11th International Conference on Hot Subdwarf Stars and Related Objects

Programme and Abstract Booklet

11th – 15th September 2023

	09:00 – 09:30 REGISTRATION
MONDAY	**09:30 – 11:00 (Surveys). Chair: Stephan Geier**
Michael Burton, Simon Jeffery, Heather Alexander	Welcome and Introduction
Ingrid Pelisoli	Hot subdwarfs with 4MOST: what to expect
Harry Dawson	Towards characterising the 500 pc volume-limited sample of hot subluminous stars
Matti Dorsch	Connecting the dots: stellar parameters, binarity, and kinematics
	11:00 - 11:30 TEA/COFFEE + REGISTRATION
MONDAY	**11:30 - 13:00 (Surveys). Chair: Stephan Geier**
Ralf Napiwotzki	The origin of subdwarf B stars II
Thomas Kupfer	Search for photometric variability in the catalog of hot subdwarf stars
Keyu Xing	Flares in hot subdwarf and white dwarf stars from the 1-4 cycles of TESS photometry
Jiangdan Li	Hot subdwarfs candidates surrounded by remnant circumbinary material from common envelope phase
	13:00 - 14:00 LUNCH

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MONDAY	**14:00 - 15:30 (Clusters/Surveys). Chair: Roy Østensen**
	POSTERS (S1, S2, S3)
Marilyn Latour	Peering at the Blue Horizontal Branch stars in the core of Omega Centauri and NGC 6752
Oliver Steppohn	Blue Horizontal Branch Stars: Identification and Kinematics
Rick Culpan	Comparing rates of binarity in blue horizontal-branch and extended horizontal-branch objects
	15:30 - 16:00 TEA/COFFEE
MONDAY	**16:00 - 17:00 (Surveys/ELMs). Chair: Roy Østensen**
Simon Jeffery	Highlights from the SALT survey of helium-rich hot subdwarfs
Steven Parsons	The white dwarf binary pathways survey
Larissa Antunes Amaral	Search for new variable Extremely-low mass white dwarf stars
	17:15 OBERVATORY TOUR AND 19:00 RECEPTION AT AOP
TUESDAY	**09:30 – 11:00 (Evolution). Chair: Holly Preece**
Zhanwen Han	Understanding Common Envelope Evolution in sdB Binaries

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Nicolas Rodriguez Segovia	Revisiting sub-dwarf B star formation channels with the COMPAS binary population synthesis code
	DISCUSSION (SURVEYS)
	11:00 - 11:30 TEA/COFFEE
TUESDAY	**11:30 - 13:00 (Evolution). Chair: Holly Preece**
Philipp Podsiadlowski	The Spin-Down of White Dwarf Mergers
Eduardo Alfredo Arancibia Rojas	The mass range of hot subdwarf B stars from MESA simulations
Zhenwei Li	A new route to massive hot subdwarfs: common envelope ejection from asymptotic giant branch stars
Xuefei Chen	The theoretical progress and recent observations on extremely low- mass white dwarfs
	13:00 - 14:00 LUNCH
TUESDAY	**14:00 - 15:10 (Evolution/Triples). Chair: Conor Byrne**
Holly Preece	sdOB stars formed from hierarchical triples and their properties
	POSTERS (B1, E1)
	DISCUSSION (EVOLUTION)
	15:10 - 15:40 TEA/COFFEE
TUESDAY	**15:40 - 16:50 (Runaways). Chair: Conor Byrne**

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Uli Heber	The fastest hot subdwarf stars
Evan Bauer	The Fastest Hypervelocity Stars and Hot Subdwarfs
Aakash Bhat	From main sequence runaways to subluminous hypervelocity stars: a multi-modal narrative of escape
	17:00 WALKING TOUR OF ARMAGH
	19:00 PUBLIC TALK on THE EXCITING LIVES OF DOUBLE STARS by S GEIER
WEDNESDAY	**09:30 – 11:00 (Binaries). Chair: Ozgur Basturk**
Brad Barlow	Surfing the (Sine) Waves: Fourier Analyses of Hot Subdwarf Binaries Observed with TESS
Edward Snowdon	Helium-rich binary subdwarf candidates identified with SALT and TESS
Eric Stringer	Detailed Follow-up Studies of Three Ultracompact sdB Binaries
Bryce Smith	EC 23257-5443: An Anomalous Reflection Effect Binary with Phase-Dependent Emission
	11:00 - 11:30 TEA/COFFEE
WEDNESDAY	**11:30 - 12:30 (Binaries). Chair: Ozgur Basturk**
	POSTERS (B2, B3)

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Stephan Geier	Gaia strikes again - A new class of hot subdwarf binaries revealed by astrometry
Luqian Wang	Detection and Characterization of sdO companions of massive stars
	13:00 - 17:00 EXCURSION TO NAVAN FORT (INCLUDING LUNCH)
THURSDAY	**09:30 – 11:00 (Binaries). Chair: Ingrid Pelisoli**
Veronika Schaffenroth	Hot subdwarf binaries at intermediate periods
Isaac D. Lopez	Follow-up Observations of the Fastest Known HW Vir
Ozgur Basturk	PCEB Systems Displaying Eclipse Timing Variations
Kunal Prashant Deshmukh	Modelling the Double Detonation Supernova Progenitor CD -30 11223
	11:00 - 11:30 TEA/COFFEE
THURSDAY	**11:30 - 13:00 (Binaries/Pulsation). Chair: Ingrid Pelisoli**
	DISCUSSION (BINARIES + RUNAWAYS)
Mike Reed	Another Year of Pulsation Progress - Balloon, TESS, and Kepler
Xiaoyu Ma	Amplitude and frequency variations in two pulsating sdB stars from K2 photometry

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	13:00 - 14:00 LUNCH
THURSDAY	**14:00 - 15:30 (Pulsation). Chair: Mike Reed**
Conor Byrne	Binary evolution pathways of blue large-amplitude pulsators
Corey Bradshaw	An Investigation into the Properties and Evolutionary Status of Radial-Mode Hot-Subdwarf Pulsators and Blue Large-Amplitude Pulsators
Xiangcun Meng	BLAPs-the surviving companions of SNe Ia
Heran Xiong	Shell-helium-burning hot subdwarf B stars as candidates for Blue Large Amplitude Pulsators
	15:30 - 16:00 TEA/COFFEE
THURSDAY	**16:00 - 17:00 (Pulsation). Chair: Mike Reed**
	POSTERS (P1, P2)
Valerie Van Grootel	Feige 48: a modern view
Weikai Zong	A preliminary and comprehensive view of mode variability in compact pulsators
	19:00 CONFERENCE DINNER AT ARMAGH CITY HOTEL (£50 pp)
FRIDAY	**09:30 – 11:00 (Pulsation). Chair: Marilyn Latour**

