CE morphology is dependable on the evolutionary stage of the donor.
Mike	Lau	Monash University	3D hydrodynamical simulations of a massive star common-envelope	Extensive efforts have gone into modelling common-envelope evolution with 3D hydrodynamics over the past several decades. However, these simulations are very challenging due to the large dynamic range involved, and have been mostly unsuccessful in unbinding the entire envelope self-consistently and without making additional assumptions about energy deposition. These studies have also almost entirely focused on low mass donors of ~1-2 Msol (but, see Ricker et al. (2018) and Law-Smith et al. (2020)). We present our 3D, global common-envelope simulations involving a massive donor star, which is qualitatively different from low-mass stars as their envelopes have significant support from radiation pressure. We use the smoothed particle hydrodynamics code PHANTOM (Price et al., 2018) to perform a series of simulations with different equations of state in order to quantify the effects of radiation pressure and recombination energy in a red supergiant donor (Lau et al., in prep.). I will discuss how the amount of unbinding and the final separation are affected by the addition of radiation pressure and of ionisation/recombination.
Jakub	Klencki	Radboud University	Common-envelope evolution in massive binaries: insights from 1D stellar models	Although common-envelope (CE) evolution is a complex multidimentional process that inherently requires 3D hydrodynamic modelling, such simulations are computationally challenging and current numerical tools are not sufficient to answer all the questions. In an alternative approach, valuable insights can be gained from detailed 1D stellar and binary evolution computations. Low computational cost and flexibility of such models allow one to explore a large parameter space and tackle various questions related to CE evolution. I will present results from a comprehensive study of internal envelope structures of massive CE donors modeled with MESA stellar-evolution code. I will talk about factors such as the evolutionary stage of the donor, depth of the outer convective zone, and the internal mixing history, discussing their effects on the envelope and its binding energy. I will show how binary evolution models can shed some light on the pre-CE phase of mass transfer and its significance for the envelope structure at the onset of the dynamical inspiral. Finally, I will discuss how different amounts of H-rich envelope remaining on top of the giant's core can affect late stages of the CE inspiral and the post-CE evolution of a compact binary.

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Hila	Glanz	Technion - Israel Institute of Technology	Common envelope evolution of eccentric binaries	Although most binaries have non-negligible eccentricity, the effect of initial eccentricity on the CEE has been little explored. Moreover, most studies assume a complete circularization of the orbit by the CE onset, while observationally such eccentricities are detected in many post-CE binaries. Here we use smoothed-particle hydro-dynamical simulations (SPH) to study the evolution of initially eccentric (0â‰¤eâ‰¤0.95) CE-systems. We find that initially eccentric binaries only partially circularize. In addition, higher initial eccentricity leads to a higher post-CE eccentricity, with eccentricities of post-CE binaries as high as 0.2 in the most eccentric cases, and even higher if the initial peri-center of the orbit is located inside the star. CEE of more eccentric binaries leads to enhanced dynamical mass-loss of the CE compared with more circular binaries, and depends on the initial closest approach of the binary. We show that our results and the observed eccentricities of post-CE binaries suggest that the typical assumptions of circular orbits following CEE should potentially be revised. We expect post-CE eccentricities to affect the delay time distributions of various transients such as supernovae, GRBs and GWs by up to tens percents.
Sagiv	Shiber	Louisiana State University	Unbinding the stellar envelope in Grazing Envelope Evolution	I am conducting three-dimensional hydrodynamic simulations, showing that when a secondary star launches jets while interacting with a primary giant star in a close orbit, the companion slowly enters the envelope as the jets facilitate the unbinding of the giant star envelope outside the companion orbit, in what is termed grazing envelope evolution (GEE). The assumptions are that the secondary star, a main-sequence star, accretes mass via an accretion disk, and that the accretion disk launches the jets. The results indicate that systems with lower mass companions are more likely to result in a phase of GEE, when considering a certain jet power. With the smallest companion, a 0.1 solar mass star, the jets unbind 65% of the envelope mass, while almost none of the envelope is unbound if jets are not present. The jets produce a high velocity outflow in the polar directions, which is as massive as the equatorial outflow. These simulations are the first to demonstrate, from beginning to end, a GEE evolution.
