PlaN-B News

Welcome to the *bumper* first edition of the newly revived PlaN-B Newsletter! This newsletter is intended to highlight recent publications of interest to the community, collect any information regarding conferences, workshops or anything at all that might be of relevance to the community, and (hopefully) spark discussion, collaboration and, ultimately, progress in the field!
Any comments, suggestions, compliments can be sent to planb@drdjones.net and submissions for the next newsletter can be made at drdjones.net/planbsubmit. Please share with your colleagues and students! To signup for the newsletter go to drdjones.net/planbsignup.

Refereed papers

The post-common-envelope, binary central star of the planetary nebula Hen 2-11

D. Jones, H.M.J. Boffin, B. Miszalski, R. Wesson, R.L.M. Corradi & A.A. Tyndall

We present a detailed photometric study of the central star system of the planetary nebula Hen 2-11, selected for study because of its low-ionisation filaments and bipolar morphology – traits which have been strongly linked with central star binarity. Photometric monitoring with NTT-EFOSC2 reveals a highly irradiated, double-eclipsing, post-common-envelope system with a period of 0.609 days. Modelling of the lightcurve indicates that the nebular progenitor is extremely hot, while the secondary in the system is probably a K-type main sequence star. The chemical composition of the nebula is analysed, showing Hen 2-11 to be a medium-excitation non-Type I nebula. A simple photoionisation model is constructed determining abundance ratios of C/O and N/O which would be consistent with the common-envelope cutting short the AGB evolution of the nebular progenitor.

The detection of a post-common-envelope binary system at the heart of Hen 2-11 further strengthens the link between binary progeny and the formation of axisymmetric planetary nebulae with patterns of low-ionisation filaments, clearly demonstrating their use as morphological indicators of central star binarity.

arXiv:1401.1358

Studies of Variability in Proto-Planetary Nebulae: II. Light and Velocity Curve Analyses of Iras 22272+5435 and 22223+4327

Bruce J. Hrivnak, Wenxian Lu, Julius Sperauskas, Hans Van Winckel, David Bohlender, Laimons Zacs

We have carried out a detailed observational study of the light, color, and velocity variations of two bright, carbon-rich proto-planetary nebulae, IRAS 22223+4327 and 22272+5435. The light curves are based upon our observations from 1994 to 2011, together with published data by Arkhipova and collaborators. They each display four significant periods, with primary periods for IRAS 22223+4327 and 22272+5435 being 90 and 132 days, respectively. For each of them, the ratio of secondary to primary period is 0.95, a value much different from that found in Cepheids, but which may be characteristic of post-AGB stars. Fewer significant periods are found in the smaller radial velocity data sets, but they agree with those of the light curves. The color curves generally mimic the light curves, with the objects reddest when faintest. A comparison in seasons when there exist contemporaneous light, color, and velocity curves reveals that the light and color curves are in phase, while the radial velocity curves are 0.25 out of phase with the light curves. Thus they differ from what is seen in Cepheids, in which the radial velocity curve is 0.50 P out of phase with the light curve. Comparison of the observed periods and amplitudes with those of post-AGB pulsation models shows poor agreement, especially for the periods, which are much longer than predicted. These observational data, particularly the contemporaneous light, color, and velocity curves, provide an excellent benchmark for new pulsation models of cool stars in the post-AGB, proto-planetary nebula phase.

arXiv:1310.8558

Search for binary central stars of the SMC PNe

M. Hajduk, M. Gladkowski, I. Soszyński

The Optical Gravitational Lensing Experiment (OGLE), originally designed to search for microlensing events, provides a rich and uniform data set suitable for studying the variability of certain types of objects. We used the OGLE data to study the photometry of central stars of planetary nebulae (PNe) in the Small Magellanic Cloud (SMC). In particular, we searched for close binary central stars with the aim to constrain the binary fraction and period distribution in the SMC. We also searched for PNe mimics and removed them from the PNe sample. We identified 52 counterparts of PNe in the SMC in the I-band images from the OGLE-II and OGLE-III surveys. We analysed the time-series photometry of the PNe. Spectra of the photometric variables were obtained to constrain the nature of the objects or search for additional evidence for binarity. Eight variables were found. Of these, seven objects are PNe mimics, including one symbiotic star candidate. One close binary central star of PN with a period of 1.15 or 2.31 day was discovered. The obtained binary fraction for the SMC PNe and the observational biases are discussed in terms of the OGLE observations.

arXiv:1312.5917

SALT reveals the barium central star of the planetary nebula Hen 2-39

B. Miszalski, H.M.J Boffin, D. Jones, A.I. Karakas, J. Köppen, A.A. Tyndall, S.S. Mohamed, P. Rodríguez-Gil, M. Santander-García