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Stéphane Charpinet	Probing the core helium burning phase with white dwarf and hot subdwarf pulsators
Wenchao Su	TIC 441725813 : A new bright hybrid sdB pulsator with strong differential radial rotation in close binary
	DISCUSSION (PULSATION)
	11:00 - 11:30 TEA/COFFEE
FRIDAY	**11:30 - 13:00 (Atmospheres). Chair: Marilyn Latour**
Laura Scott	Modelling lead stratification in heavy metal subdwarf atmospheres
Semih Filiz	Spectral analysis of hot DA- and DAO-type white dwarfs
	SUMMARY
	13:00 - 14:00 LUNCH
	15:00 (OPTIONAL) TOUR TO LONG MEADOW CIDER COMPANY (ADDITIONAL COST)
POSTERS	
James Garbutt	S1 - White dwarf binaries in Gaia DR3 and their link to hot subdwarf systems
Marilyn Latour	S2 - The Arizona-Montréal Spectroscopic Program: A glance at the MMT sample
Asish Philip Monai	S3 - Understanding Extreme Helium Stars with Gaia

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Tahina Princy Ranaivomanana	P1 - Towards ensemble asteroseismology of hot subluminous stars with MeerLICHT and BlackGEM
Marilyn Latour (for Pawel P.)	P2 - New key results on BLAPs
Uli Heber	B1 - Spectroscopic Analysis of the elipsoidal variable TIC 63208546
Ozgur Basturk (for Ekrem M. Esmer)	B2 - Utilizing Romer Delay in Determining Mass Ratios of HW Vir-type Eclipsing Binaries through TESS Observations
Kunal Deshmukh	B3 - The Curious Case of an Accreting Massive SdO Binary
Abinaya Swaruba Rajamuthukumar	E1 - Explosions: Do they have a soft corner?

Hot subdwarfs with 4MOST: what to expect

Ingrid Pelisoli

The 4-metre Multi-Object Spectroscopic Telescope (4MOST) is a spectroscopic survey that will operate on the VISTA telescope at Cerro Paranal Observatory. Science operations are expected to start in 2024, with public data releases scheduled to happen once a year during a 5-year mission. 4MOST will carry out multiple science cases simultaneously, including a dedicated survey to hot subdwarf stars. In this talk, I will provide an overview of 4MOST and its capabilities, and detail the planning and expected outcome of the hot subdwarf survey, which will obtain spectra for almost 40,000 hot subdwarf candidates.

Towards characterising the 500 pc volume-limited sample of hot subluminous stars

Harry Dawson

We present a spectroscopically classified, volume-limited sample of hot subluminous stars out to 500 pc, entirely selected using Gaia DR3 parallaxes. We constrain the parameter space between the massive main sequence stars and the young end of the white dwarf cooling track in the Hertzsprung-Russell diagram. This region hosts a diverse zoo of exotic stellar populations like hot subdwarfs, cataclysmic variables and blue horizontal branch stars. The hot subdwarfs, which constitutes both post-RGB and post-AGB objects, dominate our sample with 302 members (76%), offering a statistically significant benchmark to test theoretical models and their predictions. In this talk, I will discuss the content of our catalogue and what new insights they may give us on the properties of the local population. I will further give an update on the efforts that are being made to constrain and characterise the binary population in this sample.

The white dwarf binary pathways survey

Steven Parsons

White dwarfs can be found in a huge variety of different binary systems with multiple evolutionary channels and end products. There are clear links between many white dwarf and hot subdwarf binary populations but these are often studied in isolation. In this talk I will present the white dwarf binary pathways survey, which set out to detect and characterise white dwarfs in binary systems with intermediate mass stellar companions in an attempt to sample multiple evolutionary channels simultaneously. Using new data from the Hubble Space Telescope we have found that short period white dwarf binaries exist with a large range of main-sequence companion masses (in contrast to hot subdwarf systems), many of which may go on to form AM CVn systems. Moreover, we have also uncovered a population of systems similar to the long period hot subdwarf binaries as well as objects that link these to shorter period EL CVn binaries.

The origin of subdwarf B stars II

Ralf Napiwotzki

We presented at sdOB10a study of population membership of sdB stars based on their kinematic properties. The result was that the fraction of apparently single stars is the same for members of the thin disk and the old thick disk and halo populations. Here we present a more in depth study of the sample. We look into the sdB formation efficiency of the thin and thick disk. It has been shown that the binary fraction of He-rich sdBs (solar and higher) is very low. We re-assess the limits of this single star dominated "He-rich" subset of sdBs. Finally we investigate the distribution of apparently single sdBs in logg and mass. We identify two components. One with a range of masses as expected for merger products. The second is consistent with stars having the standard sdB mass following a single star evolution. Possible scenarios will be discussed.

Search for photometric variability in the catalog of hot subdwarf stars

Thomas Kupfer

In this talk, we will present a systematic search for periodic variables in the hot subdwarf catalogue using data from the Zwicky Transient Facility. As part of this search we found several hundred periodic variables. We calculated variability statistics and present different statistics on this sample.

Flares in hot subdwarf and white dwarf stars from the 1-4 cycles of TESS photometry

Keyu Xing

Stellar flare is a crucial phenomenon on the surface of stars, which is related to the stellar magnetism. Based on the 1-4 cycles of TESS photometry, we have performed the pioneering project to search for flare events happened on hot subdwarf and white dwarf stars. From 30847 available 2-minute cadence light curves of these compact stars, we identified 5848 events to be the preliminary flare candidates. After repelling 486 events caused by asteroids or comets, we trained the Random Forest classifier using simulated data to validate the other 5362 events, coming out of 2642 events with high false-alarming probability. We then visually inspected the left 2720 candidates and determined 961 flare events from 191 compact stars at last. We estimate the properties of these flares, for instance, the amplitude, equivalent duration and energy in TESS bandpass. We also quantitatively measure the strength of flare activity of each flaring compact star, and fit the power-law index of the flare frequency distribution for the hot subdwarf and white dwarf stars, respectively. We foresee a more sophisticated work to be done in near future, which might be important to the knowledge of magnetism and binarity in compact systems.

Hot subdwarfs candidates surrounded by remnant circumbinary material from common envelope phase

Jiangdan Li

The common envelope evolution in binary systems plays a crucial role in understanding various astrophysical phenomena, including Type Ia supernovae and gravitational-wave sources. However, the observations of common envelope phase are challenging due to its short timescale. In this study, we utilize data from the LAMOST Low-Resolution Spectroscopic (LAMOST-LRS) survey to investigate hot subdwarf candidates that likely surrounded by remnant cicumbinary material from common envelope phase. Out of the 822 analyzed hot subdwarf candidates, we have identified a subset of 368 candidates that show evidence of remnant cicumbinary material. The findings of this study have important implications for future research on the common envelope phase and its impact on the characteristics of binary systems.

