EUROWD24

23rd European Workshop on White Dwarfs

50th anniversary

KIEL74, FRASCATI76, TEL AVIV78, PARIS81, KIEL84, MONTE PORZIO86, TOULOUSE90, LEICESTER92, KIEL94, BLANES96, TROMSØ98, DELAWARE00, NAPOLI02, KIEL04, LEICESTER06, BARCELONA08, TÜBINGEN10, KRAKOW12, MONTREAL14, WARWICK16, AUSTIN18, TÜBINGEN22, BARCELONA24

SCIENTIFIC TOPICS

WD Structure and Cooling Processes
WD Populations
WDs in New Surveys
WDs in Binaries
WD Dust Disks and Planetary Systems
WDs in Open and Stellar Clusters
WD Atmospheres, Chemical Composition, and Magnetic Fields
WD Progenitors
Asteroseismology and Pulsating WDs
Automated Classification and Statistical Techniques in WD Research

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BARCELONA, 8-12 JULY, 2024

UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

IEEC Institut d'Estudis Espacials de Catalunya

eurowd24.science@ieec.cat
eurowd24.admin@ieec.cat

Contents

About EuroWD

The 23rd European Workshop on White Dwarfs will be held in Barcelona from July 8th to 12th, 2024. In this edition, we have the pleasure of commemorating the 50th anniversary of the workshop meetings, which began in Kiel, Germany, in 1974. As in previous editions, any topic related to white dwarfs is welcome. In particular, some of the most relevant in recent years have been:

- White dwarf Structure and Cooling Processes
- White dwarf Populations, Galactic Components, Local Star-Formation History, Initial-to-Final Mass Function, Luminosity Function, Mass Distribution
- White dwarfs in New Surveys
- White dwarfs in Binaries: Cataclysmic Variables (CVs), Supernova Type Ia Progenitors, Supersoft X-ray Sources, Double Degenerates, WD/Brown Dwarf Systems, etc.
- White dwarf Dust Disks and Planetary Systems
- White dwarfs in Open and Stellar Clusters
- White dwarf Atmospheres, Chemical Composition, and Magnetic Fields
- White dwarf Progenitors; Central Stars of Planetary Nebulae, Hot-subdwarfs
- Asteroseismology and Pulsating white dwarfs.
- Automated Classification and Statistical Techniques in white-dwarf Research

We look forward to seeing you all in Barcelona24,
Santiago Torres and Alberto Rebassa-Mansergas on behalf of the LOC/SOC

50^{th} Anniversary

List of cities where the previous European Workshop on White Dwarfs meetings have been held:

- Kiel 1974, Germany
- Frascati 1976, Italy
- Tel Aviv 1978, Israel
- Paris 1981, France
- Kiel 1984, Germany
- Monte Porzio 1986, Italy
- Toulouse 1990, France
- Leicester 1992, UK
- Kiel 1994, Germany
- Blanes 1996, Spain
- Tromsø 1998, Norway
- Delaware 2000, USA
- Napoli 2002, Italy
- Kiel 2004, Germany
- Leicester 2006, UK
- Barcelona 2008, Spain
- Tübingen 2010, Germany
- Krakow 2012, Poland
- Montreal 2014, Canada
- Warwick 2016, UK
- Austin 2018, USA
- Tübingen 2022, Germany
- Barcelona 2024, Spain

Conference Program

Week Schedule

Time	Monday (08/07/2024)	Tuesday (09//07/2024)	Wednesday (10/0/20247)	Thursday (11/07/2024)	Friday (12/07/2024)
	S1.1	S2.1	S3.1	S4.1	S5.1
09:00—09:15	Welcome	Ken Shen	Christopher Manser	Snehalata Sahu	Andrew Vanderburg
09:15—09:30	Leesa Fleury	Kareem El-Badry	Abbigail Elms	James Munday	Joseph Guidry
09:30—09:45	Antoine Bédard	Mark Hollands	Sagi Ben-Ami	Zhenwei Li	Akshay Robert
09:45—10:00	Boris Gaensicke	Fionntan Callan	Mario Cadelano	Aakash Bhat	Lou Baya Ould Rouis
10:00—10:15	Mike Montgomery	Joshua Pollin	Steffani Grondin	Tim Cunningham	Santiago Torres
10:15—10:30	Maria Camisassa	Sunny Wong	David R. Miller	Camila Aros Bunster	Hiba Tu Noor
10:45—11:15	Coffee Break & Posters	Coffee Break & Posters	Coffee Break & Posters	Coffee Break & Posters	Coffee Break & Posters
	S1.2	S2.2	S3.2	S4.2	S5.2
11:15—11:30	Kurtis A. Williams	Semih Filiz	Manuel Barrientos	Maja Vuckovic	Dang Pham
11:30—11:45	S. O. Kepler	Nina Mackensen	Roberto Raddi	Matthew Green	Raquel Murillo-Ojeda
11:45—12:00	Mairi O'Brien	Adam Moss	Mariel Lares Martiz	Andrew Swan	Ayaka Okuya
12:00—12:15	Paul Ripoche	Gracyn Jewett	Murat Uzundag	Claudia Aguilera-Gómez	Felipe Lagos-Vilches
12:15—12:30	Emily Roberts	Mercedes S. Hernandez	Steven Kawaler	Anna-Maria Cutolo	Laura Rogers
12:30—14:30	Lunch Break	Lunch Break	Lunch Break	Lunch Break	Closing
	S1.3	S2.3	S3.3	S4.3	
14:30—14:45	James Garbutt	Daniel Blatman	Mariona Badenas-Agusti	Jamie Williams	
14:45—15:00	Sandino Estrada-Dorado	Jay Farihi	Malia Kao	Benjamin C. Kaiser	
15:00—15:15	Steven Parsons	Simon Blouin	Enrique Miguel García Zamora	Odette Toloza	
15:15—15:30	Alejandro Santos García	Andy Buchan	Olivier Vincent	Steven Z. Savery	
15:30—16:15	Coffee Break & Posters	Coffee Break & Posters		Coffee Break & Posters	
	S1.4	S2.4		S4.4	
16:15—16:30	Alex Brown	Matthias R. Schreiber		Max Pritzkuleit	
16:30—16:45	Natsuko Yamaguchi	Anna Francesca Pala		Harry Dawson	
16:45—17:00	Lisa Blomberg	Jan van Roestel		Abinaya S. Rajamuthukumar	
17:00—17:15	Na'ama Hallakoun	Daniela Muñoz Giraldo		Matti Dorsch	
20:00-21:00		Boat tour			
21:00-23:00			Conference Dinner		

Monday 08/07/2024

09:00	Welcome	
	S1.1: WD Structure and Cooling Processes – Chair: Patrick Dufour	
09:15	Leesa Fleury	The cooling and kinematics of ultramassive white dwarfs in Gaia EDR3
09:30	Antoine Bédard	Distillation as the explanation for the Gaia Q branch
09:45	Boris Gaensicke	The Q-branch as seen by DESI
10:00	Mike Montgomery	Fluid Mixing During Phase Separation
10:15	Maria Camisassa	Hints of carbon dredge-up in the Gaia bifurcation
10:30	*Coffee Break / Poster Session*	
	S1.2: WD Structure and Cooling Processes / WD Populations – Chair: Patrick Dufour	
11:15	Kurtis A. Williams	White Dwarf as Whirling Dervishes: The Frequency of Rapid Rotation
11:30	S. O. Kepler	White dwarf rotation distribution
11:45	Mairi O'Brien	Conclusions from the analysis of the 40 pc Gaia white dwarf sample
12:00	Paul Ripoche	Insight into the faint galactic white-dwarf population: mapping the Milky Way and calibration tools for future deep synoptic surveys
12:15	Emily Roberts	Comparison of methods for determining the star formation history using Gaia WD samples
12:30	*Lunch Break*	
	S1.3: WDs in Binaries (PCEBs & WDMS) – Chair: Ingrid Pelisoli	
14:30	James Garbutt	The white dwarf binary pathways survey and Gaia
14:45	Sandino Estrada-Dorado	Search of sub-stellar companions of White Dwarfs with X-ray observations
15:00	Steven Parsons	Timing variations in eclipsing white dwarf binaries
15:15	Alejandro Santos García	A comprehensive population synthesis study of the Gaia 100 pc unresolved WDMS binary population
15:30	*Coffee Break / Poster Session*	
	S.1.4: WDs in Binaries (PCEBs & WDMS) – Chair: Ingrid Pelisoli	
16:15	Alex Brown	Towards a volume limited sample of post-common-envelope binaries
16:30	Natsuko Yamaguchi	A large sample of WD + MS binaries from Gaia DR3 as probes of binary interactions
16:45	Lisa Blomberg	Constraints on magnetic braking from the mass distribution of post-common envelope binaries
17:00	Na'ama Hallakoun	Uncovering a hidden population of WDs in Gaia astrometric binaries: insights and the mystery of missing massive WDs

Tuesday 09/07/2024

	S2.1: WDs in Binaries (SNIa connection) – Chair: JJ Hermes	
09:00	Ken Shen	Type Ia supernovae from explosions of sub-Chandrasekhar-mass white dwarfs in double white dwarf binaries
09:15	Kareem El-Badry	The fastest stars in the galaxy
09:30	Mark Hollands	A spectroscopic and kinematic analysis of a D6 supernova survivor
09:45	Fionntan Callan	Helium as a signature of white dwarf double detonations
10:00	Joshua Pollin	Multidimensional Nebular Phase Radiative Transfer Calculations of Double-degenerate Double-detonation Type Ia supernovae
10:15	Sunny Wong	Ia supernova ejecta interacting with companion stars
10:30	*Coffee Break / Poster Session*	
	S2.2: WD Atmospheres, Chemical Composition, and Magnetic Fields – Chair: JJ Hermes	
11:15	Semih Filiz	Spectral analysis of hot DA- and DAO-type white dwarfs
11:30	Nina Mackensen	Extremely Hot and Rapidly Rotating: Insights from Spectral Analysis of the PG1159 Star RXJ0122.9-7521
11:45	Adam Moss	Discovery of a Magnetic Double-Faced DBA White Dwarf
12:00	Gracyn Jewett	Massive White Dwarfs in the 100 pc Sample: Magnetism, Rotation, Pulsations, and the Merger Fraction
12:15	Mercedes S. Hernandez	TESS Spin periods of magnetic white dwarfs
12:30	*Lunch Break*	
	S2.3: WD Atmospheres, Chemical Composition, and Magnetic Fields – Chair: Barbara Castanheira	
14:30	Daniel Blatman	Magnetic field breakout from crystallizing white dwarfs
14:45	Jay Farihi	Atmospheric heating in isolated magnetic white dwarfs, driven by 22Ne distillation resulting from mergers.
15:00	Simon Blouin	JWST spectra of three infrared-faint white dwarfs
15:15	Andy Buchan	The effect of convective overshoot and thermohaline mixing on geological inferences from metal enriched white dwarfs
15:30	*Coffee Break / Poster Session*	
	S2.4: WDs in Binaries (CVs) – Chair: Barbara Castanheira	
	Matthias R. Schreiber	The late emergence of white dwarf magnetic fields and the absence of period bouncers in observed samples of Cvs
16:30	Anna Francesca Pala	The 300 pc sample of accreting white dwarfs
16:45	Jan van Roestel	Searching for rare cataclysmic variables
17:00	Daniela Muñoz Giraldo	Cataclysmic Variables around the period-bounce: An eROSITA-enhanced multi-wavelength catalog
20:00	Boat tour: las Golondrinas	

Wednesday 10/07/2024

	S3.1: WDs in (New) Surveys / WDs in Clusters – Chair: Nicola Gentile Fusillo	
09:00	Christopher Manser	White dwarfs from the DESI Survey
09:15	Abbigail Elms	A network of cool white dwarfs as standards for flux calibration
09:30	Sagi Ben-Ami	If you build it, they will come – new facilities and instruments for the study of White Dwarfs.
09:45	Mario Cadelano	Slowly cooling white dwarfs in globular clusters
10:00	Steffani Grondin	From Clustered Environments to Common Envelopes: The first systematic identification of white dwarf-main sequence post-common envelope binaries in star clusters
10:15	David R. Miller	Developing the open-cluster-based white dwarf initial-final mass relation with Gaia DR3
10:30	*Coffee Break / Poster Session*	
	S3.2: WDs in Binaries (Wide Binaries) / Asteroseismology – Chair: Alejandro Córsico	
11:15	Manuel Barrientos	Fundamental Tests of White Dwarf Cooling Physics with Wide Binaries
11:30	Roberto Raddi	Precise gravitational redshifts of white dwarfs in wide binaries
11:45	Mariel Lares Martiz	Investigating Field Star Gyrochronology with WD+MS Wide Binary Pairs
12:00	Murat Uzundag	Asteroseismological analysis of the polluted ZZ Ceti star G29-38 with TESS
12:15	Steven Kawaler	Juggling convection and pulsation on the cool side of the DA instability strip
12:30	*Lunch Break*	
	S3.3: Automated Classification and Statistical Techniques in WD Research – Chair: Ashley Ruiter	
14:30	Mariona Badenas-Agusti	Characterizing Polluted White Dwarfs with Machine Learning to Probe Extrasolar Geochemistry
14:45	Malia Kao	Hunting for Polluted White Dwarfs and Other Treasures with Gaia XP Spectra and Unsupervised Machine Learning
15:00	Enrique Miguel García Zamora	White Dwarf Spectroscopical Classification Using Random Forest
15:15	Olivier Vincent	Simulation-Based Machine Learning for White Dwarf Spectroscopy
21:00	Conference Dinner: El Xalet de Montjuïc	

Thursday 11/07/2024

	S4.1: WDs in Binaries (DDs, mergers, sdB, AM CVn) / triples – Chair: Sarah Casewell	
09:00	Snehalata Sahu	Ultraviolet detection of carbon reveals a hot white dwarf merger remnant
09:15	James Munday	The DBL Survey I: discovery of 34 double-lined double white dwarf binaries
09:30	Zhenwei Li	Formation of Double White Dwarfs with a new mass transfer stability criterion
09:45	Aakash Bhat	Modeling the Stellar Evolution of Hypervelocity Runaways from Thermonuclear Supernovae
10:00	Tim Cunningham	Velocity structure in Pa 30 revealed
10:15	Camila Aros Bunster	Discovery of the third know triple white dwarf and implications for the formation of close double white dwarfs
10:30	*Coffee Break / Posters*	
	S4.2: WDs in Binaries (DDs, mergers, sdB, AM CVn) / triples and Planetary Debris Pollution – Chair: Sarah Casewell	
11:15	Maja Vuckovic	The double low-mass white dwarf eclipsing binary system J2102-4145, a phoenix sdB
11:30	Matthew Green	A Catalogue of AM CVn Binary Systems
11:45	Andrew Swan	Planetary material is a major source of H in He-dominated white dwarfs
12:00	Claudia Aguilera-Gómez	Linking exoplanet and stellar compositions using polluted white dwarfs
12:15	Anna-Maria Cutolo	Cool DAZs with High Metal-Enrichment
12:30	*Lunch Break*	
	S4.3: Planetary Debris Pollution – Chair: Nicole Reindl	
14:30	Jamie Williams	Interpreting the nature of material accreted by four DAZ white dwarfs using the Planetary Enriched White Dwarf Database
14:45	Benjamin C. Kaiser	A White Dwarf in Sheep's Clothing
15:00	Odette Toloza	At the proximities of G29-38
15:15	Steven Z. Savery	Asteroseismological Chronicle of the White Dwarf G29-38
15:30	*Coffee Break / Posters*	
	S4.4: Hot subdwarfs – Chair: Nicole Reindl	
16:15	Max Pritzkuleit	Runner or Merger? An enigmatic group of luminous hot subdwarfs on halo like orbits
16:30	Harry Dawson	Exploring the population of close hot subdwarf binaries in a 500 pc volume-limited sample
16:45	Abinaya S. Rajamuthukumar	Fate of close binaries containing hot subdwarfs and white dwarfs
17:00	Matti Dorsch	(Un)seen astrometric companions to hot subdwarfs

Friday 12/07/2024

	S5.1: Planetary Systems at WDs – Chair: Siyi Xu	
09:00	Andrew Vanderburg	The MIRI Exoplanets Orbiting White Dwarfs (MEOW) Survey: Early Results and Planet Candidates
09:15	Joseph Guidry	Using Mid-Infrared Variability towards White Dwarfs as a Signpost of Remnant Planetary Systems
09:30	Akshay Robert	The frequency of transiting planetary systems around polluted white dwarfs
09:45	Lou Baya Ould Rouis	Missing Planets Around Massive White Dwarfs?
10:00	Santiago Torres	The Dynamical Evolution of Planets Orbiting Interacting Binaries
10:15	Hiba Tu Noor	White dwarf pollution: one star or two?
10:30	*Coffee Break / Posters*	
	S5.2: Planetary Debris Pollution / Dusty and Gaseous disks – Chair: Siyi Xu	
11:15	Dang Pham	Polluting White Dwarfs with Oort Cloud Comet
11:30	Raquel Murillo-Ojeda	White dwarfs with infrared excess within 100 pc: Gaia and the Virtual Observatory
11:45	Ayaka Okuya	A possible indication of iron in white dwarf dusty disks
12:00	Felipe Lagos-Vilches	A general framework for the chemical characterization of circumstellar gaseous discs around white dwarfs with Cloudy
12:15	Laura Rogers	Are polluted white dwarfs with gas discs different from the general population?
12:30	Closing	
12:45	End of EUROWD24	

Contributed Talks

White dwarf Structure and Cooling Processes

S1.1: The cooling and kinematics of ultramassive white dwarfs in Gaia EDR3

Leesa Fleury (University of British Columbia), Ilaria Caiazzo and Jeremy Heyl

Gaia DR2 revealed a population of ultramassive white dwarfs in the solar neighbourhood moving anomalously quickly given their ages as inferred from photometry. An excess number of white dwarfs on the Q branch and the anomalously large transverse velocities of some of these white dwarfs have been pointed to as evidence of an anomalous cooling delay not accounted for in the white dwarf cooling models used to determine the cooling ages from the photometry. I will present the results of a reinvestigation into this apparent cooling anomaly using Gaia EDR3 observations, including an analysis of both the distribution of cooling ages and some kinematic features of this population not previously considered. I will discuss the importance of accounting for a time-dependent star formation rate and show how the apparent excess number of ultramassive white dwarfs reported on the Q branch can be explained by accounting for the time-dependent star formation history observed for the Milky Way if a large fraction (about half) of these white dwarfs were produced through double white dwarf mergers. I will also highlight some key kinematic features of the anomalous population that indicate this population did not originate from the local galactic disc and will discuss how these features challenge the cooling delay explanation.