Classical barium stars are binary systems which consist of a late-type giant enriched in carbon and slow neutron capture (s-process) elements and an evolved white dwarf (WD) that is invisible at optical wavelengths. The youngest observed barium stars are surrounded by planetary nebulae (PNe), ejected soon after the wind accretion of polluted material when the WD was in its preceeding asymptotic giant branch (AGB) phase. Such systems are rare but powerful laboratories for studying AGB nucleosynthesis as we can measure the chemical abundances of both the polluted star and the nebula ejected by the polluter. Here we present evidence for a barium star in the PN Hen 2-39. The polluted giant is very similar to that found in WeBo 1. It is a cool (Teff=4250 +/- 150 K) giant enhanced in carbon ([C/H]=0.42 +/- 0.02 dex) and barium ([Ba/Fe]=1.50 +/- 0.25 dex). A spectral type of C-R3 $C_2$4 nominally places Hen 2-39 amongst the peculiar early R-type carbon stars, however the barium enhancement and likely binary status mean that it is more likely to be a barium star with similar properties, rather than a true member of this class. An AGB star model of initial mass 1.8 Msun and a relatively large carbon pocket size can reproduce the observed abundances well, provided mass is transferred in a highly conservative way from the AGB star to the polluted star (e.g. wind Roche-lobe overflow). The nebula exhibits an apparent ring morphology in keeping with the other PNe around barium stars (WeBo 1 and A 70) and shows a high degree of ionization implying the presence of an invisible hot pre-WD companion that will require confirmation with UV observations. In contrast to A 70, the nebular chemical abundance

pattern is consistent with non-Type I PNe, in keeping with the trend found from nebular s-process studies that non-Type I PNe are more likely to be s-process enhanced. (abridged)

arXiv:1309.5239

Using Kinematic Properties of Pre-Planetary Nebulae to Constrain Engine Paradigms

Eric G. Blackman, Scott Lucchini

Some combination of binary interactions and accretion plausibly conspire to produce the ubiquitous collimated outflows from planetary nebulae (PN) and their presumed pre-planetary nebulae (PPN) precursors. But which accretion engines are viable? The difficulty in observationally resolving the engines warrants the pursuit of indirect constraints. We show how kinematic outflow data for 19 PPN can be used to determine the minimum required accretion rates. We consider main sequence (MS) and white dwarf (WD) accretors and five example accretion rates inferred from published models to compare with the minima derived from outflow momentum conservation. While our primary goal is to show the method in anticipation of more data and better theoretical constraints, taking the present results at face value already rule out modes of accretion: Bondi-Hoyle Lyttleton (BHL) wind accretion and wind Roche lobe overflow (M-WRLOF, based on Mira parameters) are too feeble for all 19/19 objects for a MS accretor. For a WD accretor, BHL is ruled out for 18/19 objects and M-WRLOF for 15/19 objects. Roche lobe overflow (RLOF) from the primary at the Red Rectangle level can accommodate 7/19 objects, though RLOF modes with higher accretion rates are not yet ruled out. Accretion modes operating from within common envelope evolution can accommodate all 19 objects, if jet collimation can be maintained. Overall, sub-Eddington rates for a MS accretor are acceptable but 8/19 would require super-Eddington rates for a WD.

arXiv:1312.5372

Two rings but no fellowship: LoTr 1 and its relation to planetary nebulae possessing barium central stars

A.A. Tyndall, D. Jones, H.M.J. Boffin, B. Miszalski, F. Faedi, M. Lloyd, J.A. López, S. Martell, D. Pollacco, M. Santander-García

LoTr 1 is a planetary nebula thought to contain an intermediate-period binary central star system (that is, a system with an orbital period, P, between 100 and, say, 1500 days). The system shows the signature of a K-type, rapidly rotating giant, and most likely constitutes an accretion-induced post-mass transfer system similar to other PNe such as LoTr 5, WeBo 1 and A70. Such systems represent rare opportunities to further the investigation into the formation of barium stars and intermediate period post-AGB systems – a formation process still far from being understood. Here, we present the first detailed analyses of both the central star system and the surrounding nebula of LoTr 1 using a combination of spectra obtained with VLT-FORS2, AAT-UCLES and NTT-EMMI, as well as SuperWASP photometry. We confirm the binary nature of the central star of LoTr 1 that consists of a K1 III giant and a hot white dwarf. The cool giant does not present any sign of s-process enhancement but is shown to have a rotation period of 6.4 days, which is a possible sign of mass accretion. LoTr 1 also presents broad double-peaked H-alpha emission lines, whose origin is still unclear. The nebula of LoTr 1 consists in two slightly elongated shells, with ages of 17,000 and 35,000 years, respectively, and with different orientations. As such, LoTr 1 present a very different nebular morphology than A70 and WeBo 1, which may be an indication of difference in the mass transfer episodes

arXiv:1309.4307

Constraints on Common Envelope Magnetic Fields from Observations of Jets in Planetary Nebulae