Peering at the Blue Horizontal Branch stars in the core of Omega Centauri and NGC 6752

Marilyn Latour

I will present the results of our spectroscopic and photometric analysis of blue Horizontal branch (HB) stars hotter than 8 000 K in Omega Cen and NGC6752. We collected the spectra of the HB stars from MUSE observations of the central regions of both globular clusters. The stars in our samples are objects for which no spectroscopic data existed so far. We fitted the spectral features of hydrogen and helium present in the observed spectra with dedicated grids of hybrid LTE/NLTE model atmospheres and to derive effective temperatures, surface gravities and helium abundances. We also use the homogeneous HST ACS and WFC3 photometric catalogs available for both clusters to perform spectral energy distribution fits. With the distance and reddening of the clusters well-constrained, we derive precise values for the angular diameter ($\sim$R/D) of each star, which allow us to derive radii and luminosities. We finally compare the observed properties of the stars with the expectations from different evolutionary sequences appropriate for both globular clusters.

Blue Horizontal Branch Stars: Identification and Kinematics

Oliver Steppohn

Like hot subdwarfs, blue horizontal branch (BHB) stars have lost much of their hydrogen envelope. These typically old stars are useful for determining the structure of the galactic halo. Using Gaia's DR3 photometric and astrometric measurements, we constructed a halo BHB catalogue that is complementary to the catalogue of Culpan et. al (2023), covering stars with greater distances and smaller proper motions. We made use of BaSTI horizontal branch models and Stilism reddening maps to define our selection criteria. This work provides two catalogues: the candidate catalogue (∼4500) was selected based on Gaia data alone. In the second step, we retrieved SDSS and LAMOST spectra and estimated the BHB fraction of this candidate catalogue to be about 80%. In addition, SDSS and LAMOST spectra selected in a somewhat wider colour range allowed us to identify 2262 BHB candidates. A kinematic analysis shows almost all BHB stars to belong to the Galactic halo, while the ∼250 hot subdwarfs in the sample are mostly thick disk stars. The fastest stars among them are identified and might provide insights on the structure of the galactic halo.

Comparing rates of binarity in blue horizontal-branch and extended horizontal-branch objects

Rick Culpan

The high rates of binarity observed in hot subdwarfs has led to the belief that interactions between binary partners is required certain stars to move onto the extended horizontal-branch (EHB). An understanding of the rates of binarity in blue horizontal-branch (BHB) objects, and a comparison to the rates seen in the EHB may lead us to an understanding of how the differing BHB and EHB stellar evolutionary paths can explain the horizontal-branch features in the Hertzsprung-Russell diagram.

Highlights from the SALT survey of helium-rich hot subdwarfs

Simon Jeffery

Hot subdwarfs are variously associated with the extreme horizontal branch and helium main-sequence, as well as other low-mass stars evolving to become white dwarfs. About 10% have partially or extremely helium-rich surfaces, with highly heterogeneous properties. Using the Southern African Large Telescope, a spectroscopic survey was begun to search for and analyse new members of various subclasses. With over 500 stars observed to date, we have discovered extreme helium stars, heavy-metal subdwarfs, super-hot pre-white dwarfs, a planetary nebula, a compact binary, and magnetic subdwarfs.

Search for new variable Extremely-low mass white dwarf stars

Larissa Antunes Amaral

The Galaxy is not old enough to form a 0.3Msun white dwarf in a single evolution. About a hundred of these extremely-low mass white dwarfs (ELMs) are known. They can only be formed by binary interactions. The recent discovery of pulsating ELMs (ELMVs) has greatly sparked the interest in these objects, as it provides a unique opportunity to explore the internal structure and shed a light on their formation. As strong sources of gravitational waves, ELMs will have an important contribution to the signal detected by space-based missions such as LISA. In this last year we followed-up both, the ELMV candidates from TESS light curves, as well as the high-probability ELMVs that were selected from a Gaia sample. In this talk I will present our recent findings.

Understanding Common Envelope Evolution in sdB Binaries

Zhanwen Han

The process of common envelope (CE) evolution plays a crucial role in the formation of numerous compact binaries, yet it remains poorly understood. SdB binaries with close orbits are believed to have originated from CE ejection. These binaries have well-defined progenitors, and the CE was lost relatively recently. As a result, they provide a valuable opportunity to study CE evolution. In this presentation, our focus is on recent observations of sdB binaries and their comparison with sdB formation models. In the canonical alpha prescription, the binding energy of the envelope is determined by defining a core mass, and alpha_CE represents the fraction of orbital energy released during the spiral-in required to overcome the binding energy. To calculate the total energy changes of the donor, we adopt Ge's adiabatic mass-loss model as a function of the remnant mass. During the spiral-in phase, if the fraction beta_CE of the released orbital energy is greater than the binding energy calculated as described above, we assume that the CE is ejected. Our findings indicate that beta_CE provides a better description of CE ejection than the traditional alpha_CE approach.

Revisiting sub-dwarf B star formation channels with the COMPAS binary population synthesis code

Nicolas Rodriguez Segovia

Sub-dwarf B (sdB) stars are widely believed to have a thin outer hydrogen layer and helium burning interior, which explains their observed surface temperatures and estimated surface gravities. However, the process through which they lose most of their hydrogen rich envelope is not completely clear. Amongst possible formation scenarios, binary evolution is the most accepted, encompassing both stable and unstable mass transfer as well as mergers. To have a better understanding of the relative frequency of the different channels and their dependence on some of the poorly constrained binary evolution properties, we have revisited these formation channels by using rapid binary population synthesis (BPS) methods with the Compact Object Mergers: Population Astrophysics and Statistics code (COMPAS), which incorporates several of the latest binary evolution prescriptions and input physics. We discuss our results by comparing them with both detailed models for long period sdBs formed through stable mass transfer and previous studies of sdB populations, highlighting similar trends and discrepancies between them.

The Spin-Down of White Dwarf Mergers

Philipp Podsiadlowski

The merger of two He white dwarfs (WDs) is believed to be the major channels for producing single hot subdwarfs (sdBOs). However, the majority of single sdBOs appear to be slowly rotating against naive expectations of a merger. Here we construct such merger products, guided by the results of SPH simulations, and follow the evolution of its structure and rotation profile. We find that, consistent with previous studies, the merger product experiences a series of helium shell flashes during which the star expands to become a red giant. Using standard mass-loss prescriptions, we find that the merger product loses only a small amount of mass, but most of its angular momentum. Using different commonly used prescriptions for the angular-momentum transport (with and without magnetic fields), the merger product is dramatically spun down to a range compatible with observations. We also speculate that some of the lost material may remain bound to the system and form a disc around the merger product, in which potentially planet- or brown-dwarf-like objects might form.