S1.1: Distillation as the explanation for the Gaia Q branch

Antoine Bédard (University of Warwick), Simon Blouin, Sihao Cheng

The Gaia HR diagram shows a salient overdensity of massive crystallising white dwarfs along the so-called Q branch. The photometric and kinematic properties of the Q branch imply that 5-9 % of ultramassive white dwarfs essentially stop cooling for at least 8 Gyr, revealing the existence of a remarkably powerful energy source in these stars. For certain core compositions, crystallisation has been predicted to trigger a solid-liquid distillation mechanism, which efficiently transports heavy neutron-rich impurities to the centre and thus releases a large amount of gravitational energy. In this talk, I will present the key results of our recent paper (Bédard, Blouin & Cheng, 2024, Nature, 627, 286), where we demonstrate that distillation explains all the observational properties of the delayed population. I will present the first white dwarf evolution models including distillation, which predict that this process can interrupt the cooling of ultramassive white dwarfs for about 10 Gyr. I will then show that population simulations including a small proportion (5-9 %) of such delayed objects successfully reproduce the location, amplitude, and width of the Gaia Q branch. This comparison also indicates that the peculiar white dwarf population is characterised by extremely thin hydrogen and helium layers, providing further evidence that these stars originate from mergers. Finally, I will highlight the critical implications of our results for age-dating applications.

S1.1: The Q-branch as seen by DESI

Boris Gaensicke (University of Warwick)

The ”Q-branch”, initially discovered as a distinct spur off the white dwarf cooling sequence in the Gaia Hertzsprung-Russell diagram, has attracted substantial attention throughout the last years in the context of crystallisation, cooling delays, and possible merger histories. We will present a detailed spectroscopic investigation of 288 white dwarfs in the Q-branch using data from the DESI survey. We identify 11 new DAQ white dwarfs, as well as various hot DQ and magnetic white dwarfs, and we discuss the implications of the statistics of spectral types on the likely evolutionary paths of white dwarfs crossing the Q-branch.

S1.1: **Fluid Mixing During Phase Separation**

Mike Montgomery (University of Texas at Austin), Bart Dunlap

We show in this talk that thermohaline convection is in general efficient enough to mix the overlying fluid layers during the process of carbon/oxygen phase separation in crystallizing white dwarf interiors. Due to the relative slowness of this process, the magnitude of the magnetic field generated is expected to be small. We also examine in detail the recent suggestion that at early times, when the crystallized mass fraction is small, the flux of carbon is large enough to induce more vigorous mixing with an associated magnetic dynamo effect. Finally, we consider the mixing expected in the layers above a neon-distilled region and how this could affect the subsequent evolution and pulsation of these stars.

S1.1: **Hints of carbon dredge-up in the Gaia bifurcation**

Maria Camisassa (Universitat Politecnica de Catalunya), Santiago Torres, Mark Hollands, Detlev Koester, Roberto Raddi, Leandro G. Althaus, Alberto Rebassa-Mansergas

The ESA Gaia space mission has revealed a bifurcation in the white dwarf (WD) sequence on the color magnitude diagram in two branches: A and B. While the A branch consists mostly of WDs with hydrogen(H)-rich atmospheres, the B branch is not completely understood. Although invoked to be populated mainly by helium(He)-rich WDs, the B branch overlaps a $\sim$0.8Msun evolutionary track with a pure He envelope, fact that would imply an unexpected peak in the WD mass distribution. In cold He-rich white dwarfs, it is expected that the outer outer convective zone reaches deep carbon(C)-rich layers, thus leading to a slight surface C contamination at $\sim$10 000K. In this talk, I will describe how the Gaia bifurcation can be explained as the natural consequence of C dredge-up by convection in cool He-dominated white dwarfs. On the basis of He-rich WD models that consider different prescriptions for the C contamination, we made a population synthesis study of the Gaia 100pc WD sample. Our study shows that He-rich WD models with a slight C contamination below the optical detection limit can accurately reproduce the Gaia bifurcation. We refer to these stars as "stealth DQ" WDs because they do not exhibit detectable C signatures in their optical spectra, but the presence of C in their atmosphere produces a continuum absorption favoring the emission in bluer wavelengths, thereby creating the B branch of the bifurcation. The mass distribution obtained employing the stealth DQ models presents a peak at $\sim$0.6 Msun, being consistent with the DA mass distribution and with the standard evolutionary channels for their formation. Furthermore, photometric signatures of ultraviolet carbon lines have been found in the Galex photometry of hydrogen deficient WDs that exhibit continuous optical spectra, thus supporting that stealth DQ WDs are causing the B branch.

S1.2: **White Dwarf as Whirling Dervishes: The Frequency of Rapid Rotation**

Kurtis A. Williams (Texas A&M University-Commerce), Zorayda Martinez, Melissa Ornelas, Fangyi Zhu, and Paradesh Adhikari

The distribution of white dwarf rotation rates can provide insight into their formation, including merger history and angular momentum transport during post main sequence evolution. Recently, due in part to precision time series data from satellites and in part to increased efforts in wide-field time domain surveys, interest in white dwarf rotation studies has grown significantly. We present results from a targeted effort to detect rapid rotation ($<$ 6 hr period) via photometric variability in two samples of white dwarfs - massive magnetic DA white dwarfs, and cool DQ white dwarfs. Each sample has well-defined selection criteria to minimize selection bias and includes WDs as faint as V$\sim$18 in order to cover a large volume. We discuss both the fraction of each sample exhibiting rapid rotation and present the resulting rotational distributions at these short periods. We end by conjecturing on the interpretation of our results and discussing some best practices for future searches for WD rotation.

White dwarf Populations

S1.2: White dwarf rotation distribution

S. O. Kepler (UFRGS Brazil), Gabriela O. da Rosa, Leonardo Taynô T. Soethe, Alejandra D. Romero, Keaton Bell

We analyzed the 25713 light curves of 9302 white dwarfs with G<17.5 observed by the TESS telescope up to sector 76, released until 8 May 2024. Most objects were observed in multiple sectors, and we concatenated them. We discovered 856 stars with stable variability above the false-alarm-probability=1/1000 estimated by randomizing the light curves and tested if the variation was indeed coming from the white dwarf using TESS-Localize (Higgins & Bell 2023, AJ, 165, 41). We found 107 new DAVs, 3 new DBVs, and 4 new DOVs and estimated the white dwarf rotation period distribution, assuming the variability not coming from pulsations or eclipses is due to rotation. The rotation period distribution for our single star sample has a median of 3.9 h and a dispersion of 9.6 h. The period distribution can be matched by the evolutionary models we calculated with MESA, including rotation and angular momentum transfer throughout the evolution, which generates internal magnetic fields through a Tayler–Sprüit dynamo.

S1.2: Conclusions from the analysis of the 40 pc Gaia white dwarf sample

Mairi O'Brien (University of Warwick)

Following extensive observational efforts over the past two decades, and with the recent Gaia revolution, over 99 % of Gaia-identified white dwarf candidates within 40 pc of the Sun have now been confirmed and characterised with medium-resolution spectroscopy. I will present some of the key conclusions from our recent analysis, which provides a comprehensive overview of the newly volume-complete, unbiased 40 pc white dwarf sample. A population of white dwarfs evolved from single-star evolution is expected to have an essentially constant median mass, independent of temperature. However, current white dwarf atmosphere models have been found to under-predict optical photometric masses and surface gravities for white dwarfs below 6000 K. Almost half of the white dwarfs within 40 pc have effective temperatures below 6000 K, exemplifying the impact of this low-mass issue. I will discuss this low-mass issue, which is likely caused by inaccurate opacities in atmosphere models. Additionally, I will discuss the frequency of magnetism in 40 pc white dwarfs, revealing some of the potential origins of the magnetic fields observed in about a quarter of these stars. I will also present an investigation into the binarity of the local white dwarf population, finding that at least 20 % of white dwarfs within 40 pc are part of multiple-star systems with other white dwarfs or main-sequence companions. Finally I will discuss the reliability of low-resolution Gaia DR3 XP spectra for characterising white dwarfs by testing them on the already-characterised 40 pc sample.

S1.2: Insight into the faint galactic white-dwarf population: mapping the Milky Way and calibration tools for future deep synoptic surveys

Paul Ripoche (University of British Columbia), Jeremy Heyl

In addition to studying galaxies and the early Universe, future deep synoptic surveys will be essential to our understanding of the structure and history of the Milky Way (MW) by providing unprecedented data on the faint galactic stellar populations. However, observing stars at unrivalled depths presents challenges in identification and calibration. Using the unprecedented 27.1-mag median depth of the Canada-France-Hawai'i Telescope Large Area U-band Deep Survey (CLAUDS), we precisely studied the galactic stellar populations among over 15 billion of astronomical objects, over 20 square degrees. In the absence of parallax measurements in the CLAUDS data, we devised photometric methods relying solely on colours to select stars in a survey designed to observe faint galaxies. We demonstrated the usefulness of precise measurements in determining properties of foreground stars, particularly white dwarfs (WDs). The near-ultraviolet and optical CLAUDS photometry allows us to fit for the physical properties of the young faint white dwarfs, such as surface temperature, mass, surface gravity, cooling age, and distance. We find a main mass peak consistent with globular-cluster studies, making our sample the largest and deepest old stellar-halo WD population. Finally, we derive a typical age of the MW stellar halo consistent with previous studies, as well as the typical age of the oldest WDs in the MW, putting further constraints on the history of our Galaxy. Furthermore, through the analysis of WDs in the CLAUDS data, we developed a powerful technique for reducing systematics in synoptic surveys, such as the Legacy Survey of Space and Time (LSST) at the Vera C. Rubin Observatory, and the Cosmological Advanced Survey Telescope for Optical and UV Research (CASTOR), a proposed Canadian space telescope. Such a technique could significantly enhance data quality and provide exciting insights into the galactic stellar-population science that can be conducted with future deep synoptic surveys.

S1.2: **Comparison of methods for determining the star formation history using Gaia WD samples**

Emily Roberts (University of Warwick)

The advent of Gaia has provided astrometric and photometric observations of white dwarfs with unparalleled precision, accuracy and sample size. This opens the door to revisiting methods for inferring the star formation history (SFH) of the solar neighbourhood using white dwarfs. I will present our findings from a comparison of three different methods of determining the SFH using the 40pc Gaia white dwarf sample, and discuss ways in which these methods could be improved and expanded to a 100pc sample. The absolute Gaia G magnitude distribution of white dwarfs is expected to have a dependence on the underlying SFH of the population. The same is true of the white dwarf luminosity function. Direct age calculations for individual white dwarfs can also construct a SFH directly by revealing the formation times of the population. We have applied these three methods to the Gaia 40pc white dwarf sample to investigate the underlying SFH and explore the differences, advantages, and disadvantages of such methods. Our simulation of the local white dwarf population preliminarily indicates that all three methods find a better fit to the observational sample with two different star formation rates at younger ($<$5 Gyr) and older (¿5 Gyr) lookback times.

White dwarfs in New Surveys

S3.1: White dwarfs from the DESI Survey

Christopher Manser (Imperial College London), Paula Izquierdo, Boris Gaensicke, Andrew Swan, Detlev Koester, Akshay Robert, Siyi Xu, Keith Inight, Ben Amroota, Nicola Gentile Fusillo, Sergey Koposov, Bokyoung Kim, Arjun Dey, Carlos Allende Prieto, and the DESI Collaboration

The Dark Energy Spectroscopic Instrument (DESI) is a Multi-Object Spectroscopic (MOS) instrument with 5000 robotic fibres that started main survey operations on 2021 May 14. At the time of this conference, DESI will be over 3 years through its 5-year observing plan. DESI targeting of white dwarfs was initially based on the Gentile Fusillo et al. 2018 catalogue of Gaia DR2 white dwarf candidates, and it has observed over 50,000 white dwarf candidates to date. The DESI collaboration released its first catalogue of spectra in the Early Data Release (EDR), which is made up of survey-validation data obtained prior to main survey operations. This includes 2706 white dwarfs which we have visually confirmed, of which 60 % were classified spectroscopically for the first time, in addition to 66 white dwarfs in binaries. In this talk I will give an overview of DESI and the DESI EDR white dwarf sample, how it improves upon previous MOS samples like that obtained by SDSS, and highlight a few interesting subgroups and individual systems identified by DESI. I will also discuss what can be expected in the DESI DR1 data release.

S3.1: A network of cool white dwarfs as standards for flux calibration

Abbigail Elms (University of Warwick), Pier-Emmanuel Tremblay, Ralph C. Bohlin, Nicola Pietro Gentile Fusillo, Mark A. Hollands, Snehalata Sahu

We have entered a pioneering era of space telescopes and instruments, which will provide previously unattainable data for objects in our Galaxy and beyond, especially at infrared (IR) wavelengths. It is of paramount importance that observations are flux calibrated accurately so that astrophysical and cosmological studies reach accurate conclusions. Currently, three hot (Teff ¿ 30 000 K) hydrogen atmosphere (DA) white dwarfs comprise the primary white dwarf flux standards and CALSPEC absolute flux scale. We propose to add a new network of 17 cool (Teff $<$ 20 000 K) white dwarfs as standards as these are more reliable IR flux calibrators than hot white dwarfs. As demonstrated in Gentile Fusillo et al. (2020), they do not suffer from non-local thermal equilibrium (NLTE) effects in continuum flux or UV metal line blanketing, have a larger sky density, and their energy distributions peak in the optical or NIR. Using the latest grid of 3D DA LTE atmosphere models, we successfully predict the observed STIS and WFC3 fluxes to within 3 % over most of the range between $1450 - 16000$ A. Fitting the white dwarf spectral energy distributions and Balmer lines independently yields similar atmospheric parameters, demonstrating the predictive power of the models for our white dwarf network.

S3.1: If you build it, they will come – new facilities and instruments for the study of White Dwarfs.

Sagi Ben-Ami (Weizmann Institute of Science), Na'ama Hallakoun, Yahel Sofer-Rimalt, Yarin Meir-Shani, Oren Ironi, Eran O. Ofek, David Polishook, Mukremin Kilic, Yossi Shvartzvald, Sergio Campana

We present new and novel facilities and instruments that will enhance our capabilities to study WDs. We focus on the Son-of-XShooter medium-resolution UV-to-NIR spectrograph for ESO NTT, the Large Array Survey Telescope wide-FoV survey with continuous cover and a footprint of 350 sq. degrees, the Multi Aperture Spectroscopic Telescope low- and high-resolution spectrographs for the Weizmann Astrophysical Observatory, which offer unprecedented efficiency and modularity, and the ULTRASAT wide-FoV UV satellite, with a FoV of 200 sq. degrees covering the NUV bandpass, expected to be launched in 2028. We discuss the unique capabilities of these facilities and give a short review of planned observing campaigns targeting the study of WDs. The presentation points to several posters presented in the conference.

White dwarfs in Binaries

S1.3: The white dwarf binary pathways survey and Gaia

James Garbutt (Univeristy of Sheffield), S. G. Parsons, O. Toloza, B. T. Gänsicke, M. S. Hernandez, D. Koester, F. Lagos, R. Raddi, A. Rebassa-Mansergas, J. J. Ren, M. R. Schreiber, M. Zorotovic

White dwarfs with a F, G or K type companion represent the last common ancestor for a plethora of exotic systems throughout the galaxy, though to this point very few of them have been fully characterised in terms of orbital period and component masses, despite the fact several thousand have been identified. Gaia data release 3 has examined many hundreds of thousands of binary systems, and as such we can use this, in conjunction with our previous UV excess catalogues, to perform spectral energy distribution fitting in order to obtain a sample of 206 binaries likely to contain a white dwarf, complete with orbital periods, and either a direct measurement of the component masses for astrometric systems, or a lower limit on the component masses for spectroscopic systems. Of this sample of 206, four have previously been observed with Hubble Space Telescope spectroscopically in the ultraviolet, which has confirmed the presence of a white dwarf, and we find excellent agreement between the dynamical and spectroscopic masses of the white dwarfs in these systems. In this talk, I will present our findings; that white dwarf plus F, G or K binaries can have a wide range of orbital periods, from less than a day to many hundreds of days. A large number of our systems are likely post-stable mass transfer systems based on their mass/period relationships, while others are difficult to explain either via stable mass transfer or standard common envelope evolution. I will also present preliminary results of expanding this search to a much larger sample.

S1.3: Timing variations in eclipsing white dwarf binaries

Steven Parsons (University of Sheffield)

The small sizes of white dwarfs leads to sharp features when they are eclipsed by binary companions, enabling these eclipses to be used as precise clocks. In principle these measurements are sensitive enough to detect the perturbations due to super-Earth mass planets in decade long orbits around these binaries. Decades of timing measurements have now detected significant timing perturbations in dozens of systems, with planetary orbits proposed in many cases, often with multiple planets required to fit the observed variations. However, almost all proposed orbits have been found to be inconsistent with new data or prove to be dynamically unstable. In this talk I will summarise the conflicting evidence for and against the existence of these planets and present our updated timing measurements for dozens of eclipsing white dwarf binary systems. I will show that we finally have sufficient data to analyse the population as a whole, instead of treating each system individually. The data indicate that variations in the internal structure of the companion stars are the most likely source of the timing variations, although proposed mechanisms still struggle to explain the magnitude of the timing variations seen in many systems.