Muhammad Zain	Mobeen	CAMK, Toruń	V838 Mon as revealed by ALMA and MATISSE	We present results from two studies that analyze observations of V838 Mon in the mid IR and Millimeter/Sub-millimeter bands using VLTI-MATISSE and ALMA respectively. Both regimes seem to indicate the presence of an elongated structure with roughly the same orientation in both bands. The ALMA data looks at V838 Mon and its B-type companion in unprecedented detail. We discuss the complex structure of the environment around V838 Mon as well as the position of the B type companion and its interaction with the merger ejecta.
Ondrej	Pejcha	Charles University	Comprehensive modeling of Luminous Red Nova progenitor and outburst: AT 2018bwo in NGC 45	Luminous red novae (LRNe) are transients that accompany common envelope (CE) events. Recent observations have revealed SEDs of the progenitors, gradual brightenings leading up to the main outburst, multi-component outburst light curves, and post-outburst evolution with complex multi-dimensional evolution of chemistry and dust. However, theories tying together all of these features are poorly constrained. Here, we show with observations and binary evolutionary models that the progenitor of LRN AT 2018bwo in NGC 45 was a yellow supergiant in a binary system undergoing semi-stable thermal-timescale mass transfer, allowing the primary to lose several M_Sun before the dynamical onset of the CE. We also suggest the onset of the dynamical instability was initiated by quick loss of angular momentum, caused by increasingly high L2/L3 mass loss, starting within the last few years before the outburst. The analysis of the primary envelopeâ€™s structure and the systemâ€™s orbital energy support a partial ejection of the binary CE, likely within the range of 0.15â˘’0.5 M_Sun. This mass is also in agreement with ejecta masses derived from modeling the energetics of the LRN outburst with both scaled supernova Type-IIP and shock-powered models.

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Yongzhi	Cai	Physics Department and Tsinghua Center for Astrophysics (THCA), Tsinghua University	The transitional gap transient AT 2018hso: new insights into the luminous red nova phenomenon	AT 2018hso is a new transient showing transitional properties between those of luminous red novae (LRNe) and the class of intermediate-luminosity red transients (ILRTs) similar to SN 2008S. The light curves of AT 2018hso show a first sharp peak (reddening-corrected M r = âˆ'13.93 mag), followed by a broader and shallower second peak that resembles a plateau in the optical bands. The spectra dramatically change with time. Early-time spectra show prominent Balmer emission lines and a weak [Ca ii] doublet, which is usually observed in ILRTs. However, the strong decrease in the continuum temperature, the appearance of narrow metal absorption lines, the great change in the HÎ± strength and profile, and the emergence of molecular bands support an LRN classification. The possible detection of a M I âˆ¼ âˆ'8 mag source at the position of AT 2018hso in HST archive images is consistent with expectations for a pre-merger massive binary, similar to the precursor of the 2015 LRN in M101. Through the detailed analysis of the observed parameters, our study supports that it actually belongs to the LRN class and was likely produced by the coalescence of two massive stars.
Vinaya	Valsan	University of Wisconsin-Milwaukee	A simplified framework to compute the observational apperence of CEE simulations to study Intermediate Luminosity Optical Transients.	Over the last decade, observations of a class of optical transients called, Intermediate Luminosity Optical Transients(ILOTs) that are brighter than novae, but dimmer than supernovae, suggest that at least a subset of them are the results of stellar mergers. However, a connection between these observed systems and numerical simulations of common envelope evolution has not been made. In an effort to make this connection, we develop a simplified framework to compute the observational appearance of common envelope evolution simulations. Here, we assume radial leakage of radiation from the radiative cooling layer in the thin-shell approximation. In this way, we can utilize purely hydrodynamic simulations of CEE without resorting to radiative hydrodynamics simulations of CEE, which is currently beyond the state of the art. We present a few example calculations as part of this ongoing work.