The mass range of hot subdwarf B stars from MESA simulations

Eduardo Alfredo Arancibia Rojas

Hot subdwarf B (sdB) stars are helium core burning stars that have lost almost their entire hydrogen envelope due to binary interaction. Their assumed canonical mass of MsdB $\sim$ 0.47 M$\odot$ has recently been debated given a broad range found both from observations as well as from the simulations. Here, we revised and refined the mass range for sdBs derived two decades ago by Han et al. (2002) using the stellar evolution code mesa and discuss the effects of metallicity and the inclusion of core overshooting during the main sequence. We found an excellent agreement for low-mass progenitors, up to $\sim$ 2.0 M$\odot$. For stars more massive than $\sim$ 2.5 M$\odot$ we obtain a wider range of sdB masses compared to the simulations of Han et al. (2002). Our mesa models for the lower metallicity predict, on average, slightly more massive sdBs. Finally, we show the results for the sdB lifetime as a function of sdB mass and discuss the effect this might have in the comparison between simulations and observational samples. This study paves the way for reproducing the observed Galactic mass distribution of sdB binaries.

A new route to massive hot subdwarfs: common envelope ejection from asymptotic giant branch stars

Zhenwei Li

The hot subdwarf O/B stars (sdO/B) are known as extreme horizontal branch stars, which is of great importance in stellar evolution theory. The sdO/B is generally thought to have a helium-burning core and a thin hydrogen envelope. In the canonical binary evolution scenario, sdO/Bs are considered to be the stripped cores of red giants. However, such a scenario cannot explain the recently discovered sdO binary, SMSS J1920, where the strong Ca H&K lines in the spectrum are found. It suggests that this binary is likely originated from the recently ejected common envelope (CE). In this talk, I introduce a new formation channel of massive sdO/Bs, namely sdO/B produced from a CE ejection process with an asymptotic giant branch (AGB) star (hereafter AGB CE channel). An evolutionary model of sdO/B star to support SMSS J1920 has been constructed successfully. The minimum sdO/B mass produced from AGB CE channel is about 0.48 Msolar. The evolutionary tracks in log Teff - log g plane support the observational samples with high-log Teff and low-log g. Considering wind mass-loss of sdO/Bs, the model could produce He-rich hot subdwarfs with log(nHe/nH) > -1.

The theoretical progress and recent observations on extremely low-mass white dwarfs

Xuefei Chen

Extremely low-mass white dwarfs (ELM WDs) are helium WDs with a mass less than 0.3 Msolar. Most ELM WDs are found in double degenerates in the ELM Survey led by Brown and Kilic. These systems are supposed to be significant gravitational-wave sources in the mHz frequency. In this talk, I first introduce the formation channels and evolutionary properties of ELM WD binaries. Then the importance of ELM WD binaries for future space-based gravitational-wave detectors will be addressed. Finally, I will introduce the recent observations of ELM WDs in LAMOST Survey.

sdOB stars formed from hierarchical triples and their properties

Holly Preece

I shall present results of the predicted properties of sdOB stars formed from hierarchical triples. I shall focus on contrasting the triple scenario with the binary scenario to outline configurations only achievable from triples.

The fastest hot subdwarf stars

Uli Heber

The MUCHFUSS project was initiated to search for hot subdwarf binaries with massive unseen companions from radial velocity variations. The Gaia mission provided proper motions of unprecedented precision to carry out kinematical investigations provided that the stars' radial velocities are constant or the systems' velocity is known. Subdwarfs found not to show radial velocity variations are, therefore, best suited for such kinematic studies. We report the final results for 53 hot subdwarf stars of various spectral types from the MUCHFUSS project.

From main sequence runaways to subluminous hypervelocity stars: a multi-modal narrative of escape

Aakash Bhat

Runaways, hyper-runaways, and hypervelocity stars have become objects of great interest in the past two decades. While main sequence runaways have been known since the last century, this century has seen the arrival of even faster and more compact objects in the form of subdwarf and white dwarf runaways. One of the ejection mechanisms responsible for the production of all these runaways is the binary supernova mechanism, which connects main sequence runaways with subdwarf and white dwarf runaway candidates. The difference lies in that while massive main sequence runaways tend to be formed earlier through a core-collapse supernova of a companion, subdwarf and white dwarf runaways are typically formed by a Type-Ia (or Iax) supernova scenario. In this talk, I link together the many subpopulations which exist, motivated by the velocity distribution of such fast stars and their respective ejection mechanisms.

The Fastest Hypervelocity Stars and Hot Subdwarfs

Evan Bauer

Recent discoveries have doubled the population of the fastest (v > 1,000 km/s) hypervelocity stellar remnants thought to originate from thermonuclear supernovae in compact binaries. This population is growing to span a large portion of the HR diagram between the main sequence and white dwarf sequence. The newest candidates are very hot (20,000 - 100,000 K), and some appear in a very similar region of the HR diagram to sdO/B stars. This talk will explore the structural similarities and differences between these hypervelocity stellar remnants and typical hot subdwarf stars, and report on recent progress toward modeling their evolution with MESA, with an emphasis on the pieces of stellar physics that make the hot subdwarf community ideally situated to contribute toward making progress in understanding this exciting new class of extreme stars.

Surfing the (Sine) Waves: Fourier Analyses of Hot Subdwarf Binaries Observed with TESS

Brad Barlow

Nearly continuous, 27+ day observations from TESS permit Fourier analyses of a large number of compact hot subdwarf binaries for the first time. Each binary class (sdB+WD, sdB+dM/BD, etc.) displays a characteristic pattern of harmonics in the periodograms of their light curves. Here we present an update on our work to understand these patterns and use them to extract fundamental properties of sdB binaries. We find that the inclination angle of non-eclipsing sdB+dM/BD systems can be determined to within $\sim$10 degrees simply by measuring their orbital periods and first harmonic strengths. We also detect a slight asymmetry in the reflection effect shape of sdB+dM/BD systems using the relative phase of the first harmonic and show that this asymmetry arises from relativistic beaming. Finally, we use information from our Fourier analyses to help generate new and updated O-C diagrams to look for period changes and orbital reflex motion. In the case of non-eclipsing sdB+dM/BD binaries, we present the first set of O-C diagrams ever constructed.