S1.3: A comprehensive population synthesis study of the Gaia 100 pc unresolved white dwarf- main sequence binary population

Alejandro Santos García (Universitat Politècnica de Catalunya), Santiago Torres, Alberto Rebassa-Mansergas

White dwarfs and binary stars can provide a wealth of information about the origin and evolution of the Galaxy and its constituents. Thanks to Gaia, we now have astrometric and photometric data from an immense number of white dwarfs previously unknown, and the number of binary systems has also increased exponentially. Moreover, the completeness of such systems to a distance of 100 pc is higher than 95 %. To understand their physics, we are simulating the different Galactic populations of binary systems that contain at least one white dwarf. To that end we use a Monte Carlo code together with a stellar evolutionary code conveniently adapted to cover a wide range of stars from all ages, masses and metallicities. Different physical processes such as mass transfer, common envelope evolution, collisions or tidal interactions are considered, which can give us a hint about the formation history and evolution of the observed stars. The ultimate end is to compare the outcome of the simulations with the nearly complete observed Gaia samples in the Solar Neighborhood to constrain current evolutionary models. More specifically, we can study the unresolved binaries consisting of a white dwarf and a main sequence companion (i.e. WDMS binaries) and their stellar parameters and compare them with those obtained from Gaia observations.

S1.4: **Towards a volume limited sample of post-common-envelope binaries**

Alex Brown (Universitat Politecnica de Catalunya), Alberto Rebassa-Mansergas, Santiago Torres, Steven Parsons, Jan van Roestel

The release of Gaia DR2 in 2018, with parallax measurements for over 1.3 billion sources, enabled the construction of high-quality volume-limited samples for the first time. These volume-limited samples, being relatively unaffected by observational biases, particularly when compared to the typically magnitude-limited samples that preceded them, allow robust statistical analyses to be performed on a chosen population. For single white dwarfs (WDs), 20pc, 40pc, and 100pc samples have been investigated. And for WDs in binaries, a 150pc sample of cataclysmic variables (CVs) has been analysed. For the latter, parameters such as the WD mass distribution, magnetic CV fraction, and space density have been measured, demonstrating that discrepancies between theory and observation are not simply due to observational biases, pointing to gaps in our understanding. One volume-limited sample that remains elusive has been the detached PCEBs. As the immediate product of the still poorly understood common envelope phase and progenitors to cataclysmic variables, they occupy an important evolutionary checkpoint, able to provide insight into both phases of binary evolution. However, the lack of accretion effects and outbursts can make their detection difficult, particularly when one component dominates the optical flux. Here we discuss previous attempts towards a volume-limited analysis of these systems as well as the ongoing work to improve on these previous attempts to obtain a representative sample of these important systems.

S1.4: **A large sample of WD + MS binaries from Gaia DR3 as probes of binary interactions**

Natsuko Yamaguchi (California Institute of Technology (Caltech)), Kareem El-Badry, Sahar Shahaf

Astrometry from Gaia DR3 has enabled the discovery of a large sample of WD + MS binary candidates with orbital periods $\sim$ 100 - 1000 days. This population was not predicted previously by binary population synthesis models, having properties that defy standard expectations of formation either through stable mass transfer or common envelope evolution. I will describe the properties of the sample, our spectroscopic follow-up to validate the Gaia orbital solutions and tighten constraints on the parameters, as well as our early efforts to model their evolution. I will also discuss self-lensing binaries as a complementary sample to the Gaia binaries and our preliminary work to look for more of these systems.

S1.4: **Constraints on magnetic braking from the mass distribution of post-common envelope binaries**

Lisa Blomberg (California Institute of Technology), Kareem El-Badry

Magnetic braking is among the most important and poorly understood ingredients in evolutionary models for cataclysmic variables and other close binaries. I will describe empirical constraints on magnetic braking from close binaries containing white dwarfs and hot subdwarfs (sdBs) orbited by main-sequence (MS) stars. We have carried out a spectroscopic survey of eclipsing sdB+MS binaries, enabling the first controlled study of the mass distribution of MS companions to sdBs. Because sdBs have shorter lifetimes than white dwarfs (WDs), they complement existing samples of WD+MS binaries that have previously been used to constrain magnetic braking. I will present the mass distribution of the companions and compare it to population synthesis predictions using a variety of empirical magnetic braking laws.

S1.4: **Uncovering a hidden population of WDs in Gaia astrometric binaries: insights and the mystery of missing massive WDs**

Na'ama Hallakoun (Weizmann Institute of Science), S. Shahaf, T. Mazeh, S. Ben-Ami, S. Toonen, P. Rekhi, K. El-Badry

The third data release of Gaia was the first to include orbital solutions assuming non-single stars. By applying the astrometric triage technique of Shahaf et al. combined with Gaia's synthetic photometry we uncovered a population of nearly 3200 binaries with main-sequence primaries, characterized by orbital separations on the order of an astronomical unit, in which the faint astrometric companion is probably a white dwarf (WD). This sample increases the number of orbitally solved binary systems of this type by about two orders of magnitude. This sample is not currently represented in synthetic binary populations, and is not easily reproduced by available binary population synthesis codes. Such systems are likely to have undergone a phase of stable mass transfer while the WD progenitor was on the asymptotic giant branch. We find that the number of massive WDs relative to the total number of WDs in a volume-complete subsample of these systems with K/M-dwarf primaries is smaller by an order of magnitude compared to their occurrence among single WDs in the field. One possible reason can be an implicit selection of the WD mass range if these are indeed post-stable-mass-transfer systems. Another reason can be the lack of merger products in our sample compared to the field, due to the relatively tight orbital separations of these systems. This sample offers a unique opportunity to gain insights into the processes governing WD formation, binary evolution, and mass transfer.

S2.1: **Type Ia supernovae from explosions of sub-Chandrasekhar-mass white dwarfs in double white dwarf binaries**

Ken Shen (UC Berkeley), Samuel Boos and Dean Townsley

The identity of Type Ia supernova progenitors has been the subject of intense study for decades, but a coherent and satisfying explanation may finally be within reach. In this talk, I will present the mounting evidence that most, if not all, Type Ia supernovae are explosions of sub-Chandrasekhar-mass white dwarfs in double WD binaries. This evidence includes progenitor modeling, explosion simulations, and radiative transfer calculations; the prediction and discovery of an increasing number of hypervelocity surviving companion WDs; and recent theoretical work showing that nearly all WDs can support double detonations at birth if impacted with sufficient strength, without the need for additional accretion. I will also describe the new and intriguing possibility that many Type Ia supernovae actually arise from the detonations of both of the sub-Chandrasekhar-mass WDs in a double WD binary.

S2.1: **The fastest stars in the galaxy**

Kareem El-Badry (California Institute of Technology)

Gravitational wave-driven inspiral of double white dwarf binaries is predicted to result in the launching of hypervelocity white dwarfs from the sites of type Ia supernovae and related thermonuclear explosions. About a dozen such objects have been discovered over the course of the last decade, thanks in large part to Gaia and wide-field spectroscopic surveys. I will describe recent developments, focusing in particular on a newly discovered population of hot and bloated objects – with physical parameters intermediate between white dwarfs and hot subdwarfs, and atmospheres consisting mostly of carbon and oxygen – whose evolutionary status is not yet understood. I will also discuss constraints on the birth rate of hypervelocity stars and on the fraction of type 1a supernovae that result from double-degenerate channels.

S2.1: **A spectroscopic and kinematic analysis of a D6 supernova survivor**

Mark Hollands (University of Warwick), Ken Shen, Roberto Raddi, Boris Gaensicke, Alberto Rebassa-Mansergas

SDSSJ1637+3631 is a peculiar white dwarf first identified from its SDSS spectrum which showed redshifted lines (¿300 km/s) of O, Mg, Si, and Ca (Raddi et al. 2019). We followed up J1637 with GTC OSIRIS spectroscopy further identifying lines from C, Ne, Al, S, and Fe. Our spectral analysis reveals a C+O dominated atmosphere with Si as the next most abundant element (log(Si/O) $\sim$= -2 dex), indiciating that J1637 was likely the donor in a dynamically-driven double-degenerate double-detonation (D6) supernova (Shen et al. 2018). Despite a Gaia DR3 parallax precision below 1 sigma, our kinematic analysis establishes the most likely ejection site within a few kpc of the Galactic centre, while refining its current distance to 5 ± 1kpc and a galactic rest-frame velocity of 1700 ± 200km/s, giving further weight to the D6 explanaiton.

S2.1: **Helium as a signature of white dwarf double detonations**

Fionntan Callan (Queen's University Belfast)

If we are to fully understand the white dwarf (WD) evolutionary pathways which lead to Type Ia supernovae (SNe Ia) determining the different explosion scenarios that produce SNe Ia is key. Double detonations of sub-Chandrasekhar mass WDs are a leading theoretical model for SNe Ia. In this scenario a detonation is triggered in an accreted surface layer of helium leading to a secondary detonation in the carbon-oxygen core of the WD. A defining property of double detonation models is unburnt helium in their outer ejecta – determining whether this helium should produce observable signatures is therefore a critical test of this scenario. Predicting helium features requires radiative transfer simulations which include a detailed treatment of non-LTE and particularly non-thermal processes. We previously carried out such a simulation of a double detonation model which demonstrated the potential of the He I 10830 spectral feature as an observational signature of the double detonation scenario. In this talk I will discuss results from new radiative transfer simulations of a double detonation which incorporate a full treatment of the He I line formation. We find that double detonation models can predict a strong He I 10830 feature that is in good agreement with a feature observed in the spectra of transitional SNe Ia. The model spectra also show a small but observable contribution from He I at 2 microns indicating the potential of this feature as a secondary signature of the double detonation scenario. This work has strengthened the case of helium as an observational signature of SNe Ia explosion scenarios. Additionally, the good agreement of these new simulations with observations provides direct evident that the double detonation scenario occurs in nature.

S2.1: **Multidimensional Nebular Phase Radiative Transfer Calculations of Double-degenerate Double-detonation Type Ia supernovae**

Joshua Pollin (Queen's University Belfast), S. A. Sim, R. Pakmor, F. P. Callan, C. E. Collins, L. J. Shingles, F. K Röpke

The double-detonation of a sub-Chandrasekhar mass white dwarf is one of the leading models for Type Ia supernovae. Double-detonations could be triggered either via accretion or during the merger of white dwarf binaries. Most previous double-detonation explosion simulations have included only the primary white dwarf, but for white dwarf mergers, the fate of the secondary can have significant consequences. Recently, simulations fully accounted for the secondary white dwarf in 3D hydrodynamic explosion simulations of double-degenerate double-detonation mergers. We present the first multidimensional nebular phase radiative transfer calculations for the double-degenerate double-detonation scenario, which utilises our full NLTE treatment of the plasma conditions. Similar to photospheric phase radiative transfer calculations, viewing angle variation is still an important effect hundreds of days after the initial explosion. The range in viewing angle variation depends heavily on the level of asymmetry in the explosion models. Nebular phase radiative transfer modelling has revealed that the exact evolutionary endpoint of the binary system has significant observational consequences. Specifically, when the secondary white dwarf detonates, the viewing angle variation produces synthetic observables which display a better agreement to normal Type Ia supernovae. These nebular calculations demonstrate how radiative transfer calculations at later phases can reveal key spectroscopic characteristics in explosion models when compared to photospheric phase calculations and highlights the importance of multidimensional effects.

S2.1: **Ia supernova ejecta interacting with companion stars**

Sunny Wong (University of California, Santa Barbara), Chris White, Lars Bildsten

In the double detonation scenario for type Ia supernovae, a donor star transfers helium-rich material to an accretor white dwarf, leading to the detonation of the helium shell and the subsequent detonation of the carbon core of the accretor. Following the explosion, the donor star leaves at its orbital velocity of over 1000 km/s. To date, seven such hypervelocity stars have been discovered from Gaia data. They show inflated radii and metal-polluted atmospheres. I will present new 3D hydrodynamical simulations modeling the interaction between the donor star and the supernova ejecta, and show that the post-shock properties of the donor star agree well with one of the best-studied hypervelocity stars. I will also discuss how much material is stripped from the donor and where it resides within the expanding supernova ejecta.

S2.2: Discovery of a Magnetic Double-Faced DBA White Dwarf

Adam Moss (University of Oklahoma), P. Bergeron, Mukremin Kilic, Gracyn Jewett, Warren R. Brown, Alekzander Kosakowski, Olivier Vincent

We report the discovery of spectroscopic variations in the magnetic DBA white dwarf SDSS J091016.43+210554.2. Follow-up time-resolved spectroscopy at the Apache Point Observatory (APO) and the MMT show significant variations in the H absorption lines over a rotation period of 7.7 or 11.3 h. Unlike recent targets that show similar discrepancies in their H and He line profiles, such as GD 323 and Janus (ZTF J203349.8+322901.1), SDSS J091016.43+210554.2 is confirmed to be magnetic, with a field strength derived from Zeeman-split H and He lines of $B \approx 0.5$ MG. Model fits using a H and He atmosphere with a constant abundance ratio across the surface fail to match our time-resolved spectra. On the other hand, we obtain excellent fits using magnetic atmosphere models with varying H/He surface abundance ratios. We use the oblique rotator model to fit the system geometry. The observed spectroscopic variations can be explained by a magnetic inhomogeneous atmosphere where the magnetic axis is offset from the rotation axis by $\beta = 52°$, and the inclination angle between the line of sight and the rotation axis is $i = 13$–$16°$. This magnetic white dwarf offers a unique opportunity to study the effect of the magnetic field on surface abundances. We propose a model where H is brought to the surface from the deep interior more efficiently along the magnetic field lines, thus producing H polar caps. This target is 1 of 10 from a sample of unresolved binary candidates, and we have detected similar variations in at least one of these other objects. We are currently constraining the geometry of this new target, in addition to observing the remaining targets in the sample.

S2.4: The late emergence of white dwarf magnetic fields and the absence of period bouncers in observed samples of CVs

Matthias R. Schreiber (Universidad Tecnica Federico Santa Maria), Diogo Belloni

In recent years it has become clear that most white dwarf magnetic fields appear 2-3 Gyr after the formation of the white dwarf. Incorporating the late appearance of white dwarf magnetic fields in models for the evolution of Cataclysmic Variables (CVs) allowed for the first time to establish an evolutionary sequence connecting post common envelope binaries, the progenitors of magnetic cataclysmic variables, white dwarf pulsars, and magnetic CVs. The currently only available scenario for the late generation of white dwarf magnetic fields is the crystallization driven dynamo. Here I show that if white dwarf magnetic fields are indeed generated when the core of the white dwarf starts to crystallize, CVs that evolved past the period minimum (usually called period bouncers) are likely to detach for several Gyr. This effect might explain the scarcity of period bouncers in observed samples of CVs and thus potentially solves one of the most serious and long-standing problems in our understanding of CV evolution.

S2.4: The 300 pc sample of accreting white dwarfs

Anna Francesca Pala (European Space Agency)

Accreting white dwarfs are ideal laboratories in which to test our understanding of the evolution of all types of compact binaries, as they are numerous, nearby and relatively bright. Large and well-defined samples of accreting white dwarfs are paramount to study their population properties and to critically test our understanding of the evolutionary models. We have started a systematic spectroscopic study of all accreting white dwarfs within 300 pc, using VLT/X-shooter and GTC/OSIRIS, in combination with the astrometry and spectra provided by Gaia DR3. In this talk, I will present the preliminary results from this survey, from which we accurately measured the space density and scale height of accreting white dwarfs. Moreover, the wide wavelength coverage of the X-shooter data allow us to identify possible brown dwarf donors and to firmly establish the contribution of these old systems to the overall population. Being largely free of any selection bias, the results of this study represent one of the most accurate and reliable tests of the current models of compact binary evolution.

S2.4: **Searching for rare cataclysmic variables**

Jan van Roestel (University of Amsterdam)

Cataclysmic variables show many kinds of optical variability which can be used to identify new CVs. The Zwicky Transient Facility (ZTF) has been observing the entire northern sky every two nights since 2018. We have searched the ZTF for outbursts, eclipses, and other periodic variability to identify new cataclysmic variables. Using these various methods, we have identified thousands of new cataclysmic variables. Most of these are outbursting dwarf novae, but some low accretion rate CVs were only found by looking for more subtle effects. The sample includes more than a dozen highly magnetic wind accreting systems that are dominated by cyclotron radiation; an equal amount of eclipsing AM CVn binaries that are extremely useful to measure binary parameters, but also AM CVn binaries that show anomalously long outbursts that do not seem to be the result of disk instabilities. Spectroscopic, photometric, and X-ray followup observations have been used to characterize these more unique CVs in more detail. With this experience of datamining ZTF, I will discuss the prospects of new and deeper time domain surveys such as LSST and how such future surveys are best utilized to learn more about Cataclysmic Variables; especially the rare subtypes.

S2.4: **Cataclysmic Variables around the period-bounce: An eROSITA-enhanced multi-wavelength catalog**

Daniela Muñoz Giraldo (Institut für Astronomie und Astrophysik, Universität Tübingen), Beate Stelzer and Axel Schwope

Period-bounce cataclysmic variables (CVs) are systems where a white dwarf accretes from a brown dwarf donor, having reached a point where the degeneracy of the donor reverses the orbit period evolution. A large portion of the CV population, between 40 % and 70 %, is predicted to be made up of period-bouncers. However, due to their intrinsic faintness, only on the order of a dozen such systems have been confidently identified so far. A promising approach to identify period-bounce CVs is an X-ray detection. It provides proof of accretion from the substellar companion onto the white dwarf because the coronal emission of a brown dwarf donor is below the sensitivity of current instruments. We have compiled a literature catalogue of CVs around the period-bounce, including known period-bouncers, containing 192 systems. We characterized this elusive subclass of CVs using values available in the literature for system parameters (including orbital period, mass and spectral type of the donor, and white dwarf temperature) as well as multi-wavelength photometry. The main result is a ”scorecard” assigning to each system the probability of being a period-bouncer. We systematically analysed X-ray data from the recent all-sky surveys carried out with the extended ROentgen Survey with an Imaging Telescope Array (eROSITA) onboard the Spektrum-Roentgen-Gamma spacecraft (SRG). Using this information we confirm 7 systems as new period-bouncers, raising their population by $\sim$40 %. We provide an outlook of the eROSITA all-sky survey capabilities for the X-ray detection of previously unknown period-bouncers.