Roger	Hatfull	University of Alberta	Simulated observation of the V1309 Sco progenitor	Using the Smoothed Particle Hydrodynamics (SPH) code StarSmasher, we created three-dimensional (3D) stellar models of the donor star in a plausible V1309 Sco progenitor binary system 1.52+0.16 Msun. Our 3D models have integrated total energy profiles which match that of their initial one-dimensional (1D) MESA models to within 0.1% in the upper 0.1 Msun of their envelopes and are the best 3D models of the V1309 Sco donor so far. We present a method with which the effective temperatures of our 3D models are obtained to within a few percent of the 1D models, which corresponds to an improvement in luminosity values by a factor of >~10^6 over standard ray tracing. We brought our highest resolution 3D model to Roche-lobe overflow with a 0.16 Msun point-mass accretor (P=~1.6 days) and found a bolometric magnitude variability amplitude of ~0.3, which is comparable to that of the V1309 Sco progenitor. The initial conditions we present in this work could be used in a dynamical calculation to create a synthetic light curve of a common envelope event starting from the first contact.
Enrique	Moreno Mendez	UNAM	Formation channels for BBHs in the PISN mass gap through HCA during CE.	Several HD numerical studies have shown that compact objects in a common envelope accrete at a significant fraction of the BHL rate. This implies accretion rates which are some 8 orders of magnitude above the Eddington limit, and some 5 orders of magnitude above the limit where neutrino-cooling allows for hypercritical accretion (HCA). It has been shown that the accretion rate for a binary which is embedded in the envelope of a third star is not substantially smaller, either. In this work, we study triple-system channels which may allow the formation of BBHs with masses in the PISN mass gap through HCA.

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Melvin	Moreno	HITS	Common envelope interactions with a 10-solar-mass primary star	The common-envelope (CE) phase is thought to be a key step in the formation of many close compact-object binaries, including the progenitors of gravitational-wave merger events. Here, we present three-dimensional, hydrodynamic simulations of the CE interaction of a 10 Msun supergiant star with 5 Msun and 1.4 Msun companions. Such binary-star configurations might be relevant for the formation of merging neutron-star and black-hole binaries. We employ the moving-mesh code AREPO and find that the neutron-star mass companion spirals in deeper in the first few orbits than the black-hole mass companion. After the initial rapid plunge-in, the orbital decay slows down and quasi-stationary orbits are reached. A large fraction of the envelope gas is ejected, and we argue that successful envelope ejection will result in both setups. We discuss the further evolution and whether the resulting binary systems might be progenitors of observable gravitational-wave merger events.
Anders	Jerkstrand	Stockholm University	Superluminous supernova SN 2006gy as a result of common envelope merger between a white dwarf and a massive star	I present recent results on understanding the origin of one of the brightest supernovae ever seen, SN 2006gy (Jerkstrand, Maeda & Kawabata, Science 2020). Identification of a large iron reservoir in the ejecta indicates a thermonuclear explosion, in contrast to the core-collapse scenario almost exclusively invoked so far. A white dwarf exploding inside a recently ejected (~100y) common envelope of mass ~10 Msun, resulting from the merger with either a AGB or RSG star, can explain all the main properties of SN 2006gy. I discuss current ideas for how such a progenitor binary system could form, how the white dwarf could inspiral and explode, and implications for our understanding of common envelope physics.
Zhuo	Chen	Tsinghua University	A 1D radiationhydrodynamic model of massive ejecta - fill the gap between classic novae and supernovae	We are in an era of witnessing more and more stellar transients that fill the gap between classic novae and supernovae. Depending on the transients' light curve shape and luminosity, they are named, (luminous) red novae, and intermediate luminous red/optical transients. Observations show that they have broad Halpha emission, 10-100 days luminosity decay time, and spectroscopy that resembles the late K to M-type stars during their late-time evolution. One of the possible causes of their light curves is ejecta with an initial temperature of about 20000 K and a mass of about 0.01-0.1 solar mass at the speed above the escape velocity. In 1D, the luminosity is initially supplied by the recombination energy of hydrogen, then the recombination energy of molecular hydrogen. Our model is based on a self-consistent treatment of the realistic gas equation of state, hydrodynamics, and radiative transfer. We show that our 1D model can produce a similar luminosity plateau and an effective temperature of the abovementioned transients. We defer the parameter space exploration to the subsequent papers.