Helium-rich binary subdwarf candidates identified with SALT and TESS

Edward Snowdon

Binary interactions are believed to be very important to the formation and evolution of hot subdwarf stars. Whilst the binary fraction for He-poor subdwarfs is known to be high, He-rich binary systems are much rarer. Since 2016, a spectroscopic survey conducted with the Southern African Large Telescope (SALT) has aimed to identify and categorise He-rich hot subdwarfs, with a key goal being to search for He-rich binaries. By systematically searching 338 objects in the survey catalogue, we were able to identify 14 binary candidates using light curves from the Transiting Exoplanet Survey Satellite (TESS) and SALT spectra. These include several binary He-sdOs, two intermediate-He binaries. We also identified a new candidate PV Tel variable. If confirmed, these discoveries significantly expand the number of known He-rich subdwarf binaries and challenge evolutionary models for these stars.

Detailed Follow-up Studies of Three Ultracompact sdB Binaries

Eric Stringer

Hot subdwarf stars are thought to be helium-core burning stars which lost most of their hydrogen rich envelope. Most of these stars are found in compact binaries with a sub-sample showing orbital periods well below one hour. These ultracompact systems have white dwarf companions and as such they are double detonation type Ia supernova progenitors if the white dwarfs are sufficiently massive. We present follow-up studies of three ultracompact hot subdwarf binaries. Using data from the Zwicky Transient Facility, we find orbital periods of 33.6, 37.3, and 36.9 minutes for ZTF 1946+3203, ZTF 0640+1738, and ZTF 0643+0318 respectively. The light curves show ellipsoidal variability of the hot subdwarf star with potential eclipses of an accretion disc. Phase-resolved spectroscopic observations with Keck were used to measure a radial velocity curve and atmospheric parameters of the hot subdwarf stars. ZTF J0643 shows evidence of accretion disk emission lines in the average spectrum. Combining light curve and spectroscopic fits will allow us to measure precise system properties such as masses, to determine the evolutionary and future evolution of these systems. In a preliminary analysis for ZTF 1946+3203 we find a mass-transferring hot subdwarf star with a low mass

white dwarf companion. This system is below the Chandrasekhar mass, so the system will most likely merge after the sdB becomes a white dwarf, forming a single R crB star instead of exploding. ZTF 0640+1738 is similarly below the Chandrasekhar mass, however the evidence for a disk is much more tenuous and more precise data is needed to fully understand the evolutionary path for this system.

EC 23257-5443: An Anomalous Reflection Effect Binary with Phase-Dependent Emission

Bryce Smith

EC 23257-5443 was classified as a hot subdwarf + F dwarf binary in Zones 4-6 of the Edinburgh-Cape Blue Object Survey nearly 30 years ago. Until recently, few observations of this relatively bright system have been published. High-cadence TESS photometry reveals a strong and coherent reflection effect variation with a peak-to-peak amplitude of 50% and an orbital period of 6.64 hr. This short orbital period draws into question the original sdB+F classification since such stars would fill their Roche lobes at this period. We obtained time-series spectroscopy with the Goodman spectrograph on the 4.1m SOAR telescope and multi-color, time-series photometry with the CTIO 0.9m telescope in order to shed further light on this system. Our spectroscopy reveals a spectrum that transitions back and forth between an absorption line spectrum and an emission line spectrum in phase with the photometric reflection effect. Our multi-color photometry shows that the reflection effect is significantly stronger at the blue wavelengths than at red wavelengths - the opposite of what is typically seen in hot subdwarf reflection effect binaries. Here we present an analysis of our data and speculate on the true nature of EC 23257-5443.

Gaia strikes again - A new class of hot subdwarf binaries revealed by astrometry

Stephan Geier

We report the discovery of a yet unknown class of wide sdB binaries with compact companions and orbital periods of several hundred days revealed by astrometry from Gaia DR3. The implications of this finding for sdB formation and potential relations to thermonuclear supernovae and X-ray binaries are discussed as well.

Detection and Characterization of sdO companions of massive stars

Luqian Wang

Close binary interactions may play a critical role in the formation of the rapidly rotating Be stars. Mass transfer can result in a mass gainer star spun up by the accretion of mass and angular momentum, while the mass donor is stripped of its envelope to form a hot and faint helium star. Far-UV spectroscopy has led to the detection of about 20 such binary Be+sdO systems. Here we summarize our past and present works on detecting and characterizing the hot sdO companions of rapidly rotating Be stars using spectroscopic observations from the International Ultraviolet Explorer and Hubble Space Telescope. By complementing the study with ground optical spectra analysis, we determined the orbital and physical properties of several Be+sdO binary systems and found that the sdO stars in a few of them could be progenitors of Type Ib and Ic supernovae.

Hot subdwarf binaries at intermediate periods

Veronika Schaffenroth

Two third of the sdBs are found in binaries with either periods of hours to a few days with low-mass main sequence or white dwarf companions from the common envelope channel or several hundred to one thousand days with FGK type main sequence companions resulting from the Roche lobe overflow channel. There is a large period gap in between where no sdB binaries were found. We recently found a sdB binary in the period gap. In this talk I will present the analysis of this special object.

Follow-up Observations of the Fastest Known HW Vir

Isaac D. Lopez

In this talk, I will present dual-band high-speed photometry and time-series spectroscopy of ZTF J054217.01+124950.55, a recently discovered HW Vir type binary with the shortest known orbital period of 67 minutes. I will share how these observations give support for a sub-stellar companion and discuss where this system fits among the other eclipsing sdB+dM/BD systems.

PCEB Systems Displaying Eclipse Timing Variations

Ozgur Basturk, Ekrem M. Esmer, Ezgi Sertkan, Baris Guler, Furkan Akar, Selcuk Yalcinkaya, Ahmet Cem Kutluay

Low-mass companions within planetary mass limits around Post-Common Envelope Binary (PCEB) systems can be very common. Since they are difficult to find with other techniques employed in exoplanet discovery due to the small sizes and masses of binary companions, analyses of Eclipse Timing Variations (ETVs) turn out to be the most efficient way to reveal them. We started a project to efficiently track ETVs observed in PCEBs based on data from space-borne and ground-based observatories. As the data accumulate over time, ETV models converge to more consistent solutions, which hint at the existence of multi-body systems formed either in ensemble (first-generation hypothesis) or from the material ejected by the primary companion during its evolution, which we now observe as a hot sub-dwarf or a white dwarf (second-generation hypothesis). Within this contribution, we introduce our project and the work we have done so far in terms of follow-up observations, data acquisition from telescope archives, and their analyses. We believe that this effort will help us understand the reasons behind ETVs in PCEBs more clearly and prepare the data to extend the observation baselines to span longer time intervals

required to reveal larger numbers of cycles of variations for future generations. We thank TUBITAK for their support with the project F122F358.