S3.2: **Fundamental Tests of White Dwarf Cooling Physics with Wide Binaries**

Manuel Barrientos (University of Oklahoma), Mukremin Kilic, Simon Blouin, Warren Brown, Jeff Andrews

We present follow-up spectroscopy and a detailed model atmosphere analysis of 28 wide double white dwarfs, including 8 systems with a C/O core crystallized member. We use the current evolutionary models to constrain the physical parameters of each star, including the total age. Since the members of wide binaries are coeval, any age difference between the binary members can be used to test the cooling physics for white dwarf stars, including potential delays due to crystallization and ^{22}Ne distillation. We use our control sample of 14 wide binaries with non-crystallized members to show that this method works well; the control sample shows an age difference of only ΔAge = -0.03$\pm$ 0.15 Gyr between its members. On the other hand, the 8 C/O core crystallized systems show an age difference of ΔAge= $1.13^{+1.20}_{-1.07}$ Gyr. Even though the large uncertainties make these results not statistically significant, these are consistent with a small (~ 1 Gyr) additional cooling delay for crystallized white dwarfs that are currently not included in the evolutionary models. In addition, we rule out cooling delays longer than 3.6 Gyr at the 99.7
,% (3σ) confidence level for 0.6-0.9 $M_\odot$ white dwarfs. Further progress requires larger samples of

wide binaries with crystallized massive white dwarf members. We provide a list of subgiant + white dwarf binaries that could be used for this purpose in the future.

S3.2: **Precise gravitational redshifts of white dwarfs in wide binaries**

Roberto Raddi (Universitat Politecnica de Catalunya)

The mass-radius relation is an important property of white dwarfs, which is related to their composition and evolution. Its theoretical modelling is confirmed by the accuracy of Gaia parallaxes. However, the precise measurement of masses and radii of white dwarfs has only been possible empirically for a relatively small of low-mass objects in eclipsing binaries. The mass-radius relation can also be tested for white dwarfs in clusters and wide binaries. The latter, in particular, can be used to directly measure the gravitational redshift of white dwarfs and, thus, their masses and radii. We present our analysis of DA, DB, and DAB white dwarfs in wide binaries with high-resolution spectra.

S3.2: **Investigating Field Star Gyrochronology with WD+MS Wide Binary Pairs**

Mariel Lares Martiz (Embry-Riddle Aeronautical University), Terry Oswalt

Open clusters have been the canonical systems to study gyrochronology. However, the age-rotation-mass paradigm has yet to be proven as an age-determination method for every star, including field stars. Wide binaries are considered the smallest open clusters where the coeval property holds. Additionally, each component has likely evolved as a single star without mass transfer or common envelope evolution. Therefore, properties of wide binaries makes them excellent laboratories for testing the gyrochronology paradigm for field stars. Pairs composed of a main sequence star and a white dwarf(WD+MS) offer an extra advantage: Cooling models provide a completely independent method to obtain the age of the white dwarf, which, in theory, should be of the order of the main sequence component. We tested this for a vetted sample of WD+MS wide binaries. Results showed that the tendency of high rotation periods corresponding to older stars still holds.

S4.1: **Ultraviolet detection of carbon reveals a hot white dwarf merger remnant**

Snehalata Sahu (University of Warwick, UK), Antoine Bedard, Boris Gaensicke, Pier-Emmanuel Tremblay, Detlev Koester

The Gaia identification of Q-branch has led to the discoveries of interesting physical phenomena such as crystallisation and distillation causing a cooling delay in the ultra-massive white dwarfs ($> 1.1\,\mathrm{M}_{\odot}$). The Q-branch is dominated by white dwarfs having hydrogen-rich or carbon-rich atmospheres (DA and DQ). However, recently, five DAQ white dwarfs (13000 $<$ Teff $<$ 17000 K) have been detected using optical spectroscopic observations (Hollands et al.2019, Kilic et al.2024). These white dwarfs with high masses (1.13-1.17 $\mathrm{M}_{\odot}$) and unusual velocity dispersion have been interpreted as stellar mergers. Despite this, the evolution and exact merger fraction of these white dwarfs are not well known. Here, we report the detection of photospheric carbon in the hydrogen dominated atmosphere of a hot ($\sim$21000 K) and ultra-massive (1.22 $\mathrm{M}_{\odot}$) white dwarf using HST COS ultraviolet spectroscopic observations. We measured a carbon abundance of log(C/H) = -4.62 which is $\sim$5 orders of magnitude lower than the known DAQs (log (C/H)=-0.48 to 0.97). Since convection is inefficient in dredging up carbon in this hot DAQ unlike its cooler counterparts, we computed envelope composition models to understand the reason behind the carbon detection. We present the model results and showcase that UV spectroscopy provides a novel method to identify white dwarf merger remnants, and hence determine the merger fraction in the Q-branch.

S4.1: **The DBL Survey I: discovery of 34 double-lined double white dwarf binaries**

James Munday (University of Warwick), Ingrid Pelisoli, P.-E. Tremblay, T. R. Marsh, Gijs Nelemans, Antoine Bédard, Silvia Toonen, Elmé Breedt, Tim Cunningham, Mairi W. O'Brien, Harry Dawson

We present the first instalment of the double-lined double white dwarf (DBL) survey and its success up to now. The DBL survey targets overluminous white dwarf candidates with respect to the typical 0.6 solar mass cooling sequence that are prime targets for 1) being double white dwarf binaries 2) showing a unique spectral signature of both stars, which are separated in the spectrum due to Doppler shift and are easily disentangled. We randomly selected targets within a magnitude-limited search selection for a medium-resolution spectroscopic campaign (R∼9,000) and detected 34 double-lined systems out of a total of 117 candidates. The DBL survey has hence already almost doubled the population of double-lined double white dwarfs in the literature. A further 38 of the 117 are single-lined double white dwarfs and 38 more are single-lined DAs. We atmospherically fit all systems with a new and publicly available white dwarf fitting routine (capable of photometric, spectroscopic and hybrid fitting) called ”WD-BASS” to determine masses for all stars in all observed sources. Fascinatingly, we recovered a large sample of compact, high total mass (1.0 - 1.3 solar masses) double white dwarf systems, where very few were known in the past due to detrimental selection biases that plague the observed sample towards an overabundance of low-mass, single-lined white dwarfs. One remarkable system is both double-lined and super-Chandrasekhar mass, which we have now discovered as the most compact, confirmed to be ¿1.44 solar masses double white dwarf binary known to date.

S4.1: **Formation of Double White Dwarfs with a new mass transfer stability criterion**

Zhenwei Li (Yunnan Observatories, CAS)

Mass transfer stability is a key issue in studies of binary evolution. Critical mass ratios for dynamically stable mass transfer have been analyzed on the basis of an adiabatic mass loss model, finding that the donor stars on the giant branches tend to be more stable than that based on the composite polytropic stellar model. Double white dwarfs (DWDs) are of great importance in many fields and their properties would be significantly affected under the new mass transfer stability criterion. In this talk, I will introduce the influence of mass transfer stability on the formation and properties of DWD populations. The comparison with observational DWD samples is also addressed.

S4.1: **Modeling the Stellar Evolution of Hypervelocity Runaways from Thermonuclear Supernovae**

Aakash Bhat (University of Potsdam), Evan Bauer, Rüdiger Pakmor, Ken Shen, Abhinay Rajamuthukumar

The fastest runaway stars in our Galaxy are produced by supernovae in very compact double white dwarf binaries. Their measured velocities alone provide strong constraints on the configurations of the binaries that produced them at the moment of supernova explosion. We have observed the runaway stellar remnants a hundred thousand to a few million years after they were released from their companion supernova at ∼2000 km/s, but their current stellar structure is very different from the compact configuration they must have had in a double white dwarf binary. No detailed stellar evolution simulations have yet succeeded in reproducing and explaining their currently inflated and luminous states, and recent discoveries have provided fresh motivation for stellar evolution models to compare to the growing population of these hypervelocity runaways. Existing simulations of the hydrodynamics in the binary leading up to supernova detonation provide an excellent starting point for building models to explore the subsequent stellar evolution of the runaway donor using MESA.

S4.1: **Velocity structure in Pa 30 revealed**

Tim Cunningham (Harvard University)

The recently discovered Pa 30 nebula, likely the supernova remnant of historical supernova SN 1181, exhibits a unique radial and filamentary structure unlike any other. At its center is a stellar remnant, and due to its high temperature and high-speed winds, it has been suggested that it formed from a double-degenerate white dwarf merger, possibly of super-Chandrasekhar mass. The merger would have caused a failed thermonuclear detonation, producing a sub-luminous transient, a sub-type of the Ia class of supernovae called Type Iax. This is supported by the absence of hydrogen or helium in the star and nebula and detection of carbon-burning products in its X-ray spectrum. We have recently conducted the first detailed study of the 3D structure and velocities of a full radial section of the nebula. The analysis, made possible thanks to Integral Field Unit spectroscopic observations with the newly commissioned red arm of the Keck Cosmic Web Imager (KCWI) spectrograph, reveals a large cavity inside the supernova remnant and a sharp inner edge to the filamentary structure. The identification of an inner edge allows the first determination of the extent of the reverse shock commonly observed in supernova remnants. We also detect strong asymmetry in ejecta, hinting at an asymmetric explosion. Our analysis provides the strongest evidence to date that the explosion originated from SN 1181. Finally, ejecta velocities are near-ballistic at 90 ± 6 % of free expansion, indicating some deceleration from interaction with circumstellar material may have occurred.

S4.1: **Discovery of the third know triple white dwarf and implications for the formation of close double white dwarfs**

Camila Aros Bunster (Universidad Técnica Federico Santa María), Matthias Schreiber

Double white dwarfs that evolve through two periods of mass transfer and end up with small separations are potential SN Ia progenitors and important sources of gravitational wave radiation. Despite some recent progress we are still unable to reproduce the observed population of double white dwarfs with binary population models. Even worse, the existence of some of the individual observed double white dwarfs contradicts our understanding of how these binaries may form. Here we present the discovery of the only third known triple white dwarf. This system is a hierarchical triple and the inner binary is one of the currently unexplained double degenerates. The presence of the distant tertiary allows us to determine the total age of the system which hints towards an alternative formation scenario of the inner binary. We discuss the implications of this finding for our general understanding of white dwarf binary star evolution

S4.2: **The double low-mass white dwarf eclipsing binary system J2102-4145, a phoenix sdB**

Maja Vuckovic (Universidad de Valaraiso), LARISSA AMARAL ANTUNES, James Munday et al.

Approximately 150 low-mass white dwarfs (WDs), with masses below 0.4 Msun, have been discovered. The majority of these low-mass WDs are observed in binary systems as they cannot be formed through single-star evolution within the Hubble time. In this talk, I will present a comprehensive analysis of the double low-mass WD eclipsing binary system J2102-4145. The investigation involved an extensive observational campaign, resulting in the acquisition of approximately 28 hours of high-speed photometric data across multiple nights using NTT/ULTRACAM, SOAR/Goodman, and SMARTS-1m telescopes. These observations have provided critical insights into the orbital characteristics of this system, including parameters such as inclination and orbital period. To disentangle the binary components of J2102-4145, the study employed the XTgrid spectral fitting method with GMOS/Gemini-South and X-Shooter data. Additionally, the PHOEBE package was used for light curve analysis on NTT/ULTRACAM high-speed time-series photometry data to constrain the properties of the binary. The analysis reveals remarkable similarities between the two components of this binary system. For the primary star, we determined Teff,1 = 13688 (65) K, log(g1) = 7.36 (0.01), R1 = 0.0211 (0.0002) Rsun, and M1 = 0.375 (0.003) Msun, while the secondary star is characterized by Teff,2 = 12952 (53) K, log(g2) = 7.32 (0.01), R2 = 0.0203 (0.0002) Rsun, and M2 = 0.310 (0.003) Msun. Furthermore, there is a notable discrepancy between Teff and R of the less massive WD compared to evolutionary sequences for WDs from the literature, which has significant implications for our understanding of WD evolution. I will discuss a potential formation scenario for this system that might explain this discrepancy. As for its future evolution, this system will merge in about 800 Myr, most likely forming a single hot subdwarf star which will further evolve into a hybrid He/CO WD.

S4.2: **A Catalogue of AM CVn Binary Systems**

Matthew Green (Max Planck Institute for Astronomy, Heidelberg), Jan van Roestel

Due to large-scale surveys, the discovery rate of accreting, ultracompact binary systems (also known as AM CVn-type binaries) has increased rapidly over the last several years. At the time of writing, the known population includes over 100 confirmed or candidate binaries. As the known population grows, it becomes more challenging for individual researchers to keep track of the entire population. To aid in this, we have compiled a catalogue of all such systems that are currently known, adopting an expansive definition: all accreting binary systems with orbital periods less than 70 min and in which the accretor is a white dwarf. I will present an overview of the catalogue and the known ultracompact accreting binaries, and I will comment on the current outstanding questions in the field and how the rapid growth in the population will aid in answering those questions.

White dwarf Dust Disks and Planetary Systems

S4.2: Planetary material is a major source of H in He-dominated white dwarfs

Andrew Swan (University of Warwick), Paula Izquierdo, Christopher Manser, Boris Gänsicke, Joan Najita

The He-dominated atmospheres of some white dwarfs often contain detectable amounts of H, whose abundance may vary as they cool. Accounting for that time-dependence has proved challenging, as diffusion and convection can deliver H to the atmosphere, or dilute it into the envelope. Detections of metals and H are correlated in such stars, with the metals unambiguously linked to accretion from planetary systems that survived stellar evolution. The accreted objects may carry hydrated minerals or volatiles, allowing H to accumulate over time. Analysis of two independent samples of He-dominated white dwarfs observed by the DESI and SDSS spectroscopic surveys shows that at least 40 % of those with detectable H have acquired some of it from their planetary systems. Therefore, internal mixing processes are necessary, but not sufficient, to model the population of He-dominated white dwarfs with trace H, and external accretion must also be considered.

S4.2: Linking exoplanet and stellar compositions using polluted white dwarfs

Claudia Aguilera-Gómez (Pontificia Universidad Católica de Chile), Laura Rogers, Amy Bonsor, Paula Jofré, et al.

Planets are formed from the same material as their host stars and as such, the star indicates the composition of the material available to form planets. However, the process of planet formation could alter the composition of exoplanets, and some key questions remain to understand the interior composition of rocky exoplanets: Do planetary bodies retain their refractory elements? Are volatile elements lost due to the high temperatures in the disc? I will discuss how we can use polluted white dwarfs in wide binary systems to constrain the composition of rocky exoplanets and find how closely the planet's composition resembles that of their host star. We compare the abundances of a polluted white dwarf, indicative of the composition of the planetary material, with the abundances of its main-sequence wide binary companion, which will work as a proxy for the composition of the host star. By doing this, we can find signatures of the planet formation process, such as loss of moderate volatiles. We highlight the importance of using such systems to constrain the composition of rocky exoplanetary material.

S4.2: Cool DAZs with High Metal-Enrichment

Anna-Maria Cutolo (University of Warwick)

As main sequence stars evolve into white dwarfs, we expect the outer planets and other bodies in the system to survive evaporation by or engulfment into the giant branch star. White dwarf atmospheres are primarily H/He, and so the detection of metals in their spectra is a sign of enrichment from the accretion of planetary material. By analysing the photospheric abundances and comparing them to Solar System benchmarks – for example, bulk Earth, mantle or crust compositions, or individual asteroid families – we are able to determine the composition of extrasolar planetary bodies, which in turn provides crucially important information on the formation and evolution of planets. We present the analysis of four cool and highly metal-enriched DAZ white dwarfs, all with strong lines of Mg, Al, Ca, and Fe. We fit Koester atmosphere models to the X-Shooter spectra and photometric data of the stars using MCMC methods to determine Teff, log g and detailed metal abundances, finding up to 11 individual elements present. We also identify one of our sample to be weakly magnetic (B $\simeq$ 60 kG). We find the abundances in these DAZs to be consistent with meteorite compositions from the Nittler database and conclude them to be some of the most metal-enriched cool DAZs studied, currently accreting planetary debris at a high rate. As such, this is the first equivalent to the large sample of strongly polluted cool helium atmosphere white dwarfs which have very long ($\simeq$ 106 yr) diffusion timescales compared to hydrogen atmospheres, and so have most likely finished the accretion episode.

S4.3: Interpreting the nature of material accreted by four DAZ white dwarfs using the Planetary Enriched White Dwarf Database

Jamie Williams (University of Warwick), Boris Gaensicke, Snehalata Sahu, David Wilson, Detlev Koester

Ultraviolet observations of hot DAZ white dwarfs enable an opportunity to directly link atmospheric enrichment to the composition of accreted planetesimals without the degeneracies present when considering white dwarfs with longer sinking timescales. I will present the analysis of four DAZ white dwarfs with both ultraviolet HST/COS and optical VLT/UVES spectra. WD0059+257 is among the most core-rich planetesimals ever detected, HS2229+2335 has a mysterious Ca enhancement, the abundances of C and S within WD1943+163 imply the accretion of a Mars-like object and the volatile-rich material around WD1953-715 is likely from an icy world. These objects offer exciting new insights into the behaviour of volatile species, particularly within exoplanetary cores. In order to put these objects into a greater context, I will introduce the publicly accessible Planetary Enriched White Dwarf Database (PEWDD), a collection of over 1700 unique white dwarfs with computed photospheric number abundances taken from the literature. Using this, I will highlight the importance of studying hot DAZ white dwarfs, which allow the detection of key metals that constitute a large proportion of rocky material (O, Si, Mg, Fe) as well as important trace metals (C, S, Ni), the combination of which are difficult to detect in other temperature ranges. Comparing these DAZ white dwarfs to other planetary enriched white dwarfs will highlight the usefulness and necessity of PEWDD.