Andrei	Igoshev	University of Leeds	Timescale of common envelope ejection	The physics of the envelope ejection (CEE) is not yet understood, and several mechanisms were suggested to be involved. These mechanisms could give rise to different time-scales for the CEE. In order to probe the CEE-time-scales we study wide companions to post-CE binaries. Faster mass-loss time-scales give rise to higher disruption rates of wide binaries and result in larger average separations. We make use of data from Gaia DR2 to search for ultrawide companions (projected separations 1e3 - 2e5 au and M_2 > 0.4 solar masses) to several types of post-CEE systems, including sdBs, white dwarf post-common binaries, and cataclysmic variables. We find a (wide-orbit) multiplicity fraction of 1.4 Â± 0.2% for sdBs to be compared with a multiplicity fraction of 5.0 Â± 0.2% for late-B/A/F stars which are possible sdB progenitors. The distribution of projected separations of ultrawide pairs to main sequence stars and sdBs differs significantly and is compatible with prompt mass-loss. The survival rate of ultrawide pairs to the cataclysmic variables suggest much longer, ~1e4 yr time-scales for the CEE in these systems, possibly suggesting non-dynamical CEE in this regime.

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A. Miguel	Holgado	Carnegie Mellon University	The Role of Strong Gravity and the Nuclear Equation of State on Neutron-Star CE Accretion	As a neutron star inspirals within a massive star during common-envelope evolution, it accretes and spins up. Because neutron stars are in the strong-gravity regime, they have a substantial relativistic mass deficit, i.e., their gravitational mass is less than their baryonic mass. This effect causes some fraction of the accreted baryonic mass to convert into neutron star binding energy. The relativistic mass deficit also depends on the nuclear equation of state, since more compact neutron stars will have larger binding energies. We model the mass growth and spin-up of neutron stars inspiraling within common-envelope environments and quantify how different initial binary conditions and hadronic equations of state affect the post-common-envelope neutron star's mass and spin. From these models, we find that neutron star mass growth is suppressed by â‰ˆ15â ˆ'30%. We also find that for a given amount of accreted baryonic mass, more compact neutron stars will spin-up faster while gaining less gravitational mass, and vice versa. This work demonstrates that a neutron star's strong gravity and nuclear microphysics plays a role in neutron-star-common-envelope evolution, in addition to the macroscopic astrophysics of the envelope.
Javier	Moran Fraile	HITS	Gravitational Wave emission from Dynamic Stellar interactions	With the perspective of the LISA observatory being launched in the near future, we discuss whether the gravitational waves resulting from stellar interactions can be detected by LISA. On the basis of 3D simulations, we analyse the chances of detecting successful and failed common envelope events and stellar mergers, as well as what new aspects we can learn from the detailed computation of the signals they produce.
Avishai	Gilkis	Tel Aviv University	An optimal envelope ejection efficiency for merging neutron stars	We use the rapid binary stellar evolution code binary_c to estimate the rate of merging neutron stars for numerous combinations of envelope ejection efficiency and natal kick dispersion. We find a peak in the local rate of merging neutron stars as a function of the efficiency of utilizing orbital energy to unbind the envelope. The peak height decreases with increasing electron-capture supernova kick dispersion. We explain the peak as a competition between the total number of systems which survive the common-envelope phase increasing with ejection efficiency and their separation, which increases with the ejection efficiency as well. Increasing the ejection efficiency reduces the fraction of systems which merge within a time shorter than the age of the Universe and results in different mass distributions for merging and non-merging double neutron stars, offering a possible explanation for the discrepancy between the Galactic double neutron star mass distribution and the recently observed massive merging neutron star event GW190425. The estimated rate of merging neutron stars spans several orders of magnitude and can be higher than the observed upper limit or lower than the observed lower limit inferred thus far from merging neutron stars detected by gravitational waves.