Modelling the Double Detonation Supernova Progenitor CD -30 11223

Kunal Prashant Deshmukh

Double detonation supernovae form an interesting subset of Type Ia supernovae owing to their characteristic sub-Chandrasekhar explosion of a white dwarf. In this channel, it is crucial for the white dwarf to have a helium rich companion filling its Roche lobe and transferring helium onto the white dwarf surface. Hot subdwarf stars in compact binaries are excellent candidates for such companions. CD-3011223, a compact hot subdwarf-white dwarf binary, was the first double detonation supernova progenitor candidate discovered in 2013. We present detailed modelling of this system using the MESA stellar evolution code. The observed atmospheric and orbital properties are used as reference points to model the hot subdwarf star in CD-3011223 as well as the binary system as a whole. We report possible evolutionary scenarios and the eventual fate of the system as a potential AM CVn followed by a double detonation supernova.

Another Year of Pulsation Progress - Balloon, TESS, and Kepler

Mike Reed

This talk will focus on progress made since sdOB10 in Liege last year. We have completed analyses of V585 Peg (aka Balloon 09) with some interesting results. We have also continued our work on K2-observed sdBV stars, and now that TESS has completed a reasonable survey in both hemispheres, we can examine statistics of both pulsators and non-detections.

Amplitude and frequency variations in two pulsating sdB stars from K2 photometry

Xiaoyu Ma

Kepler performed high-precision photometry on 19 campaigns near the ecliptic plane for approximately 80 days, providing valuable data for investigating amplitude and frequency modulation in B-type hot subdwarf (sdB) pulsators. We carried out an in-depth examination of the pulsation modes of two sdB stars, EPIC 220422705 and EPIC 220376019, and systematically analyzed their modulation properties and timescales. Both sdBs are components of binary systems, yet their rotational speeds differ considerably. This offers crucial samples for understanding the nature of pulsation mode modulation as rotational frequencies transition from indistinguishable to distinguishable. We put forward several innovative methods and concepts to explore the short-timescale modulation of sdB pulsation modes, presenting new perspectives for the study of nonlinear astroseismology samples.

Binary evolution pathways of blue large-amplitude pulsators

Conor Byrne

Blue large amplitude pulsators (BLAPs) are a rare class of pulsating star, characterised (as their name would suggest) by their high amplitude oscillations and high surface temperatures. One interpretation of their evolutionary status is that of a low-mass proto-white dwarf, produced by mass stripping of a red giant when it has a small helium core. While the total number of confirmed BLAPs remains small, the population forms two distinct groups in terms of their surface gravity, pulsation period and inferred mass. This is in slight tension with theoretical predictions, which indicate that stars in the observational gap are also expected to pulsate. I will present work carried out with BPASS (Binary Population and Spectral Synthesis) to identify the predicted evolutionary pathways that a star can take to become a BLAP. We find that BLAPs can be produced either through common envelope evolution or through Roche lobe overflow, with either a main-sequence star or an evolved compact object being capable of stripping the envelope of a red giant of a suitable helium core mass. The mass distribution of the inferred population indicates that fewer BLAPs are expected with masses intermediate to the two known groups of pulsators, suggesting that the lack

of observational detections may be a result of the underlying population of pre-white dwarf stars. We also consider the impact that variation in metallicity and star formation histories may have on the expected number counts. Based on this analysis, we expect the Milky Way to host around 12,000 BLAPs and we predict the number density of detectable sources expected in future observations such as the Legacy Survey of Space and Time at the Vera Rubin Observatory.

An Investigation into the Properties and Evolutionary Status of Radial-Mode Hot-Subdwarf Pulsators and Blue Large-Amplitude Pulsators

Corey Bradshaw

Hot subdwarfs are a unique class of stellar objects that provide insight into late stages of stellar evolution as well as compact binary studies and astroseismology. These stars have high temperatures and luminosities which fall below the main sequence. They have been shown to evolve through binary interaction, where a significant portion of the stellar envelope has been stripped. In addition, instabilities in the interior of these stars can lead to stellar pulsations that can be observed through variability of their atmospheric parameters. Non-radial pulsations in hot subdwarfs have been theorized and observed, providing additional details into their stellar interior. Recently, radial-mode pulsations have been discovered in these stars, leading to new, seemingly independent, classes of pulsators. These classes are known as blue large-amplitude pulsators (BLAPs) and B-type radial-mode subdwarf variables (sdBVs). BLAPs have large amplitude pulsations (200 - 400 mmag) and short pulsation periods (10 - 40 min) while radial-mode sdBVs have lower amplitudes (20 - 70 mmag) and even shorter pulsation periods (5 - 16 min). Little is known about the fundamental properties and evolutionary status

of these objects, since there are few spectroscopic observations. Presented here is follow-up analysis on a case study for one of the originally discovered BLAPs which was found during the Optical Gravitational Lensing Experiment (OGLE) survey. In addition, a comparison case study for one radial-mode sdBV which was discovered during the Zwicky Transient Facility (ZTF) survey is presented. The aim of these studies is to use time-series photometry and spectroscopy to estimate the fundamental properties of these stars, such as mass and radius, and to place constraints on their evolutionary status using stellar evolution models developed with MESA and GYRE. Additionally, metal abundance calculations and searches for any binary companions will be discussed. The presented methods will serve as a test for future analysis on a larger sample of these objects in order to try and characterize the classes as a whole.

BLAPs-the surviving companions of SNe Ia

Xiangcun Meng

The single degenerate (SD) model, one of the leading models for the progenitors of Type Ia supernovae (SNe Ia), predicts that there should be binary companions that survive the supernova explosion, which, in principle, should be detectable in the Galaxy. The discovery of such surviving companions could therefore provide conclusive support for the SD model. Several years ago, a new type of mysterious variable was discovered, the so-called blue large-amplitude pulsators (BLAPs). Here we show that all the properties of BLAPs can be reasonably well reproduced if they are indeed such surviving companions, in contrast to other proposed channels. This suggests that BLAPs could potentially be the long-sought surviving companions of SNe Ia. Our model predicts that the structure of BLAPs is similar to hot subdwarf stars and when the central helium is exhausted, the change rate of the pulsating period becomes larger than normal BLAPs by one magnitude. Such a prediction was recently observed in a peculiar BLAP. Our model also predicts a new channel for forming single hot subdwarf stars, consistent with a small group in the present sample of hot subdwarf stars.

Shell-helium-burning hot subdwarf B stars as candidates for Blue Large Amplitude Pulsators

Heran Xiong

The Blue Large-Amplitude Pulsators (BLAPs) is rare and captivating class of variable stars. With pulsation periods on the order of tens of minutes and significant amplitudes in optical bands, BLAPs have drawn considerable attention. Their rates of period change, which can be positive or negative, further contribute to their mystique. Previous studies proposed two scenarios to explain BLAPs: as pre-white dwarfs or as core-helium-burning stars. However, our investigation focuses on an alternative possibility: shell-helium-burning subdwarfs of type B (SHeB sdBs). Through MESA models, we find that BLAPs can be explained by SHeB sdBs with helium core masses in the range of 0.45-0.5 times the mass of the Sun. While most BLAPs are single stars, we delve into the formation channels, particularly considering Roche lobe overflow in long-period binary systems. Our computations of 304 binary evolution models reveal that such systems could evade current observational constraints, shedding light on the poor understanding of BLAP binaries.