S4.3: **A White Dwarf in Sheep's Clothing**

Benjamin C. Kaiser (University of North Carolina at Chapel Hill), J. Christopher Clemens, Simon Blouin

White dwarf surveys have always dealt with contamination by misidentified main-sequence stars. However, in our haste to dismiss contaminants that we think are main-sequence stars, perhaps we have been discarding some of the most interesting white dwarfs. We present the discovery of a low-temperature, H-dominated white dwarf that is so heavily metal polluted that its spectrum bears a striking resemblance to a late K-type main-sequence star, but it is conclusively a white dwarf with no light contributions from a companion. We suspect this white dwarf and others like it would be discarded in many surveys as a contaminant because it is only with careful examination that the differences between this spectrum and a K dwarf can be distinguished. We therefore performed a search of SDSS-classified ”K” stars cross-matched with Gaia DR3 to find any additional misidentified metal-polluted white dwarfs. We present the results of this search in addition to our original identification.

S4.3: **At the proximities of G29-38**

Odette Toloza (Universidad Técnica Federico Santa María), Tim Cunningham, Pete Wheatley, Boris Gaensicke, Valentina Ortuzar and Martin Gaytan

The metal-polluted white dwarf G29-38 has been a focal point of extensive research due to its pulsations, molecular hydrogen presence in its atmosphere, infrared excess from a dust disc, and X-ray emission from accreting circumstellar material. Our HST/COS observations show significant detection of Si IV emission. In the context of planetary material, this emission cannot originate from a gas disc around the white dwarf, which would require an unlikely high inclination. Alternatively, we propose that the formation of this line may occur very close to the white dwarf's surface, akin to a corona. Using the differential emission measure (DEM) technique, we aim to reconstruct the corona spectrum. In this talk, we will show the results and conclusions of our analysis.

S4.3: **Asteroseismological Chronicle of the White Dwarf G29-38**

Steven Z. Savery (University of Delaware), Judith L. Provencal

This research project is focused on G29-38, an extremely interesting white dwarf as it was one of the first known to have a debris disk due to the disk's high infrared emission. The debris disk is important to study, as it contains information on what material has survived the star's transformation into a white dwarf. The disk around G29-38 is also interacting with the star's pulsations, meaning they can be used to probe the disk's structure. My research has involved examining optical observation periodograms for G29-38 from as far back as 1975. These observations include ground-based observations up to last fall, as well as three sectors of TESS observations. In general, white dwarfs are expected to have pretty stable groups of pulsation frequencies that reflect the internal structure of the star. However G29-38's frequencies have changed much over time, with my analysis of their complete distribution showing that G29-38 does not follow this simple model. I was able to identify 535 independent frequencies throughout the years of observations for G29-38, out of the 856 total frequencies observed. The vast majority of these frequencies represent the L = 1 spherical harmonic of pulsation in the star. I have made use of both the K-S test and the Fourier Transform in order to look for the mean-period-spacing seen throughout G29-38's data. The mean-period-spacing is one of the fundamental parameters that can be derived from the frequency distribution and allows us to determine the star's mass. This allows for finding the mean-period associated with the L = 1 modes, as well as determination of the higher order harmonics like L = 2. This project is the first time a chronology containing all of the observations of G29-38 has been compiled. Before only the shorter week-/month-long sets of observations have been examined. By creating this large chronology of the observed frequencies in G29-38, I will be able to hunt for longer term changes in the star's behavior. This has included looking for variations in the star's multiplet spacing that would be consistent with the presence of a magnetic field. The next step in this research will be leading a multiwavelength concurrent observation run of G29-38, focusing on the infrared and optical regions of the EM spectrum. I will be proposing for observation time on both JWST and TESS during the fall of 2025, as well as with several ground based telescopes such as SOAR and SARA for this observation campaign. In the fall of 2025, I will be helping to lead a Whole Earth Telescope (WET) campaign to observe G29-38 in optical wavelengths. My research will also be expanding into analysis of other DAV white dwarfs with debris disks such as V* KX Dra.

S5.1: The MIRI Exoplanets Orbiting White Dwarfs (MEOW) Survey: Early Results and Planet Candidates

Andrew Vanderburg (MIT), Mary Anne Limbach

Most stars in the Milky Way will end their lives as white dwarfs, but little is known about the ultimate fates of their planetary systems. Using mid-infrared JWST observations, we are searching for giant planets orbiting white dwarfs with separations from $\sim$0.01 to $\sim$1000 AU and masses as low as Saturn's. We probe close-in planets (like the known transiting planet WD 1856+534 b that must have migrated inwards) by looking for thermal infrared excess and we search for widely-separated planets with direct imaging (to identify planets in locations where they could have survived the star's expansion during the red giant phase in place). Ultimately, these observations will enable a population comparison between main-sequence and white dwarf systems, revealing how post-main-sequence evolution changes and sculpts planetary systems. We will present the first planet candidates from the survey and discuss prospects for confirming these detections.

S5.1: Using Mid-Infrared Variability towards White Dwarfs as a Signpost of Remnant Planetary Systems

Joseph Guidry (Boston University), JJ Hermes (Boston University), Kishalay De (MIT), Lou Baya Ould Rouis (Boston University), Brison Ewing (Boston University), B. C. Kaiser (UNC Chapel Hill)

White dwarf spectra commonly show evidence for the recent accretion of planetary material indicated by metal pollution. Collisions are expected to be an important step along the road map to metal pollution, grinding down planetesimals into the dusty and gaseous debris disks we observe around these stars. We present new photometry that further illuminate ongoing collisions in white dwarf debris disks. Building on previous works linking the mid-infrared variability of white dwarf debris disks to collisions, we search for variability among over 3000 Gaia white dwarfs using light curves extracted from the unWISE images at 3.6 microns. We rank these objects by variability, again finding the most variable sources are those with dusty debris disks, especially the disks with gaseous components in emission. We also generate a new catalog of infrared variables. We showcase our near-infrared spectroscopic follow-up of some new candidate variables in search of metallic gas in emission, confirming at least one remnant planetary system, and posit that empirical mid-infrared variability can be a discovery engine for gaseous debris disks.

S5.1: The frequency of transiting planetary systems around polluted white dwarfs

Akshay Robert (University College London)

The recent discoveries of transits around white dwarfs have provided a unique and exciting view into their circumstellar debris discs. This family of white dwarfs with transiting debris exhibits significant diversity, where some display line-of-sight gas absorption, are highly dynamic with large scale heights, and the most recent system was detected to have circumstellar material in the habitable zone, where a planetary surface can support liquid water. At present, however, there are no constraints on the transit frequency towards polluted white dwarfs. I present a search for new transiting systems using high-cadence ground- and space-based photometry. The occurrence of these systems is constrained using simulations encompassing radii from dwarf to Kronian planets, with periods from 1h to 27d. These results show that the dearth of short-period, solid-body planets transiting polluted white dwarfs is consistent with engulfment during the giant phases of stellar evolution, and modestly constrain both dynamical re-injection of planets to the shortest orbital periods and cometary birth and survival around intermediate-mass stars.

S5.1: **Missing Planets Around Massive White Dwarfs?**

Lou Baya Ould Rouis (Boston University), JJ Hermes, Boris Gaensicke

As the descendants of stars less than 7 solar masses on the main sequence, white dwarfs provide a unique way to constrain planetary occurrence around stars that are otherwise difficult to measure with radial-velocity or transit surveys. Ultraviolet spectra of hot white dwarfs collected by the Hubble Space Telescope in the past decade offer one the most sensitive probes for the presence of remnant planetary systems. Out of over 140 white dwarfs under 0.8 solar masses observed by HST/COS, 41 % +/- 5 % are metal polluted and likely to be actively accreting. However, for massive white dwarfs (above 0.8 solar masses, descendants of stars greater than 3.5 solar masses on the main sequence), the fraction exhibiting metal pollution significantly decrease to just 7 % (+5 -3) %. We find that while remnant planetary systems around white dwarfs are common, there are missing around massive white dwarfs, which we find not to be significantly affected by stellar mergers.

S5.1: **The Dynamical Evolution of Planets Orbiting Interacting Binaries**

Santiago Torres (Institute of Science and Technology Austria (ISTA))

About 15 % of solar-type stars are in such close binaries that interaction is bound to occur as the stars evolve and swell. Around 5600 planets have been detected in solar types of stars. However, only about twenty circumbinary planets have been identified. Understanding the intricate dynamics within such complex systems is crucial for unraveling the processes of planet formation and binary evolution and constraining the detection of planets in binary systems. The tightest orbit binaries would harbor the most dynamically stable and enduring circumbinary planetary systems; however, they are also prone to experience mass transfer, common envelope evolution, or stellar mergers. Subdwarfs are one of the most common products resulting from binary evolution. They are both long-lived and easy to recognize. Understanding the impact of subdwarf formation on the surrounding planetary system constitutes one of the most promising avenues for revealing how binary evolution, in general, affects planetary systems. We have developed an integration framework to unravel the complex dynamics of planets around evolved and interacting binaries. This framework seamlessly combines binary evolution data from the MESA stellar evolution code with a detailed N-body simulation within the REBOUND environment. To ensure numerical robustness, we have devised a binary star model including a circumbinary planet and implemented a recalibration method to address errors stemming from updates in binary properties during dynamical computations. Our findings indicate that the closest stable orbital separation for circumbinary planets is approximately 2.5 times the binary separation following mass transfer. In this presentation, I will introduce our new model and our latest results of the evolution of planets orbiting binaries that evolve into white dwarfs or subdwarf systems.

S5.1: **White dwarf pollution: one star or two?**

Hiba Tu Noor (UCL), Jay Farihi, Mark Hollands, Silvia Toonen

Numerous studies have suggested that a widely orbiting companion star can dynamically excite planetary bodies into close approach with the white dwarf and be largely responsible for the metal-polluted atmospheres that are observed. In this talk, I present findings from a study aimed at investigating the extent to which white dwarf pollution is assisted by a companion star. Utilising Gaia DR3 astrometry, we searched for spatially-resolved co-moving companions around three target and three control samples of white dwarfs. While the wide binary fraction of the DAZ stars is found to be roughly 10 per cent and consistent with that of the corresponding field, the DZ stars exhibit a significantly lower fraction than their field counterparts. Neither of these results are consistent with models where wide stellar companions are the primary cause of white dwarf pollution, and hence the delivery of metals to white dwarf surfaces must be caused by major planets. The discrepancy between the DAZ and DZ star wide binary fractions is difficult to understand and cannot be caused by white dwarf spectral evolution, suggesting these two populations may have distinct planetary architectures.

S5.2: **Polluting White Dwarfs with Oort Cloud Comet**

Dang Pham (University of Toronto), Hanno Rein

Observations point to old white dwarfs (WDs) accreting metals at a relatively constant rate over 8 Gyrs. Exo-Oort clouds around WDs have been proposed as potential reservoirs of materials, with galactic tide as a mechanism to deliver distant comets to the WD's Roche limit. In this work, we characterise the dynamics of comets around a WD with a companion having semi-major axes on the orders of 10–100 AU. We develop simulation techniques capable of integrating a large number (10^8) of objects over a 1 Gyr timescale. Our simulations include galactic tide and are capable of resolving close-interactions with a massive companion. Through simulations, we study the accretion rate of exo-Oort cloud comets into a WD's Roche limit. We also characterise the dynamics of precession and scattering induced on a comet by a massive companion. We find that (i) WD pollution by an exo-Oort cloud can be sustained over a Gyr timescale, (ii) an exo-Oort cloud with structure like our own Solar System's is capable of delivering materials into an isolated WD with pollution rate $\sim 10^8$ g/s, (iii) adding a planetary-mass companion reduces the pollution rate to $\sim 10^7$ g/s, and (iv) if the companion is stellar-mass, with $M_p \gtrsim 0.1\,\mathrm{M}_\odot$, the pollution rate reduces to $\sim 3 \times 10^5$ g/s due to a combination of precession induced on a comet by the companion, a strong scattering barrier, and low-likelihood of direct collisions of comets with the companion.

S5.2: **White dwarfs with infrared excess within 100 pc: Gaia and the Virtual Observatory**

Raquel Murillo-Ojeda (Centro de Astrobiología (CAB), CSIC-INTA), Francisco Jiménez-Esteban, Alberto Rebassa-Mansergas, Santiago Torres, Enrique Solano

White dwarfs (WDs) are one of the most common objects in the Galaxy. They are stellar remnants of low and intermediate mass stars, such as the Sun. WDs are compact objects, with typical masses around half a solar mass and planetary sizes. They are the key to understanding the composition and evolution of exoplanetary material around intermediate mass stars in their late stages of evolution. In this talk we will describe the work aimed at identifying a volume-limited sample of nearby ($<$ 100 pc) WDs with infrared excess. Starting from the so far most complete volume-limited WD (Jiménez-Esteban et al. 2023, 10.1093/mnras/stac3382). We used Gaia DR3 spectroscopic coefficients and GaiaXPy to obtain JPAS synthetic photometry. Using VOSA, a Virtual Observatory tool, we complemented JPAS photometry with infrared photometry gathered from astronomical archives. Then, we compared the SEDs to different atmosphere models to identify flux excess at infrared wavelengths. Once we have got rid of the potential sources of contamination, the origin of the excess can be attributed to two causes: The presence of a low mass, cool companion or the existence of a circumstellar dust disk. Spectroscopic observations are required to discern between the two possible scenarios. To that end we started a follow-up program of the most promising candidates using the X-Shooter instrument at the Very Large Telescope. In this talk, we will show the first results obtained in this analysis.

S5.2: **A possible indication of iron in white dwarf dusty disks**

Ayaka Okuya (National Astronomical Observatory of Japan), Satoshi Okuzumi, Aki Takigawa, Hanako Enomoto

A quarter to half of white dwarfs (WDs) have metals in their atmospheres (e.g., Zuckerman et al. 2010). They are thought to originate from minor planets that orbit WDs, enabling us to probe the solid composition of planetary bodies beyond the solar system. Dust disks observed around metal-polluted WDs could provide additional compositional insights through thermal emission spectra (Reach et al. 2009). For several disk emission spectra, it is pointed out that pure silicate dust could reproduce the 10

μm silicate feature but falls short in explaining near-infrared emission at $\sim$5 μm. On the other hand, materials (e.g., amorphous carbon, metallic iron, and FeO) with conductivity orders of magnitude higher than insulators (e.g., silicate) can have larger opacity at these wavelengths. In this study, we aim to identify the origin of the 5 μm emission by considering silicate dust that includes materials with significantly higher conductivity. We compare observed infrared disk spectra around G29-38 with those calculated from a disk thermal emission model (Chiang & Goldreich 1997). We find that dust containing metallic iron or FeO with abundances consistent with Fe:Mg:Si:O:C ratios in the WD atmosphere can successfully reproduce the disk emission at $\sim$5 μm. This scenario also predicts that the Fe/Si ratio in the WD atmosphere should be positively correlated with the metallic iron/FeO ratio in the disk dust. We analyze observed disk spectra around other DA-type WDs and tentatively confirm this prediction.

S5.2: **A general framework for the chemical characterization of circumstellar gaseous discs around white dwarfs with Cloudy**

Felipe Lagos-Vilches (University of Warwick), Boris T. Gänsicke,1 C. J. Manser, C. Morisset, N. P. Gentile Fusillo, Odette Toloza, S. H. Ramirez, M. R. Schreiber

Double-peak emission lines from gaseous debris discs around white dwarfs offer a unique opportunity to model the chemical abundances of the disrupted planet(esimal)s from which they are formed. We here present a python-based framework to characterize the radial extent of those gaseous discs along with their element abundances by modeling the observed emission-line intensity ratios with the photo-ionization code Cloudy. To explore the wide parameter space of chemical compositions and/or radial extent of the disc, we implemented a multiprocessing wrapper around cloudy to conduct a large number of simultaneous simulations, which are ranked in a semi-automatic fashion according to their capability to reproduce the observed intensity ratios. To test our algorithm we use as a benchmark the gaseous disc around the white dwarf WD J0914+1914 which shows emission lines of sulphur, oxygen and hydrogen. We found that intensity ratios are well reproduced by abundance ratios (by number) of log10 (S/H) = log10 (O/H) $\simeq -0.5$, total hydrogen number density n(H) $\simeq 10^{1}0\,\mathrm{cm}^{-3}$ and total gas density $\simeq 10^{-12}$ g/cm^3, with the best model predicting the presence of additional emission lines which were later confirmed through a thorough inspection of the data. Future characterizations will also include the use of Doppler maps to better constraint line ratios in white dwarfs with eccentric gaseous discs, such as SDSS 1228+1040.

S5.2: **Are polluted white dwarfs with gas discs different from the general population?**

Laura Rogers (University of Cambridge)

At least 30 % of white dwarfs are observed with signatures of swallowed exoplanets in their atmospheres and from these polluted white dwarfs we infer the bulk composition of the parent body that was accreted. A small subsample of polluted white dwarfs are those that host circumstellar dust and more rarely gas, with only 21 systems known to date. Understanding this small subsample of polluted white dwarfs will help us to understand how planetary material ultimately ends up in the atmospheres of these white dwarfs and why only some host gas and dust discs. We present VLT/X-shooter, KECK/HIRES and HST/COS observations of 7 polluted white dwarf systems with circumstellar gas to discover the composition of the planetary material that has 'polluted' the white dwarf. We will address: what can the composition tell us about exo-planetary material and geological processes in exo-planetary systems? Are there any differences with those polluted white dwarf systems that display circumstellar gas compared to those that don't show detectable levels? What can this tell us about how planetary material ultimately ends up polluting white dwarfs?