Barry	Ginat	Technion - Israel Institute of Technology	Gravitational waves from in-spirals of compact objects in binary common-envelope evolution	Detection of gravitational-wave sources enables the characterization of binary compact objects and of their in-spiral. However, other dissipative processes can affect the in-spiral. In this talk I will show that the in-spiral of compact objects through a gaseous common envelope arising from an evolved stellar companion produces a novel type of gravitational-wave sources, whose evolution is dominated by the dissipative gas dynamical friction effects from the common envelope, rather than the gravitational-wave emission itself. The evolution and properties of the gravitational-wave signals differ from those of isolated gas-poor mergers significantly. Characteristic strains of âˆ¼10-23-10-21 (10 kpc/{D}) are found for such sources - observable by next-generation space-based detectors (at rates of once per a few centuries for LISA, and about once a year for BBO). The evolution of the gravitational-wave signal can serve as a probe of the interior regions of the evolved star, and the final stages of common envelope evolution, otherwise inaccessible through other observational means. Moreover, such common envelope mergers are frequently followed by observable explosive electromagnetic counterparts and/or the formation of exotic stars.

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Muhammad	Akashi	Technion & Kinneret College	Explosive neutron star binary merger in common envelope jets supernovae	I will present three-dimensional hydrodynamical simulations of an explosive merger of two neutron stars (NSs) inside the envelope of a red supergiant (RSG) star during a triple-star common envelope evolution. The pre-merger evolution is of a RSG star that engulfs a tight (inner) NS binary system that starts spiraling-in inside the RSG envelope. The NSs accretes mass through an accretion disk and launch jets. The jets power a bright transient event that is termed a common envelope jets supernova (CEJSN). The jets also inflate the RSG envelope. The accretion of mass and dynamical friction might lead the two close NS to merge inside the envelope, a process that releases 1e50 to 1e51 erg. I will present simulations of explosive NS-NS mergers inside the inflated envelope of a non-rotating RSG of initial mass of 30Mo. The simulations include a point mass gravity that represents the RSG core and radiation pressure. I will present the propagation of the shock inside the RSG star and demonstrate that some mass in the center stays bound, allowing further common envelope evolution.
Ashley	Ruiter	University of New South Wales Canberra	Common envelopes in giant couples	In the near future a massive deluge of data from transient stellar sources will be upon us. While many of these stellar transients will result from cosmic explosions (various types of supernovae and other outbursts involving compact and/or accretingÂ binaries), a number of transients that will be picked up by the Vera Rubin Observatory will involve interacting stars that exchange and/or expel matter more quiescently - during a common envelope. Binaries consisting of two red giant-like stars that undergo a common envelope event will be easier to spot (electromagnetically) leading up to the interaction compared to their low-visibility progeny - double white dwarf binaries. These 'giant couples' that interact present an interestingÂ opportunity to learnÂ about binary evolution, the common envelope phase, and its outcomes, in low-mass evolved stars.Â
stephania	hernandez	universidad de valparaiso	The white dwarf binary pathways survey	The binary pathway survey search to improve the knowledge we have about detached binaries of AFGK type secondary stars with a white dwarf companion (WD+ AFGK). Studying the evolution of these systems can help us to constrain important phases of close compact binary star formation and evolution with deep implications for our understanding of the pathways towards supernova Ia explosions. We used the binary star evolution code and the Modules for Experiments in Stellar Astrophysics (MESA), to estimate the history and future evolution of five WD binaries with a G spectral type secondary stars and orbital periods between 1-2 days. Based on spectral fitting and Gaia parallaxes, we found the radii of the secondaries in three systems are significantly larger than their corresponding ZAMS radii, indicating they are slightly evolved. We predict the future of these five binaries and find that they will take very different ways, all of them interesting and providing new constraints on white dwarf binary star evolution.
Karan	Dsilva	KU Leuven	The multiplicity of galactic Wolf-Rayet stars	Massive stars â€‹are key drivers in the evolution of galaxies, responsible for a plethora of astrophysical phenomena such as supernovae, pulsars, black holes, and gravitational waves. It is now well established that the majority of massive stars form and evolve in the presence of one or more companions with which they will interact during their lifetime. Stars that are massive enough will eventually reach the classical Wolf-Rayet (WR) phase that is characterized by strong winds and hydrogen depletion. However, the fraction of WR stars that may form via binary interaction is unclear. Knowledge of the true multiplicity of WR stars is crucial for understanding the impact of binarity on the evolution of massive stars. So far, no systematic studies attempting to derive the bias-corrected binary fraction of the Galactic WR stars were performed. Here we present the results of a multi-epoch, radial-velocity (RV) survey of galactic WR stars with high-resolution spectra observed with the HERMES spectrograph mounted on the Mercator telescope. In my talk, I will illustrate the first bias-corrected determination of the binary fraction of Galactic WR stars and discuss the evolutionary link with literature studies of O-stars and LBVs.