Feige 48: a modern view

Valerie Van Grootel

Feige 48 is one of the very first sdB pulsators discovered, and one of the most studied. Though, the exact orbital period and nature of its companion have been settled only recently. In this talk I will tell the story of Feige 48, and will present photometric data obtained at Mt Bigelow observatory in 2009, as well as TESS observations in several sectors started in August 2019. From these data I will present new asteroseismic analyses and inferences about the rotational properties of the sdB star. These will give the modern view of Feige 48 and the new challenges it opens.

A preliminary and comprehensive view of mode variability in compact pulsators

Weikai Zong

Over 500 pulsating hot subdwarfs and white dwarfs have been observed since the successful launch of Kepler and TESS. This presents an opportunity to develop a comprehensive understanding of the variability of oscillation modes in these faint compact stars. It is worth noting that nearly a decade has passed since the first discovery of clear evidence related to nonlinear weak mode interaction in these fascinating objects. In this presentation, I will outline the processes prepared for the initiation of this yearslong project that aims to the statistics of mode variability in compact stars.

Probing the core helium burning phase with white dwarf and hot subdwarf pulsators

Stéphane Charpinet

Deep asteroseismic sounding of the core structure of white dwarf and hot subdwarf pulsators can reveal key – and sometimes challenging – features directly connected to the core helium burning (CHeB) phase of low-mass stars. This stage of stellar evolution is notoriously affected by large uncertainties and evolution models proceeding through it often rely on prescriptions that remain mostly untested. In this presentation, I will link results obtained so far from detailed seismic probing of the core structure of evolved compact pulsators with CHeB evolution and discuss how Kepler/TESS, coupled with a new generation of seismic models for hot subdwarfs could allow us to lift some of these uncertainties.

TIC 441725813 : A new bright hybrid sdB pulsator with strong differential radial rotation in close binary

Wenchao Su

We present the detailed analysis of a new hybrid (p- and g-mode) sdB pulsator, TIC 441725813 (TYC 4427-1021-1), discovered and monitored by TESS for more than 600 days. The TESS light curves available for this star were analyzed using prewhitening techniques to extract mode frequencies accurately. The pulsation spectrum is then interpreted through methods that include asymptotic period spacing relationships and frequency multiplet identification. We also exploited a high-S/N, low-resolution spectrum of TIC 441725813 using grids of NLTE model atmospheres to derive its atmospheric parameters. We have shown that TIC 441725813 is another of the few known sdB stars whose envelope rotates faster than the core. Additionally, both the optical spectrum and light curve independently show hints of the close binary orbit signal. We hypothesize that differential radial rotation might be caused by the effects of tidal interaction with a companion.

Modelling lead stratification in heavy metal subdwarf atmospheres

Laura Scott

Heavy metal subdwarfs are a class of hot subdwarfs with very high abundances of heavy elements, typically around 4 dex above solar, and a helium to hydrogen ratio between around 0.1 and 10. They include stars which are strongly enhanced in either lead or zirconium, as well as other elements. Stratification of the enhanced elements, where the element is concentrated in a narrow layer of the atmosphere, has been proposed as a mechanism for the apparent high abundances in heavy metal stars. This talk will present results of a parameter study on the observable effects of stratification of lead in model atmospheres. We have tested the size and position of lead layers needed to alter the spectral line profiles, and found that this effect is broadly wavelength-dependent. We therefore expect that spectral observations in both the optical and the UV would be needed to detect chemical stratification in heavy metal subdwarfs.

Connecting the dots: stellar parameters, binarity, and kinematics

Matti Dorsch

Detailed analysis of single stars are important to constrain the physical processes of their formation and evolution. However, such analysis can not fully constrain important quantities such as the relative importance of specific formation channels or the parameter ranges that can be produced. This information can only be obtained from statistically significant samples of stars. I will talk about insights gained from the spectral energy distributions and Galactic kinematics of the sample spectroscopically identified hot subdwarf stars. This will include their observed radius and mass distributions, the prevalence of F/G/K-type companions, as well as their membership to the Galactic thin disk, thick disk, and halo. These results are discussed briefly in the context of existing evolutionary models, pointing out the most important differences to their predictions.

Spectral analysis of hot DA- and DAO-type white dwarfs

Semih Filiz

We aim to understand the spectral evolution of a small subgroup of H-rich WDs, the so-called hybrid (or DAO) WDs which exhibit both, H and He lines in their spectra. Though small in number, they represent an evolutionary phase run through by the majority ($\approx$ 75%) of all WDs. We started a NLTE analysis of UV and optical spectra of 36 hot (Teff $>$ 60 000 K) WDs which allows, together with distances precisely measured by Gaia, to locate them in the HRD and to derive their stellar parameters (M, R, L). We measure metal abundances to shed light on the question, when and how the hybrid WDs transform into helium-free objects because of gravitational settling of elements. The results will help to clarify the relative importance of the different physical processes acting on helium and metal abundances. First results indicate that previous analyses using Balmer and Lyman lines often significantly under- or overestimated effective temperatures.

White dwarf binaries in Gaia DR3 and their link to hot subdwarf systems

James Garbutt

White dwarf binaries serve as the progenitor for a number of exotic systems, such as cataclysmic variables, supersoft x ray sources, and thermonuclear supernovae. Using existing samples of white dwarf + FGK binaries and orbital periods from GAIA DR3, we were able to calculate stellar masses for both binary components in a new sample of 223 binary white dwarf candidates. The combination of masses and orbital periods allow us to investigate the evolution of these binary systems. We find a large population of likely post-stable mass transfer systems analogous to long period hot subdwarf binaries and potentially their descendants. The vast majority of these systems are likely to survive a future common envelope phase and produce close double white dwarf binaries. Moreover we also find 6 long period systems hosting extremely low mass (ELM) white dwarfs, which will also likely end their lives as double white dwarf binaries, in which the ELM component formed first.

The Arizona-Montréal Spectroscopic Program: A glance at the MMT sample

Marilyn Latour

More than two decades ago, a collaboration program between Steward Observatory and the Université de Montréal started with the goal of collecting an unprecedented amount of high signal-to-noise and homogeneous spectra of hot subdwarf stars. Multiple observations of more than 400 stars have been collected and we aim at providing the community with reliable and accurate atmospheric parameters for this invaluable dataset. These can be, in turn, combined with information from the Gaia data release to derive stellar parameters such as radii, luminosities, and masses. In this poster, we present the MMT sample, which consists of medium-resolution (delta lambda 1 A) spectra for about a hundred hot subdwarfs, mostly typical H-rich sdBs.