White dwarfs in Open and Stellar Clusters

S3.1: **Slowly cooling white dwarfs in globular clusters**

Mario Cadelano (University of Bologna), Jianxing Chen, Francesco R. Ferraro, Barbara Lanzoni

White dwarfs are the final evolutionary product of the ∼98 % stars in the Universe. They are electron-degenerate structures characterised by no stable thermonuclear activity, and thus their evolution is generally described as a pure cooling process. Their cooling rate is exploited as a cosmic chronometer to measure the age of several Galactic populations, including the disk, globular and open clusters. This is why a significant observational effort has been made to study the cooling sequences of white dwarfs in Galactic stellar systems, including open and globular clusters. In this respect, globular clusters are of particular interest as they are the densest and most massive aggregates of stars in the Galaxy. Galactic globular clusters were formed ∼13 Gyr ago in a single short-lasting star formation event, possibly from a chemical homogeneous molecular cloud. This means that they host a population of coeval stars sharing approximately the same chemical composition. For this reason, they also provide an ideal laboratory for studying white dwarf populations. In fact, despite their relatively large distances (typically ∼10 kpc), each globular cluster provides a large and homogeneous sample of white dwarfs from coeval progenitors, all located at the same distance from the observer. Here I will present the latest findings of an ongoing investigation into the white dwarf populations of a sample of globular clusters. By using deep and high-resolution near-UV observations obtained with the Hubble Space Telescope, we are demonstrating that coeval clusters sharing similar structural and chemical properties can host strikingly different white dwarf populations. In particular, we found that some clusters (such as M 13 and NGC 6752) host a clear and unexpected overabundance of bright white dwarfs with respect to others (such as M 5 and M 3). By comparing these results with theoretical models, we argue that this overabundance is due to the presence of ∼70 % of "slowly cooling white dwarfs", whose cooling is slowed down by stable thermonuclear activity in a residual hydrogen-rich envelope. This interpretation is supported by the peculiar morphology of the horizontal branches of the clusters hosting such an unexpected population. In fact, their horizontal branches extend to very blue colours (i.e., hot temperatures, low masses), where stars partially or totally skip the asymptotic giant branch phase (and thus the "third dredge-up"), thus allowing the proto-white dwarf to enter the cooling sequence with a residual hydrogen envelope thick enough to sustain stable thermonuclear burning. I will discuss this discovery in terms of its impact on our understanding of white dwarf formation and evolution, as well as its potential impact on the use of white dwarfs' cooling rate as a cosmic chronometer.

S3.1: **From Clustered Environments to Common Envelopes: The first systematic identification of white dwarf-main sequence post-common envelope binaries in star clusters**

Steffani Grondin (University of Toronto), Maria Drout, Philip Muirhead, Jason Nordhaus, Joshua Speagle

Close binary systems are the progenitors to a variety of compact object mergers producing Type Ia supernovae and gravitational waves. While most short-period binaries are believed to have evolved through at least one common envelope (CE) phase, our understanding of CE evolution is limited due to the lack of observational benchmarks that connect the post-CE parameters with the pre-CE initial conditions. Identifying post-CE systems in star clusters can circumvent this issue by providing an independent constraint on the system's age, but only two white dwarf-main sequence (WD+MS) post-CE systems in a stellar cluster have ever been discovered. In this talk, I will describe our ongoing efforts to systematically identify the first population of WD+MS post-CE binary systems in Milky Way star clusters. First, I will describe our new catalogue of ∼50 WD+MS binary candidates in ∼30 open star clusters identified through multi-wavelength observations and supervised machine learning. Next, I'll detail the follow-up spectroscopy and monitoring of a subset of our systems that led to the characterization of new WD+MS post-CE systems in clusters. Our new sample will at least double the known population of WD+MS post-CE systems in clusters, ultimately allowing for new observational constraints on one of the most uncertain yet important phases of binary evolution.

S3.1: Developing the open-cluster-based white dwarf initial-final mass relation with Gaia DR3

David R. Miller (University of British Columbia), Ilaria Caiazzo, Jeremy Heyl, Harvey B. Richer

We have been further developing the open-cluster-based WD initial-final mass relation (IFMR) using only WDs associated with their birth cluster using Gaia astrometry. Despite the breadth and quality of Gaia data, the WD IFMR remains poorly populated, especially in the very high-mass region above $\sim$1.1 solar masses. Taking advantage of available Gaia DR3 Milky Way open-cluster catalogues, we have identified more than forty additional candidate open-cluster member white dwarfs. Some of these had previously available spectra in the literature, while many others were followed up with optical spectroscopy to assess potential cluster membership further. We present the results of this analysis and an update to our Gaia-based WD IFMR. While the very high-mass region of the WD IFMR remains poorly populated, the overall number of WDs included in the IFMR has increased by more than 50 %, with a notable uptick in the number of sources near the potential kink in the IFMR at $\sim$0.9 solar masses.

White dwarf Atmospheres, Chemical Composition, and Magnetic Fields

S2.2: Spectral analysis of hot DA- and DAO-type white dwarfs

Semih Filiz (University of Tübingen), Klaus Werner, Thomas Rauch, Nicole Reindl

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 32 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 of when and how the hybrid WDs transform into helium-free objects because of the gravitational settling of elements. The results will help to clarify the relative importance of the different physical processes acting on helium and metal abundances.

S2.2: Extremely Hot and Rapidly Rotating: Insights from Spectral Analysis of the PG1159 Star RXJ0122.9-7521

Nina Mackensen (Landessternwarte Königstuhl (LSW) / Zentrum für Astronomie Heidelberg (ZAH)), Nicole Reindl, Klaus Werner, Matti Dorsch

PG1159 stars are thought to be progenitors of the majority of H-deficient white dwarfs. Their unusual He-, C-, and O-dominated surface composition is typically believed to result from a late thermal pulse experienced by a single (pre-)white dwarf. Yet other formation channels - involving close binary evolution - have been proposed recently that could lead to similar surface compositions. From our sample of 110 hot white dwarfs covered by FUV COS spectra, the extremely hot ($\sim$200kK) PG1159 star RXJ0122.9-7521 stands out , as it shows strongly rotationally broadened lines. A rapid rotation is also in line with the previously reported photometric period of 41min, and which we suggest corresponds to the rotational period of this star. We present preliminary results of our non-LTE spectral analysis based on optical and UV data and our kinematic analysis. Finally, we will discuss possible implications of our findings on the evolutionary status of this object.

S2.2: Massive White Dwarfs in the 100 pc Sample: Magnetism, Rotation, Pulsations, and the Merger Fraction

Gracyn Jewett (University of Oklahoma), Mukremin Kilic, Pierre Bergeron, Adam Moss, Simon Blouin, Warren R. Brown, Alekzander Kosakowski, Silvia Toonen, Marcel A. Agüeros

We present a detailed model atmosphere analysis of massive white dwarfs with M ¿ 0.9 Msol and Teff ¿ 11,000 K in the Montreal White Dwarf Database 100 pc sample and the Pan-STARRS footprint. We obtained follow-up optical spectroscopy of 109 objects with no previous spectral classification in the literature. Our spectroscopic follow-up is now complete for all 204 objects in the sample. We find 121 normal DA white dwarfs, including 45 massive DAs near the ZZ Ceti instability strip. There are no normal massive DBs: the five DBs in the sample are strongly magnetic and/or rapidly rotating. There are 17 massive DQ white dwarfs in our sample, and all are found in the crystallization sequence. In addition, 66 targets are magnetic (32 % of the sample). We use magnetic white dwarf atmosphere models to constrain the field strength and geometry using offset dipole models. We also use magnetism, kinematics, and rotation measurements to constrain the fraction of merger system candidates among this population. The merger fraction of this sample increases from 25 % for 0.9-1 Msol white dwarfs to 50 % for 1.2-1.3 Msol. However, this fraction is as high as 78(+4/-7) % for 1.1–1.2 Msol white dwarfs in this population. Previous works have demonstrated that 5-9 % of high-mass white dwarfs stop cooling for at least 8 Gyr due to the Ne-22 distillation process, which leads to an overdensity of Q-branch stars in the solar neighborhood. We demonstrate that the over-abundance of the merger remnant candidates in our sample is likely due to the same process.

S2.3: Magnetic field breakout from crystallizing white dwarfs

Daniel Blatman (The Hebrew University), Sivan Ginzburg

Magnetic field breakout from crystallizing white dwarfs The origin of white dwarf magnetism is still an open question. Convective dynamos operating during white dwarf crystallization are one of the promising channels to explain their observed strong magnetic fields. Although the magnitude of the fields generated by crystallization dynamos is uncertain, their timing may serve as an orthogonal test of this channel's contribution. When white dwarfs begin to crystallize, they can generate magnetic fields, but these fields are initially trapped in interior convection zones – deep inside the white dwarfs. Only once a substantial mass has crystallized, the convection zone approaches the white dwarf's helium layer, such that the magnetic diffusion time through the envelope shortens sufficiently for the field to break out to the surface, where it can be observed. The magnetic breakout process in a carbon-oxygen white dwarf implies that magnetism may probe the carbon-oxygen phase diagram, as well as uncertainties during the core helium burning phase in the white dwarf's progenitor, such as the 12C(α, γ)16O nuclear reaction. Similar thoughts and calculations can also be done for ultra-massive oxygen-neon white dwarfs and preliminary results for this type of white dwarfs will be shown.

S2.3: **Atmospheric heating in isolated magnetic white dwarfs, driven by 22Ne distillation resulting from mergers**

Jay Farihi (University College London), A. F. Lanza, N. Z. Rui, S. Bagnulo, J. D. Landstreet

The origin of atmospheric heating in the cool, magnetic white dwarf GD 356 remains unsolved nearly 40 years after its discovery. This once idiosyncratic star with T=7500K, yet Balmer lines in Zeeman-split emission is now part of a growing class of white dwarfs exhibiting similar features, and which are tightly clustered in the HR diagram suggesting an intrinsic power source. This paper proposes that convective motions associated with an internal dynamo can power electric currents along magnetic field lines that heat the atmosphere via Ohmic dissipation. Such currents would require a dynamo driven by core 22Ne distillation, and would further corroborate magnetic field generation in white dwarfs by this process. The model predicts that the heating will be highest near the magnetic poles, and virtually absent toward the equator, in agreement with observations. This picture is also consistent with the absence of X-ray or extreme ultraviolet emission, because the resistivity would decrease by several orders of magnitude at the typical coronal temperatures. The proposed model suggests that i) DAHe stars are mergers with enhanced 22Ne that enables distillation and may result in significant cooling delays; and ii) any mergers that distill neon will generate magnetism and chromospheres. The latter prediction is consistent with the two known massive DQe white dwarfs.

S2.3: **JWST spectra of three infrared-faint white dwarfs**

Simon Blouin (University of Victoria), Mukremin Kilic, Loic Albert, Patrick Dufour

We present JWST spectroscopy (0.6-10 μm) of three infrared-faint white dwarfs. These WDs have cool, dense atmospheres where collision-induced absorption (CIA) by H2 molecules strongly suppresses infrared radiation. Thanks to JWST, we can resolve the precise shape of the CIA absorption features for the first time. Our preliminary results support the proposal by Bergeron et al. (2022) that IR-faint white dwarfs are not "ultracool" as suggested for 20 years, but rather have effective temperatures above 4000K. Additionally, we detect unexpected emission features, which we attribute to the interaction between CIA and a temperature inversion in the upper atmosphere.

S2.3: **The effect of convective overshoot and thermohaline mixing on geological inferences from metal enriched white dwarfs**

Andy Buchan (University of Warwick), Pier-Emmanuel Tremblay, Antoine Bédard, Tim Cunningham, Evan Bauer

White dwarfs which are enriched with metals provide unique and valuable insights into the composition of exoplanetary material. However, any attempt to model relative metal abundances must contend with differential sinking: different metals sink through the white dwarf's atmosphere on different timescales. The relative sinking timescales are determined from white dwarf atmospheric modelling, in which the extent of convection is of particular importance. However, convective overshoot can be parameterised according to a number of different methods, which potentially result in different relative sinking timescales and ultimately a different interpretation of the accreted material's geology. Thermohaline mixing, which is sometimes included in atmospheric modelling, has a similar effect. Convective overshoot and thermohaline mixing therefore represent crucial variables which are not yet well understood in terms of their impact on geology. In this work, we compile grids of timescales calculated using different treatments of convective overshoot and incorporate them into a model of metal enrichment in order to determine their effect across a range of effective temperatures and surface gravities, with and without thermohaline mixing. We present preliminary results showing how the geological interpretation of exoplanetary material is affected in a variety of test cases.

White dwarf Progenitors; Central Stars of Planetary Nebulae, Hot-subdwarfs

S4.4: Runner or Merger? An enigmatic group of luminous hot subdwarfs on halo like orbits

Max Pritzkuleit (University of Potsdam), Matti Dorsch, Stephan Geier, Patrick Neunteufel

Close binary systems of massive white dwarfs with hot subdwarf companions are possible progenitors of supernovae type Ia. As a result, the hot subdwarf is ejected at nearly the orbital speed which is predicted to range between 500 and up to more than 1000 km/s. So far, US 708 is the only known hot subdwarf linked to this scenario but it is expected to be an extreme outlier due to its low mass. More massive and thus slower ejected hot subdwarfs are predicted which have not been found so far. Here, we report about an enigmatic group of luminous and helium rich hot subdwarfs whose kinematic properties fit to the supernova Ia scenario. However, some white dwarf merger channels might also be responsible for their formation and will be addressed in this talk.

S4.4: Exploring the population of close hot subdwarf binaries in a 500 pc volume-limited sample

Harry Dawson (University of Potsdam), Stephan Geier, Ulrich Heber, Ingrid Pelisoli, Matti Dorsch, Max Pritzkuleit, Aakash Bhat, James Munday et al.

Hot subluminous pre-white dwarf objects occupy the sparsely populated region between massive main sequence stars and the young end of the white dwarf cooling track in the Hertzsprung-Russell diagram. In this talk, I will first present the first spectroscopically classified, 500 pc volume-limited sample using Gaia DR3 parallaxes that encapsulates this parameter space. This sample provides the most reliable space densities of this population, and its sub-populations, to date. The dominant population consists of helium-burning hot subdwarfs with 305 members (77 %), with the remainder being hot white dwarfs, helium-core white dwarf progenitors, blue horizontal branch stars, and cataclysmic variables. Secondly, I will detail our ongoing radial velocity variability monitoring campaign that seeks to unveil and study the population of hidden companions to hot subdwarfs, many of which are white dwarfs.

S4.4: (Un)seen astrometric companions to hot subdwarfs

Matti Dorsch (University of Potsdam), Stephan Geier, Harry Dawson, Ingrid Pelisoli, James Munday

Most hot subdwarf stars are core helium-burning cores that lack the large hydrogen envelopes of other horizontal branch stars; they seem to be formed almost exclusively by binary interaction. Recently several sdBs were discovered in wide binaries by Gaia DR3 astrometry, including the first sdB with a massive compact companion at long orbital periods ($P = 892.5 \pm 60.2$ d, Geier+ 2023). This unseen companion must be a very massive WD or a low-mass neutron star ($M = 1.5 \pm 0.4$ Msun). In case the companion is a WD, this binary might be the prototype of a new class of supernovae type Ia progenitors, as predicted by theory. Otherwise it would be the first hot subdwarf with a NS companion, which was also predicted. Here we report first results of a dedicated radial velocity follow-up survey for five astrometric binaries which will provide precise orbital solutions and masses, while also testing the results provided by Gaia astrometry.

Asteroseismology and Pulsating white dwarfs

S3.2: Asteroseismological analysis of the polluted ZZ Ceti star G29-38 with TESS

Murat Uzundag (KU Leuven)

G29−38 (TIC422526868) stands out as one of the brightest and closest pulsating white dwarfs with a hydrogen-rich atmosphere (DAV/ZZ Ceti class). It was observed by the TESS spacecraft in sectors 42 and 56. The atmosphere of G29−38 is polluted by heavy elements that are expected to sink out of visible layers on short timescales, making it a captivating subject for study. Our analysis of the ∼51-day TESS dataset unveiled 56 significant pulsation frequencies, including rotational frequency multiplets, and 30 combination frequencies per sector. The oscillation frequencies that we found are associated with g-mode pulsations, with periods spanning from ∼260 s to ∼1400 s. In this presentation, I will delve into the intricate asteroseismic modeling of G29−38, leveraging the wealth of insights gained from TESS observations.

S3.2: Juggling convection and pulsation on the cool side of the DA instability strip

Steven Kawaler (Iowa State University), Anwesha Biswas, Ian Clark

Stars near the red edge of the DA white dwarf instability strip exhibit multiple behaviors that do not comport with our relatively simple understanding of pulsation and convection in stars. In particular, we are interested in better understanding the cessation of pulsation at the observationally well-defined red edge, and the onset of outbursting behavior. Models of pulsating DA white dwarfs can readily explain the onset of pulsations at the blue edge , which coincides with the development of the surface convection zone. However, the disappearance of pulsations beyond the observationally well defined red edge is more difficult to explain, as the convection zone is still capable of providing ample driving if the same destabilizing mechanisms operate. We use MESA and GYRE to numerically model nonadiabatic pulsations in DA white dwarf models of various masses and convection prescriptions to explore these effects and compare with observations. We discuss some processes that can drain pulsation energy from otherwise observable modes, including boundary condition changes and non-linear coupling between growing and damped modes, and connect these with the outbursts seen in some cooler DA pulsators (as proposed by Luan and Goldreich several years ago). In addition, we discuss the more common ”habitual” outbursters, and identify a few ”recreational” outbursters, which undergo similar outbursts but much less frequently.