James Tocknell, Orsola De Marco, Mark Wardle

The common envelope (CE) interaction describes the swallowing of a nearby companion by a growing, evolving star. CEs that take place during the asymptotic giant branch phase of the primary and may lead to the formation of a planetary nebula (PN) with a post-CE close binary in the middle. We have used published observations of masses and kinematics of jets in four post-CE PN to infer physical characteristics of the CE interaction. In three of the four systems studied, Abell 63, ETHOS 1 and the Necklace PN, the kinematics indicate that the jets were launched a few thousand years before the CE and we favour a scenario where this happened before Roche lobe overflow, although better models of wind accretion and wind Roche lobe overflow are needed. The magnetic fields inferred to launch pre-CE jets are of the order of a few Gauss. In the fourth case, NGC 6778, the kinematics indicate that the jets were launched about 3000 years after the CE interaction. Magnetic fields of the order of a few hundreds to a few thousands Gauss are inferred in this case, approximately in line with predictions of post-CE magnetic fields. However, we remark that in the case of this system, it is impossible to find a reasonable scenario for the formation of the two jet pairs observed: the small orbital separation would preclude the formation of even one accretion disk able to supply the necessary accretion rate to cause the observed jets.

arXiv:1308.5027

Evidence of a Binary-Induced Spiral from an Incomplete Ring Pattern of CIT 6

Hyosun Kim, I-Ta Hsieh, Sheng-Yuan Liu, Ronald E. Taam

With the advent of high-resolution high-sensitivity observations, spiral patterns have been revealed around several asymptotic giant branch (AGB) stars. Such patterns can provide possible evidence for the existence of central binary stars embedded in outflowing circumstellar envelopes. Here, we suggest the viability of explaining the previously observed incomplete ring-like patterns with the spiral-shell structure due to the motion of (unknown) binary components viewed at an inclination with respect to the orbital plane. We describe a method of extracting such spiral-shells from an incomplete ring-like pattern to place constraints on the characteristics of the central binary stars. The use of gas kinematics is essential in facilitating a detailed modeling for the three-dimensional structure of the circumstellar pattern. We show that a hydrodynamic radiative transfer model can reproduce the structure of the HC3N molecular line emission of the extreme carbon star, CIT 6. This method can be applied to other sources in the AGB phase and to the outer ring-like patterns of pre-planetary nebulae for probing the existence of embedded binary stars, which are highly anticipated with future observations using the Atacama Large Millimeter/submillimeter Array.

arXiv:1308.4140

Discovery of a planetary nebula surrounding the symbiotic star DT Serpentis

U. Munari, R. L. M. Corradi, A. Siviero, L. Baldinelli, A. Maitan

We report the discovery of a planetary nebula centered on the poorly studied symbiotic binary star DT Ser. In a few other symbiotic stars spatially resolved nebulae have been discovered: however, only one of them might be a genuine planetary nebula, while the others are likely to originate in complex mass ejections episodes from the interacting binary central stars, possibly related to nova-like outbursts. The rim of the planetary nebula around DT Ser is severely distorted toward a brighter star, 5 arcsec away. In infrared WISE data, this star shows the presence of a detached cold dust shell such as those observed in post-AGB stars. The apparent association of the symbiotic star and its planetary nebula with the nearby possible post-AGB object is discussed. We also discuss the sparse and conflicting literature data that could support an observed variability of the

surface brightness of the planetary nebula. The puzzling and intriguing characteristics displayed by DT Ser are surely worth further and more detailed investigations.

arXiv:1308.3979

Planetary nebulae after common-envelope phases initiated by low-mass red giants

Philip D. Hall, Christopher A. Tout, Robert G. Izzard, Denise Keller

It is likely that at least some planetary nebulae are composed of matter which was ejected from a binary star system during common-envelope (CE) evolution. For these planetary nebulae the ionizing component is the hot and luminous remnant of a giant which had its envelope ejected by a companion in the process of spiralling-in to its current short-period orbit. A large fraction of CE phases which end with ejection of the envelope are thought to be initiated by low-mass red giants, giants with inert, degenerate helium cores. We discuss the possible end-of-CE structures of such stars and their subsequent evolution to investigate for which structures planetary nebulae are formed. We assume that a planetary nebula forms if the remnant reaches an effective temperature greater than 30 kK within 10^4 yr of ejecting its envelope. We assume that the composition profile is unchanged during the CE phase so that possible remnant structures are parametrized by the end-of-CE core mass, envelope mass and entropy profile. We find that planetary nebulae are expected in post-CE systems with core masses greater than about 0.3 solar masses if remnants end the CE phase in thermal equilibrium. We show that whether the remnant undergoes a pre-white dwarf plateau phase depends on the prescribed end-of-CE envelope mass. Thus, observing a young post-CE system would constrain the end-of CE envelope mass and post-CE evolution.

arXiv:1307.8023