Understanding Extreme Helium Stars with Gaia

Asish Philip Monai

Hydrogen-deficient stars consist of several groups of chemically peculiar stars ranging from the cold hydrogen-deficient carbon stars to the extreme helium stars and the extremely hot helium-rich subdwarfs. The surface characteristics and variability of these stars are reasonably well understood. However, given their large distances, we have been limited in understanding their astrometric properties and hence luminosities and masses of these stars. An intriguing question that these groups pose is their origin channel. Current theory suggests that they formed from merger of double white dwarf binary systems. Binary population synthesis models suggest that double helium white dwarf mergers are from star formation older than 4 Gyr and carbon-oxygen and helium white dwarf mergers occur from stellar populations between 0.5 and 2 Gyr old, contradicting notional population assignments. To test this theory, we have combined the Gaia positional and proper motion data and ground-based radial velocity data to obtain full 6-space positions thereby attempting to infer the parent population from the kinematics of these stars. The launch of Gaia followed by the publication of the third Data Release provided a unique opportunity to address these questions using direct measurements of distance for a large fraction of

the Galactic population of these very rare stars.

Towards ensemble asteroseismology of hot subluminous stars with MeerLICHT and BlackGEM

Tahina Princy Ranaivomanana

Colour-magnitude diagrams reveal a population of blue (hot) sub-luminous objects with respect to the main sequence. These hot sub-luminous stars are the result of evolutionary processes that require stars to expel their obscuring, hydrogen-rich envelopes to reveal the hot helium core. As such, these objects offer a direct window into the hearts of stars that are otherwise inaccessible to direct observation. MeerLICHT is a wide-field optical telescope that collects multi-band photometric data in six band filters (sloan u, g, r, i, z, and a custom q filter), whose primary goals are to study transient phenomena, gravitational wave counterparts, and variable stars. We showcase MeerLICHT's capabilities of detecting faint, hot subdwarfs and identifying the dominant frequency in the photometric variability of these compact hot stars, in comparison to their Gaia DR3 data. We further demonstrate the combined efficiency. of using photometric time-series from various instruments to identify and characterise oscillations, which is an essential ingredient for accurately modelling stellar interiors in detailed asteroseismic analysis. Our MeerLICHT results are a proof-of-concept of the capacity of the BlackGEM instrument at ESO's La Silla Observatory in Chile.

New key results on BLAPs

Marilyn Latour (on behalf of Pawel P.)

Blue Large-Amplitude Pulsators (BLAPs) form a mysterious group of hot pulsating stars. We present new results based on a homogeneous set of moderate-resolution spectra obtained for a dozen of the stars and additional data from the literature. We found that BLAPs obey a linear period-gravity relationship. For the first time in the case of Z-bump pulsators, we have derived a period–luminosity relation. A comparison with theoretical models confirms that BLAPs pulsate in the fundamental radial mode. The stars form a homogeneous group in the period, surface gravity, and effective temperature space. However, there is a split into two groups in the helium-to-hydrogen content. The atmospheres of the stars appear to be a few times more enriched in metals than the atmosphere of the Sun. The new results will help to solve the mystery of the structure and origin of BLAPs.

Spectroscopic Analysis of the elipsoidal variable TIC 63208546

Uli Heber

TESS observations of TIC 63208546 found the object to be a pulsating elipsoidal variable indicating that it is a close binary with a compact companion. A first spectrum classifies it as sdA. Time-series spectroscopy was carried out with the Bok spectrograph at KPNO. A spectroscopic analysis of these low-resolution spectra using hybrid NLTE models allowed us to determine its atmospheric parameters as well as the radial velocity curve. The results will be reported and the nature of the binary shall be discussed.

Utilizing the Rømer Delay: Determining Mass Ratios of HW Vir-like Eclipsing Binaries through TESS Observations

Ekrem M. Esmer, Furkan Akar, Baris Guler, Ezgi Sertkan, Ozgur Basturk

Romer delay, also known as the light-time effect, can be utilized to determine the mass ratio of eclipsing binaries (Kaplan 2010). In cases where the mass ratio is less than unity, the secondary eclipse, where the object with the smaller mass is eclipsed, experiences a shift from the orbital phase 0.5 due to the light-time effect. This phenomenon proves particularly valuable in determination of the mass ratios of HW Vir-like binaries, as the secondaries are typically much fainter than the primaries, which poses challenges in deriving the mass ratios solely from radial velocity observations, potentially making the observation of the shift in the secondary eclipse an essential tool in understanding these binary systems. In this study, we applied the Romer delay to the primary and secondary eclipse timings derived from TESS observations of several HW Vir-like eclipsing binaries. To obtain the data, we collected all available TESS light curves from the Mikulski Archive for Space Telescopes (MAST) Portal. Eclipse timings were calculated for each primary and secondary eclipse using the Kwee-van Woerden method. We calculated the shift of the secondary eclipses from

phase 0.5 and examined the potential implications of the Romer delay within the context provided by Kaplan (2010) for these systems, taking 20-second and 120-second TESS cadences into account during our calculations and discussion of the results. We thank TUBITAK for their support with the project F122F358.

The Curious Case of an Accreting Massive SdO Binary

Kunal Deshmukh

Accreting sdOB-white dwarf binaries are an exotic class of compact sdOB binaries that have been thought to originate from systems that end their common envelope evolution at periods less than 2 hours. Although only a handful such systems have been found so far, their orbital periods are consistent with the above condition. J1921 is a 3.9-hour sdO binary with a lightcurve showing the characteristic features of ellipsoidal modulation and possible accretion. Along with its relatively long period, it also shows an unusual difference between the two maxima in its lightcurve that seems to be irreconcilable with the LCURVE modelling code. The system parameters are indicative of a massive mass-transferring sdO, however a concrete solution is yet to be found. In this poster, we present a brief summary of our current knowledge of J1921 and plans to study it further.

Explosions: Do they have a soft corner?

Abinaya Swaruba Rajamuthukumar

He accreting white dwarfs (WDs) are enticing because of the potential explosive fate of the full WD or the He envelope. In this work, we use MESA to simultaneously evolve sdB and WD stars interacting in binaries, exploring the possibility of their evolution leading to either Type Ia supernovae or helium novae. We extensively probe an initial parameter space in mass and period, with the aim of identifying the existence of a precise 'boundary' that distinguishes between detonation and deflagration. Our study greatly expands upon previous binary evolution modeling by investigating a broader parameter space of masses and orbital periods. We believe that our study will improve the modeling of past observations and serve as a precedent for possible future observations.