Automated Classification and Statistical Techniques in white-dwarf Research

S3.3: Characterizing Polluted White Dwarfs with Machine Learning to Probe Extrasolar Geochemistry

Mariona Badenas-Agusti (Massachusetts Institute of Technology), Andrew Vanderburg, Javier Viaña, Patrick Dufour, Simon Blouin, Siyi Xu, Lizhou Sha, Kishalay De

A large fraction (25-50 %) of white dwarfs (WDs) are polluted with traces of heavy elements in their atmospheres, likely from the engulfment of tidally disrupted debris. These stellar remnants provide the most direct and accurate way to reconstruct the geology and chemistry of their accreted material. However, as of today, there are only several dozen of them with well-characterized abundances from high-resolution spectroscopy. The scarcity of well-known polluted WDs is partly due to the nature of conventional WD analysis techniques, which involve slow, manual, and iterative work, as well as substantial computational resources that may not be easily available. To address these limitations, we have developed "cecilia," the first Bayesian and Machine Learning (ML)-based interpolation and modeling framework capable of accurately ($\lesssim$0.15 dex) measuring the abundances of polluted WDs from their spectra (R$\lesssim$50,000) with a modest training set and limited human supervision. In this talk, I will summarize the ML architecture and performance of cecilia, describe its predictive accuracy with synthetic and real data of polluted WDs, and present preliminary abundance results for a previously un-analyzed heavily polluted WD with existing SDSS (R$\approx$2,000) and Keck/ESI spectroscopy (R$\approx$4,500). More broadly, I will discuss how cecilia can be used to exploit forthcoming "Big" data from massively multiplexed astronomical surveys in order to unlock large-scale, statistical studies of extrasolar geochemistry.

S3.3: Hunting for Polluted White Dwarfs and Other Treasures with Gaia XP Spectra and Unsupervised Machine Learning

Malia Kao (University of Texas at Austin), Keith Hawkins, Laura Rogers, Amy Bonsor, Bart Dunlap, Jason Sanders, Mike Montgomery, Don Winget

White dwarfs (WDs) polluted by exoplanetary material provide the unprecedented opportunity to directly observe the interiors of exoplanets. However, spectroscopic surveys are often limited by brightness constraints, and WDs tend to be very faint, making detections of large populations of polluted WDs difficult. In this work, we aim to increase considerably the number of WDs with multiple metals in their atmospheres. Using 96,134 WDs with Gaia DR3 BP/RP (XP) spectra, we constructed a 2D map using an unsupervised machine learning technique called Uniform Manifold Approximation and Projection (UMAP) to organize the WDs into identifiable spectral regions. The polluted WDs are among the distinct spectral groups identified in our map. We have shown that this selection method could potentially increase the number of known WDs with 5 or more metal species in their atmospheres by an order of magnitude. Such systems are essential for characterizing exoplanet diversity and geology.

S3.3: White Dwarf Spectroscopical Classification Using Random Forest

Enrique Miguel García Zamora (Universitat Politècnica de Catalunya), Santiago Torres Gil; Alberto Rebassa Mansergas

The third Gaia data release has provided astrophysicists around the world with approximately 220 million mean low resolution BP/RP spectra. Among these, about 100,000 correspond to white dwarfs in a 500 pc radius around the Sun. The sheer magnitude of this quantity precludes the possibility of performing spectral analysis and type determination by human inspection. In order to tackle this issue, an artificial intelligence algorithm approach has been pursued. We will show the result of our validation tests, which use the classified white dwarfs in the Montreal White Dwarf Database a 500-pc radius around the Sun. Once the validity of the application of the Random Forest algorithm for spectral classification has been shown, we will present the result of the application of our method to the unclassified 500-pc white dwarf sample.

S3.3: Simulation-Based Machine Learning for White Dwarf Spectroscopy

Olivier Vincent (Université de Montréal), Pierre Bergeron, Patrick Dufour

Machine learning applications have recently made their way to the field of white dwarf astronomy as an effort to prepare for upcoming spectroscopic surveys. In this talk, challenges with current classifiers are discussed, such as class imbalance, sub-type classification and propagation of survey biases through the training data. We present a promising new approach to address these issues by combining simulated spectra and unsupervised learning. We also explore the potential of neural simulation-based methods for the physical parameter inference of white dwarf stars with complex atmospheres and show a preliminary application to Hot DQs.

Posters

White dwarf Structure and Cooling Processes

[D1.1] The evolution of low-mass white dwarf resulting from common envelope episodes

Leandro Althaus (Universidad Nacional de La Plata-CONICET), Córsico Alejandro

Theoretical and observational evidence predicts the formation of low-mass white dwarfs with helium cores as a result of common envelope (CE) episodes during mass transfer stages in binary evolution. In this study, we present a new set of evolutionary sequences suitable for such white dwarfs with masses less than 0.45 solar masses. We assess their impact on structure and evolution, contrasting the evolutionary predictions with those of white dwarfs resulting from stable mass transfer episodes, where residual nuclear burning dominates their evolution. Additionally, we assess the prospects regarding the pulsational consequences that these white dwarfs would exhibit.

[D1.2] Exsolution process in white dwarf stars

Maria Camisassa (Universitat Politècnica de Catalunya), Denis Baiko, Santiago Torres, and Alberto Rebassa-Mansergas

We have studied exsolution in the interior of white dwarf stars, a process in which a crystallized ionic binary mixture separates into two solid solutions with different fractions of the constituents. Depending on the composition of the parent solid mixture, this process can release or absorb heat, thus leading to a delay or a speed-up of white dwarf cooling. Relying on accurate phase diagrams for exsolution, we have incorporated this process to the stellar evolutionary code LPCODE and calculated a large grid of white dwarf models. We found that this slow process takes place at low luminosities ($\log$(L/Lsun)$<$-2.75) and effective temperatures ($T_{\rm eff} < 18,000\,$K). The net effect of exsolution on white dwarf cooling times depends on the stellar mass and the exact chemical profile. For standard core chemical profiles and preferred assumptions regarding miscibility gap microphysics, the cooling delay can be as large as $\sim$0.35 Gyr at $\log(L/Lsun) \sim -5$. We have neglected any chemical redistribution possibly associated with this process, which could lead to a further cooling delay. Although exsolution has a marginal effect on white dwarf cooling times and, accordingly, we find no white dwarf branches associated with it on the Gaia color–magnitude diagram, exsolution in massive white dwarfs can alter the faint end of the white dwarf luminosity function, thus impacting white dwarf cosmochronology.

[P1.1] A Short Intense Dynamo Following Crystallization in White Dwarf Stars

Matias Castro-Tapia (McGill University), J. R. Fuentes, Andrew Cumming, Shu Zhang

A crystallization-driven dynamo due to compositional convection has been proposed to explain large magnetic fields ($\geq 10^6$ G) observed in isolated white dwarfs (WDs). However, whether convection is efficient enough to explain the large intensity of the observed magnetic fields is still under debate. In this work, we show that the crystallization-driven dynamo is only feasible near the onset of crystallization, convection being efficient enough only for a few Myr. To achieve this, we carefully investigated the convective transport and the energetics in the interior of crystallizing carbon-oxygen WDs using mixing length theory, fluid dynamics, and numerical simulations. We find: 1. The convective efficiency spans two regimes for WD interiors, thermohaline (inefficient) convection and fast overturning compositionally-driven convection. For the first case, efficient thermal diffusion reduces the convective transport for most of the star's evolution leading to very small convective velocities .The fast regime of convection is found just at the beginning of the crystallization for a few Myr, where the effective composition flux is large enough to make the convective transport close to adiabatic. 2. By using the balance between buoyancy, rotation, and magnetic force we demonstrated that large magnetic fields cannot be created in the slow regime of convection. However, in the fast regime, convection is efficient enough to produce magnetic fields of orders of 10^6 to 10^8 G . We show that from this balance the resulting field is independent of the rotation rate and its intensity has an upper limit. 3. Whether these strong fields can emerge at the surface depends on whether there is enough time for outwards ohmic diffusion before the star crystallizes, freezing in the magnetic field. We present results showing the reduction of the initial magnetic field strength when reaching the surface of the star, which depends on the assumptions of the initial size of the convective region and the magnetic diffusivity. We show that just a few observed magnetic WDs can be explained through the transport of the magnetic field produced by the crystallization-driven dynamo.

[P1.2] Influence of crystallization in SNIa explosions

Jordi Isern (ICE-CSIC/IEEC/RACAB), Eduardo Bravo & Luciano Piersanti

Type Ia supernovae are the outcome of the explosion of a carbon-oxygen white dwarf in a close binary system. Recent analyses of the phase diagram of carbon and oxygen containing impurities such as 22Ne and 56Fe suggest that both isotopes can partially separate when the white dwarf starts to solidify. The purpose of the present paper is to examine the impact of this separation on the yields of the different chemical species synthesized during explosions. We find that the main properties of the ejecta, the kinetic energy, and the ejected mass of 56Ni, only vary slightly when the separation is taken into account. However, the yields of important isotopes that are used as diagnostic tools, such as manganese, can be strongly modified and several indicators related to the metallicity of the progenitor and the mass of the exploding star mass can be misnterpreted.

[P1.3] Oxygen opacity experiments for stellar and white dwarf interiors

Daniel C. Mayes (University of Texas at Austin), J.E. Bailey, T. Nagayama, G.P. Loisel, R.F. Heeter, T.S. Perry, H.M. Johns, Y.P. Opachich, S.B. Hansen, C.J. Fontes, D.E. Winget, M.H. Montgomery

Opacities are one mechanism within stars that control the flow of energy to the surface. To accurately model stellar interior structure and evolution, one must have accurate model calculations for the opacities of matter at the conditions within the star. For stars like the Sun, this can affect, for example, the predicted location of the base of the convection zone (CZB). In white dwarf stars (WDs), it can affect the envelop structure and the rate at which WDs are predicted to cool, affecting ages inferred from WDs. To test opacity model predictions at stellar interior conditions, experiments at the Z Facility and the National Ignition Facility (NIF) are ongoing to measure the photon energy resolved opacity of iron and oxygen. The two platforms are considerably different from one another but are complementary, and they allow cross-comparison of the experimental results. Previously, the experiments at Z revealed severe model-data discrepancies in iron opacity as conditions approach the solar CZB, suggesting that revisions may be needed for opacity theory as temperature and density are increased. Oxygen opacity is important in both WDs and the Sun, and it may be more strongly affected by how density effects are treated in opacity calculations. This poster will focus on the progress of the oxygen opacity experiments at each facility. It will discuss the experimental platforms, the methods used for diagnosing experiment conditions and measuring opacities, as well as some of the preliminary results from each platform.

[P1.4] A Deep Dive into the DB Gap

Henry Sanford-Crane (University of Delaware), J. Provencal

A review of current population data putting constraints on the temperature range of the gap; the magnitude of the gap and its change with temperature. Identify possible DA dwarfs that are DB dwarfs masquerading as DA dwarfs. Estimate of the cooling rate of DB stars in the gap is also presented.

White dwarf Populations

[P2.1] Preparing a hot white dwarf sample for the luminosity function

Karolina Jarosik (1. Astronomical Observatory of the Jagiellonian University, 2. Doctoral School of Exact and Natural Sciences of the Jagiellonian University)

In the era of new large-scale surveys, the number of confirmed white dwarfs is in the few hundred thousands. With such vast datasets, it becomes increasingly viable to derive more specialized samples for separate analysis from the general white dwarf population. In this work, I focus on deriving the luminosity function specifically for hot white dwarfs, both DA and non-DA types ($T_{\rm eff}$¿20000 K). To achieve this, I collected a sample of approximately 30,000 hot white dwarfs based on spectra from Gaia, SDSS, LAMOST, and catalogues by Gentile Fusillo et al. (2018) and Torres et al. (2023). I present the initial analysis of the aggregated spectra and discuss the discrepancies in physical parameters observed across different surveys for the same stars, along with the various approaches and models used to estimate these parameters.

[D2.1] Ages and Properties of Individual White Dwarfs Observed with Gaia

Elizabeth Jeffery (California Polytechnic State University), T. von Hippel, E. Robinson, D.A. van Dyk, D.C. Stenning

White dwarfs are an important chronometer for measuring the ages of stellar populations. By combining high precision parallaxes from Gaia and photometry from surveys such as Pan-STARRS and SDSS, we apply a sophisticated Bayesian algorithm to determine ages and other fundamental properties for individual white dwarfs. To improve and calibrate our methods, we apply our technique to known white dwarfs in open clusters, as well as a subset of well-studied DA field white dwarfs. With an eye towards our ultimate goal of applying this technique to every white dwarf in the Gaia catalog, these tests provide important understanding of any systematics that arise when using different filter sets, model sets, etc.

[D2.2] White dwarf spectral evolution through Gaia and Virtual Observatory spectral classification

F. Jiménez-Esteban (Jiménez-Esteban), Torres, S.; Rebassa-Mansergas, A.; Cruz, P.; Murillo-Ojeda, R.; Solano, E.; Camisassa, M. E.; Raddi, R.; Doliguez Le Lourec, J.; Rodrigo, C.

The spectral evolution of the white dwarf population, that is, the ratio between the number of non-DAs to the total number of white dwarfs as a function of the effective temperature, has become an important tool in the analysis of the atmospheric composition along the cooling sequence. Besides, the third data release of Gaia has provided low-resolution spectra for $\sim$100 000 white dwarfs that, together with the excellent photometry and astrometry, represent an unrivaled benchmark for the study of this population. With the help of the Virtual Observatory Spectral energy distribution Analyzer tool, we have spectroscopically classified the population of white dwarfs up to 500 pc into hydrogen-rich or hydrogen-deficient atmospheres based on Gaia spectra with an accuracy ¿90 %. Our analysis have allowed to build the largest observed unbiased sample of these objects, and derive the largest spectral evolution sample for nearly 34.000 white dwarfs. Some characteristic features of the spectral evolution, such as the deficit of helium-rich stars at $T_{\rm eff} \approx$ 35.000 - 40.000 K and in the range of 22.000 $\lesssim T_{\rm eff} \lesssim$ 25.000 K, as well as a gradual increase from 18.000 K to $T_{\rm eff} \approx$ 7,000 K, where the non-DA stars percentage reaches its maximum of 41 %, followed by a decrease for cooler temperatures, are statistically significant. These findings will provide precise constraints for spectral evolution models. Additionally, our results show that while the A branch of the Gaia white dwarf Hertzsprung-Russell diagram is practically populated by DAs, the B branch is largely formed by non-DAs (65 per cent).

[P2.2] Retrieving Galaxy's Star Formation Rate from Gaia's White Dwarf population

Antonio Marzoa (Universitat Politècnica de Catalunya), Santiago Torres; Maria Camisassa, Roberto Raddi; Alberto Rebassa-Mansergas

The properties of white dwarfs stars as cosmochronometers have been widely used for the retrieval of the Star Formation Rate (SFR). In particular, the so-called luminosity function has been extensively used for that purpose. However, obtaining the SFR from the luminosity function requires the solution of an invers problem which, combined with the poorly statistics of the historical white dwarf samples, has made it a difficult task. With the advent of Gaia's mission data, the sample of known white dwarfs of our Galaxy has increased drastically, and the colour-magnitude diagram has been revealed as a powerful tool to retrieve the SFR. In this work, a methodology used to obtain the SFR from resolved galaxies is applied, for the first time, to the most recent catalogue of white dwarfs in our Solar neighborhood. The methodology is validated using different models of white dwarf population synthesis and the results are compared with other approaches.

[P2.3] Studying 3D dust extinction maps using HST spectroscopic data of white dwarfs

Snehalata Sahu (University of Warwick, UK), Pier-Emmanuel Tremblay, Rosine Lallement, Boris T. Gänsicke, Seth Redfield

Accurate astrometric and photometric measurements from Gaia have led to the construction of 3D dust extinction maps that can now be used for estimating the integrated extinctions of Galactic sources located within 5 kpc. These maps are based on optical photometric observations, hence are not well-inspected in the ultraviolet (UV) which is more sensitive to reddening. Past studies have focused on studying UV extinction using main sequence stars but lack comparisons with 3D dust maps. White dwarfs with well-modeled atmospheres dominated by hydrogen Balmer lines (DA) provide an advantage over main-sequence stars affected by magnetic activity. Here, we use HST COS spectroscopic data of 121 DA white dwarfs located within 200 pc to independently test the 3D dust extinction maps from EXPLORE (formally STILISM). We derived the properties of interstellar medium (ISM) at the different line-of-sights of these white dwarfs. The column densities measured from Si II lines were used to infer optical extinction and study their variation with 3D dust maps. We present a comparison of measured central velocities of interstellar clouds with the predictions of a kinematic model of Local ISM, thus demonstrating the importance of UV observations of white dwarfs in the field of interstellar medium and extinction.

[D2.3] A kinematic origin of the white dwarfs in the Solar neighborhood

Ainhoa Zubiaur (UPC), Santago Torres and Roberto Raddi

White dwarfs are considered to be feasible cosmochronometers. Thanks to the recent space-borne mission *Gaia*, there is a nearly complete sample up to about 100 parsecs from the Sun. However, the Galaxy, as a dynamic system, implies that these objects may have very diverse origins. It is therefore of paramount importance to characterize the origins of white dwarfs from the different Galactic structure components found in our Solar neighborhood. We aim to compute the Galactic orbits for white dwarfs of the thin and thick disk, and halo components observed in our Solar neighborhood. Once these orbits are determined, we will analyze the most probable regions of the Galaxy where they could have formed, the distribution of their orbital parameters, as well as the observational biases introduced when constructing the local sample. We used a detailed Galactic orbit integration package, in conjunction with a detailed population synthesis code specifically designed to replicate the different Galactic components of the white dwarf population. Synthetic stars are generated based on the current observational sample, and subsequently, their orbital integration allows for the reconstruction of the population past history. Our kinematic analysis of the white dwarf population reveals the ephemeral nature of the concept of Solar neighborhood, as the majority of thin disk, thick disk, and halo white dwarfs will have left our 100 pc neighborhood in approximately 3.30 Myr, 1.05 Myr, and 0.6 Myr, respectively. Moreover, the spatial distribution of the integrated thin disk orbits suggests that 68 % of these stars were formed at less than 1 kpc from the Sun, while most of thick disk suffered from radial disk migration. Halo members are those stars that typically belong to the "inner halo", being their orbits mostly planar and not extending beyond $R = 20$–25 kpc. Despite the observational bias, which mostly affects the oldest stars in the thick disk and halo, we show that the wider distribution of orbital parameters is well represented by the observed sample. The Solar neighborhood is a transitory concept, whose current population of white dwarfs originates from larger regions of the Galaxy. This fact must be taken into account when analyzing the overall properties of such a population, such as its age distribution, metallicities or formation history. Even so, the kinematic properties observed by recent missions such as *Gaia* are representative of the total population up to a distance of approximately 500 pc.