First Name	Last Name	Afiliation	Title	Abstract
Palmira	Jimenez	Instituto de Radioastronomía y Astrofísica, UNAM	Dust properties in M1-67 and RCW 58: evidence for a post-common envelope scenario in massive stars?	The properties of gas and dust in ejecta nebulae around Wolf-Rayet stars can be used to infer the mass-loss history of massive stars in the late stages of their evolution. We use archive photometric observations from WISE, Spitzer and Herschel to construct the spectral energy distributions (SED) of the nebulae M1-67 and RCW 58, which surround stars of the enigmatic WN8h spectral type. Modeling with the spectral synthesis code Cloudy shows that in both nebulae the infrared SED and photoionized gas properties can be reproduced by a dusty shell consisting of two population of grains. The mass of the dust is dominated by the population of largest grains, with size around 0.9 micron. The large grain size and high dust-to-gas mass ratio in both nebulae suggest a similar eruptive dust-formation history for the two objects. Common Envelope (CE) evolution can result in the ejection of the CE and a tighter binary. We speculate that M 1-67 and RCW 58 could represent the first observational evidence for a post-CE scenario in massive stars.
Aldana	Grichener	Technion Israel Institute of Technology	Common envelope jets supernovae with a black hole companion as possible high energy neutrino sources	We study high energy neutrino emission from relativistic jets launched by a black hole (BH) spiraling-in inside the envelope of a red supergiant (RSG), and find that such common envelope jets supernovae (CEJSNe) are a potential source for the ~10^15 eV neutrinos detected by IceCube. We study the propagation of jets inside an extended RSG envelope and find that in most cases the jets do not penetrate the envelope but are rather stalled. We show that such jets can accelerate cosmic rays to high enough energies to produce high energy neutrinos, and that CEJSNe with BH companions might have a substantial contribution to the high energy neutrinos flux detected by IceCube.
Diego	Lopez Camara	Instituto de Astronomía, UNAM	Jets during the plunge in the Common Envelope phase	During the common envelope (CE) phase the less massive star of the binary stellar system is engulfed by the envelope of the most massive star. Also, the less massive star may accrete material hypercritically and launch a jet. In this talk, by a set of 3D hydrodynamic simulations, I will show the effects and importance that a jet launched from a main sequence (MS) in the CE of a red giant (RG) has. Three characteristic moments (a. when the MS is grazing the RG, b. when it is plunging in, and c. when the plunge-in ends), as well as the differences if the jet is self-regulated or constantly powered, are studied.
Yangyuxin (Amy)	Zou	Department of Physics and Astronomy, University of Rochester, NY 14620, USA	Jets in Common Envelope Simulations	We conduct global 3D hydrodynamic simulations of common envelope evolution involving accretion and jets associated with the companion. We compare cases with different jet mass loss rates up to ten times the Eddington accretion rate of a main sequence star. The differences between simulations with and without jets are small for jet mass loss rates up to ten times the Eddington value. The jets become quenched around the time of first periastron passage. We find that the simulations with jets unbind slightly more envelope material in the first ten orbits (40-day duration of the simulation) compared to the run with no jets. We will also report on simulations with a white dwarf or neutron star accretor.
Shlomi	Hillel	Technion	Feedback and outflow morphology from simulations of common envelope jets supernovae	We will present three-dimensional hydrodynamical simulations of the interaction of jets that a neutron star (NS) companion launches inside the envelope of a giant massive star as the binary system experiences the common envelope jets supernova (CEJSN) evolution. We maintain an idealized constant orbital radius to find the negative feedback effect of the jets on the mass accretion rate as the jets inflate the envelope. We will also present the outflow morphology as a result of the jet-envelope interaction. Both the negative feedback effect and the highly non-spherical outflow morphology affect the light-curves of CEJSN and impostors.

First Name	Last Name	Afiliation	Title	Abstract
Ron	Schreier	Technion Israel Institute of Technology	Simulations of highly-eccentric common envelope jets supernova (CEJSN) impostors	We will present three-dimensional hydrodynamical simulations of eccentric common envelope jets supernova (CEJSN) impostors, i.e., a neutron star (NS) that crosses through the envelope of a red supergiant star on a highly eccentric orbit and launches jets as it accretes mass from the envelope. We will present a movie of the very complicated outflow morphology, being clumpy, and non-spherical. We estimate by simple means the light curve to be very bumpy, to have a rise time of one to a few months, and to slowly decay in about a year to several years. These eccentric CEJSN impostors will be classified as `gap' objects, i.e., having a luminosity between those of classical novae and typical supernovae. We strengthen a previous conclusion that CEJSN impostors might account for some peculiar transients, in particular those that might repeat over timescales of months to years.
Luke	Chamandy	University of Rochester	Common envelope evolution and low-mass companions	Most stars host planets, some of which will be engulfed when the star expands during its post-main sequence evolution. Soszy\'{n}ski et al.~(2021) recently argued that planets around evolved stars often accrete enough material to become brown dwarfs or low-mass M-dwarfs. Understanding the common envelope evolution that results from engulfment of low-mass companions is crucial for predicting the properties of companions around white dwarfs, and may be a key to understanding mass loss, aspherical planetary nebulae, high-field magnetic white dwarfs, and other classes of stars. After briefly reviewing the subject, I will describe a simple model we are developing to explain the system WD 1856+534, which contains the first planet detected orbiting a white dwarf. I will also present initial results from our first CE simulations involving planet and brown dwarf companions.
Felipe	Lagos	University of ValparaÃso	WD1856b: a close giant planet around a white dwarf that could have survived a common-envelope phase	The discovery of a giant planet candidate orbiting the white dwarf WD 1856+534 with an orbital period of 1.4 d poses the questions of how the planet reached its current position. We here reconstruct the evolutionary history of the system assuming common envelope evolution as the main mechanism that brought the planet to its current position. We find that common envelope evolution can explain the present configuration if it was initiated when the host star was on the AGB, the separation of the planet at the onset of mass transfer was in the range 1.69â€“2.35 au, and if in addition to the orbital energy of the surviving planet either recombination energy stored in the envelope or another source of additional energy contributed to expelling the envelope. We also discuss the evolution of the planet prior to and following common envelope evolution. Finally, we find that if the system formed through common envelope evolution,its total age is in agreement with its membership to the Galactic thin disc.We therefore conclude that common envelope evolution is at least as likely as alternative formation scenarios previously suggested such as planet-planet scattering or Zeipel-Kozai-Lidov oscillations.
Semih	Filiz	University of Potsdam	A new class of variable white dwarfs and their mysterious nature	The occurrence of absorption lines of ultra-highly excited (UHE) metals (e.g. O VIII) in their optical spectra of freshly born white dwarfs pose a decades-long mystery. Our recent photometric study revealed that these UHE white dwarfs show a high variability rate (75%), identifying them as a new class of variable white dwarfs. The period-distribution of UHE white dwarfs agrees with the orbital period distribution of post-common envelope binaries, raising the question whether a reflection effect could be the source of the photometric variability. In my talk, Iâ€™ll discuss further possibilities for the origin of photometric variability and indications of our most recent results.

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Bruce	Balick	University of Washington	Did you ever see the winds emerging from a close binary star?	The geometry, momentum flux, and speed distribution of winds ejected from a CE are the best observational constraints that we can place on their launching mechanisms. However, until now, the winds have been invisible (aside from poorly resolved soft x-rays): all we could observe was the loci of wind impacts where the winds strike, compress, and shock old, ambient gas. In this talk I will present a video of the winds flowing from its famous jets into the surrounding lobes of R Aqrâ€”a very active symbiotic binary star. The video is comprised multi-filter images spanning six years extracted from the Hubble Legacy Archives. We find the same sort of collimated, frothy, and visibly turbulent structure powered by thermal pressure, much as the ignited gas from the nozzle of a flamethrower. In addition, the ionization state of the gas changes as we watch, presumably as ephemeral shocks form at the outer edges of expanding bubbles of hot gas within turbulent post-ejection medium.