White dwarfs in New Surveys

[D3.1] The white dwarf population in Gaia

Martin Barstow (University of Leicester), Chris Mander, Olivier Vincent, Stefan Jordan, Pierre Bergeron and Patrick Dufour

The various Gaia catalogues have had a huge influence on our understanding of the galactic white dwarf population. The most recent release, DR3, introduced some important new data products including XP spectra for a sample of 100,000 isolated white dwarfs and samples of eclipsing, astrometric and spectroscopic binaries, many of which have white dwarf companions. We review the results of several analyses of these white dwarf samples, leading to the derivation of a new white dwarf luminosity function (WDLF), which can be differentiated by white dwarf type and, therefore, evolutionary history.

[D3.2] Future space missions for white dwarf research

Martin Barstow (University of Leicester), Sarah Casewell, Matthew Burleigh, Nigel Bannister

The landscape of future missions has changed completely since the 2022 European White Dwarf Workshop. The US decadal survey of astronomy has resulted in the selection of the UVOIR Habitable Worlds Observatory as the next NASA flagship. This mission will have international participants and a large study team has already been assembled to define the scientific drivers for this mission and instrument suite it will need. On a smaller scale, the SIRIUS high resolution spectrograph is being developed as a UK-led bi-lateral mission. However, approximately 50 % if the targets for this mission will be hot white dwarfs, focussing on studies of their composition and structure and their use as background sources for studies of the local interstellar medium. This paper will provide updates on the status of these two missions and looks at opportunities for community participation.

[D3.3] Observing White Dwarfs in the HET Dark Energy Experiment

Barbara Castanheira (Baylor University)

I will present the results of our survey of white dwarfs that were discovered in the Hobby-Eberly Telescope Dark Energy Experiment (HETDEX). Observations were done using the VIRUS Integral-field Units (IFU) array, covering between 3500Å and 5600Å, with resolution R$\sim$2Å. As a by-product of the data releases of the dark energy survey, we have obtained high signal-to-noise spectrum of hundreds of white dwarfs down to a magnitude of 21, in the g-band. We have cross-matched our catalag with the Gaia data and with the Sloan Digital Sky Survey (SDSS) to reliably fit the spectra for effective temperature and surface gravity. The final science goal of our project is to produce a unique magnitude-limited catalog of as many as 10,000 spectroscopically confirmed white dwarfs. Since we are using IFU data, our survey is free of the selection biases that plagued the SDSS. Our final survey will produce a WD luminosity function five magnitudes fainter than the one derived from the Palomar-Green survey (PG) and with a similar number of faint stars as the one from SDSS.

[P3.1] DAHe white dwarfs from the DESI survey

Christopher Manser (Imperial College London), Boris Gaensicke, Keith Inight, Akshay Robert

A new class of white dwarfs, dubbed DAHe, that present Zeeman-split Balmer lines in emission has recently emerged. However, the physical origin of these emission lines remains unclear and previous to 2023, only 3 of these sources were known. We present here a sample of 21 newly identified DAHe systems, all but four of which were identified from the Dark Energy Spectroscopic Instrument (DESI) survey sample of more than 47000 white dwarf candidates observed during its first year of observations. We present detailed analysis of the new DAHe WDJ161634.36+541011.51 with a spin period of 95.3 min, which exhibits an anti-correlation between broadband flux and Balmer line strength that is typically observed for this class of systems. All DAHe systems cluster closely on the Gaia Hertzsprung-Russell diagram where they represent ~ 1 % of white dwarfs within that region. Nine of the new DAHe systems are identifiable from SDSS spectra of white dwarfs that had been previously classified as featureless DC-type systems. We suggest high S/N, unbiased observations of DCs as a possible route for discovering additional DAHe systems.

[D3.4] The Absolute Color Calibration of the Dark Energy Survey: A Spectrophotometric Sample of DA White Dwarfs in the Southern Sky.

Douglas Tucker (Fermilab), Sahar Allam, J. Allyn Smith, William Wester, Pier-Emmanuel Tremblay, Sean Peete, Meagan Porter, for the Dark Energy Survey Collaboration

The Dark Energy Survey (DES), which is nearing the completion of the analysis of its full data set, is an imaging survey of one-quarter of the Southern sky down to an apparent magnitude of i 24.5. The survey observations were conducted between 2013 and 2019 with a 3-square-degree wide-field CCD mosaic camera (the Dark Energy Camera, or DECam) on the Blanco 4-meter telescope at the Cerro Tololo Interamerican Observatory in the Chilean Andes. The primary scientific goal of the DES is to measure properties of Dark Energy. In order to achieve its science goals, the DES has tight requirements on both its relative and absolute photometric calibrations. The requirements for the completed survey are (1) an internal uniformity requirement of 2°,% rms (2) an absolute color (”filter-to-filter”) calibration of 0.5 %, and (3) an absolute flux calibration of 0.5 % (in i-band relative to a Hubble Space Telescope [HST] CalSpec standard). In this presentation, we describe the creation of a ”Golden Sample” of 100 pure-hydrogen-atmosphere (“DA”) white dwarfs that was instrumental in meeting the DES absolute color calibration requirements.

[D3.5] The Absolute Color Calibration of the Dark Energy Survey: Results fromthe Calibration Procedure, plus the Discovery of an Intriguing Feature in the Photometry of DA White Dwarfs.

J. Allyn Smith (Austin Peay State University), Douglas Tucker, Sahar Allam, William Wester, Pier-Emmanuel Tremblay, Sean Peete, Meagan Porter, for the Dark Energy Survey Collaboration

The Dark Energy Survey (DES), is an imaging survey of one-quarter of the Southern sky down to an apparent magnitude of i$\sim$24.5. The survey observations were conducted with a 3-square-degree wide-field CCD mosaic camera (the Dark Energy Camera, or DECam) on the Blanco 4-meter telescope at the Cerro Tololo Interamerican Observatory in the Chilean Andes, between 2013 and 2019. The primary scientific goal of the DES is to measure properties of Dark Energy. In order to achieve its science goals, the DES has tight requirements on both its relative and absolute photometric calibrations. The requirements for the completed survey are (1) an internal uniformity requirement of 2 % rms (2) an absolute color (”filter-to-filter”) calibration of 0.5 %, and (3) an absolute flux calibration of 0.5 % (in i-band relative to a Hubble Space Telescope [HST] CalSpec standard). In this presentation, not only will we describe how well the DES’s absolute color calibration requirements were met based on our ”Golden Sample” of $\sim$100 pure-hydrogen-atmosphere (“DA”) white dwarfs, but we will present an interesting feature that was discovered in the photometry of DA white dwarfs during this process.

White dwarfs in Binaries

[D4.1] Standstill periods and accretion disc temperatures' profiles of two Z Cam stars

Daniela Boneva (Space Research and Technology Institute, Bulgarian Academy of Sciences), Krasimira Yankova, Denislav Rusev

Z Cam stars are a subclass of the dwarf novae type cataclysmic variables. They exhibit two individual states - outbursts and standstills, which is typical for this class of objects. In this work, we present our study on two Z Cam stars: Z Cam (Camelopardalis) and AT Cnc (Cancer). We apply observational data for different periods that cover the two states. Oscillations in brightness during the standstills of AT Cnc are detected. We find they have a relation to fluctuations that appeared at the outer layers of the white dwarf accretion disc. Accretion discs' temperatures profiles are calculated and then compared for both objects. We evaluate the difference in parameters' development for the two object's discs. We conclude that different mechanisms are responsible for their behavior during the standstill periods.

[P4.1] The enigmatic nova shell around V1425 Aql as seen by MUSE

Lientur Celedón (Universidad de Valparaíso), Claus Tappert, Linda Schmidtobreick, Fernando Selman

Nova eruptions occur in cataclysmic variables when enough material from the companion star has been accreted onto the surface of the white dwarf primary. After the eruption the material that has been accreted is expelled into the interstellar medium, forming a nova shell around the system. Understanding the processes that shape the nova shell is necessary to obtain a full comprenhension of the physics behind a nova eruption. An enigmatic nova shell is the one surrounding the system V1425 Aql. This young shell presents an spatial asimmetry in the observed forbidden lines of [OIII] and [NII] when compared with the allowed transitions traced by Hydrogen. Such an strong asymmetry has not been observed in other young shells. Here we present our latter results regarding the analysis of the shell around V1425 Aql as it was observed by the Multi-Unit Spectroscopic Explorer at the Paranal Observatory. These new observations support the previous results, as well as indicates that the forbidden lines are spatially confined to an arc that surrounds the central, more spherical allowed emission.

[D4.11] A systematic search of short period variability in white dwarfs using ATLAS and TESS

Emma Chickles (MIT)

Galactic double-degenerate binaries with short sub-hour orbital periods will be the most numerous sources of gravitational waves detectable by the upcoming Laser Interferometer Space Antenna (LISA). Studies of LISA-detectable ultracompact binaries have almost exclusively been conducted in the Northern hemisphere, such as the Zwicky Transient Facility. We are conducting a systematic search for ultracompact white dwarf binaries using two all-sky surveys; the Asteroid Terrestrial-impact Last Alert System and the Transiting Exoplanet Survey Satellite. Our search identified an accreting $1\,M_\odot$ white dwarf in a nearby ≈ 30-min-orbital-period ultracompact binary. This LISA-detectable system is a candidate progenitor of sub-Chandrasekhar Type Ia channel via detonation of a thin-accreted helium layer that triggers the detonation of the underlying carbon-oxygen core.

[D4.2] Search for Cataclysmic Variables in J-PLUS

Alessandro Ederoclite (CEFCA)

The third data release of the Javalambre Photometric Local Universe Survey (J-PLUS) contains 49 million objects observed in 5 broadband and 7 narrow band filters. These filters have been designed for the characterisation of stars. Yet, the amount of photometric information, together with a large number of objects, allows us to identify peculiar objects, in this specific case, cataclysmic variables (CVs), whose spectral energy distribution is made of the composition of an accreting white dwarf, a donor main sequence star and an accretion disc. The contributions of these three components can vary according to the properties of the system. In this talk, I present the catalogue of CVs identified in J-PLUS DR3 and the perspectives for the future use of other wide-field surveys like J-PAS.

[P4.2] Searching the non-accreting white dwarf population in eROSITA data

Susanne Friedrich (Max-Planck-Institute for extraterrestrial Physics), C. Maitra, K. Dennerl, A. Schwope, B. Stelzer, K. Werner

The first all-sky X-ray survey was performed by the ROSAT X-ray observatory in the 0.1–2.4 keV energy range (Trümper 1982). It was not until almost 30 years later that an all-sky X-ray survey was to be carried out again with the SRG/eROSITA X-ray mission. Between December 2019 and December 2021 four all-sky surveys were completed. The sensitivity of eROSITA at soft energies (about 0.1 keV) is not as good as ROSAT's but a larger effective area makes up for this. Only the hotter isolated white dwarfs ($T_{\rm eff}$ >20000 K) are observed in X-rays. Taking the current cumulative eROSITA all-sky data from the surveys 1–4, which are limited at lower energies to 0.2 keV, and determining the hardness ratios we found about 35000 soft sources with ((0.5keV–2.3keV) – (0.2keV–0.5keV)) / ((0.2keV–0.5 keV)+(0.5keV–2.3keV))= –1. From this sample about 700 have matches with the Gaia white dwarf catalogue (Fusillo et al. 2021) and about 300 have a probability of more than 80 percent to be a white dwarf. To improve these findings eROSITA data will be processed to a lower energy limit of about 0.1 keV, in order to create a flux limited sample of isolated white dwarfs observed with eROSITA. First results on dedicated sky regions are promising.

[D4.3]Reconstructing histories of white dwarf-main sequence binary systems after common envelope events using inverse population synthesis methods

Marta Gili Esteva (Universitat Politècnica de Catalunya), Santiago Torres Gil, Alberto Rebassa-Mansergas

The evolution of binary stars involves a wide range of physical processes, many of which are not yet well understood. This is particularly true for close binary systems formed of a white dwarf and a main-sequence star. For instance, characterizing certain mass transfer episodes that may lead to a common-envelope phase and its subsequent evolution is still an open problem. Fortunately, the observational capabilities of current surveys, coupled with the feasibility of population synthesis models, enable us to reconstruct the past history of these systems, shedding light on their evolution and theoretical modeling. To that end, in this poster we present an algorithm based on inverse population synthesis techniques, able to reconstruct the past history of binary systems, particularly those involving a white dwarfs and a main sequence stars. This algorithm is applied to a sample of eclipsing binaries, aiming to ascertain their progenitors and past histories. We find a mild anticorrelation between the common-envelope efficiency parameter and the secondary star mass, the absence of a universal value of $\alpha_{\rm CE}$ and no need for internal energy.

[D4.4] Insights into White Dwarf Age Dating using Wide WD+WD Binaries

JJ Hermes (Boston University), Tyler Heintz

Gaia DR3 revealed more than 3000 white dwarfs that reside in a wide (¿100 au) binary with another white dwarf, a population of coeval binaries that are unlikely to have interacted in the past. This population has revealed valuable insights into best-practices for white dwarf parameter estimation, especially age determinations from both the photometric and spectroscopic methods. This work, presented on behalf of BU graduate student Tyler Heintz, has also revealed that roughly 20 % of the white dwarfs in these wide WD+WD binaries are or were once in triples and likely underwent a past merger event. We conclude with new insights into other astrophysics enabled by improved white dwarf age estimation, especially gyrochronology of cool main-sequence stars.

[P4.3] Orbital periods of magnetic Cataclysmic Variables and their detection limits in TESS light curves

Santiago Hernández Díaz (Institut für Astronomie und Astrophysik, Eberhard Karls Universität Tübingen), Beate Stelzer, Daniela Muñoz-Giraldo, Axel Schwope, Stefanie Raetz, Alex Binks

Magnetic cataclysmic variables (CVs), also known as polars, are a class of close binary systems consisting of a white dwarf primary accreting from a low-mass donor secondary, typically a main sequence star. The main distinction of polars with respect to other types of CVs is the strong magnetic field of the accreting white dwarf, often exceeding 10 million Gauss. The presence of this intense magnetic field plays a fundamental role in controlling the accretion flow and preventing the formation of an accretion disk. Material overflowing the Roche lobe of the secondary is directed by the magnetic field and accrestes to the magnetic poles of the white dwarf, producing a brightness modulation at the orbital period of the system. We have compiled a complete catalogue of polars with an extensive literature research. Based on TESS light curves we provide updated orbital period measurements for 93 systems by means of a robust methodology that employs four different numerical methods. Precise uncertainties and confidence interval estimations, which constitute a problematic not very well resolved as of today, are obtained with the use of bootstrapping. In addition, with the aim of finding an observational limiting magnitude for the detection of orbital periods in CVs with TESS, an analysis is conducted where simulations, resembling the statistical characteristics of observed light curves, and a study of the correlation between photometric noise and TESS magnitude in observed light curves are combined.

[P4.4] Obtaining the IFMR of the Sirius Binary System with MESA

Momin Khan (Baylor)

The Sirius binary system is the topic of many astrophysical studies, as understanding its formation and evolution will lead to many insights on the lifespan of main sequence-white dwarf binary systems. Howard Bond et. al published years of astrometric measurements of this system and combined with model determinations from the TYCHO stellar evolution code, determined with great precision the masses of Sirius A and B to be 2.063 ± 0.023 $M_\odot$ and 1.018 ± 0.011 $M_\odot$. Under the assumption that there is little to no mass transfer between the two stars, and using these determinations for the mass of Sirius A, the period, and eccentricity of orbit, we attempt to model the evolution of the Sirius system. We present a grid of models of varying initial mass and metallicity of Sirius B using MESA to accurately determine the physical characteristics of the Sirius system. We obtain that the best fitting model utilizes the same subsolar metallicity of about 0.85 $Z_\odot$ by using the luminosity of Sirius B as a stopping condition. In this poster, we present our results that the age of Sirius B, and thus the system, is about 220 MYr, which is also in agreement with previous publications. Our results place constraints on the progenitor mass of Sirius B to be 5.7 $M_\odot$ for the subsolar metallicity of 0.85 $Z_\odot$ with an age of 206 Myr and a white dwarf mass of 0.996 $M_\odot$. Additionally, we concluded that the effective temperature is 25,704 K and the surface gravity is 8.643 for this model. Higher metallicity models than these resulted in inaccurate final mass and age values that did not agree with observational data.

[P4.5] The structure of a historical supernova 1181 remnant and a white dwarf in its center

Takatoshi Ko (The University of Tokyo), Hiromasa Suzuki, Kazumi Kashiyama, Hiroyuki Uchida, Tkaaki Tanaka, Daichi Tsuna, Kotaro Fujisawa, Aya Bamba, and Toshikazu Shigeyama

IRAS 00500+6713 has been a leading candidate of a historical supernova 1181. This supernova is thought to be caused by a binary white dwarf merger and interestingly a massive white dwarf was found inside this remnant. In addition, optical observations reveal that, from this white dwarf, the very fast wind of about 15,000 km/s is blowing, forming wind termination shock inside the supernova remnant by colliding with the supernova ejecta. The gases shocked by both the termination shock and the outer supernova remnant shock are expected to be sources of luminous X-ray emission. We constructed a theoretical model for the time evolution of both shocked regions, and compared it with the multi-wavelength observation results. In this talk, we report the structures of the multi-layer SNR and its implications for the central white dwarf properties and the formation scenarios.

[P4.6] Cataclysmic Variables Within Hot Subdwarf Candidates.

Jurek Krzesinski (Astronomical Observatory of the Jagiellonian University, Krakow, Poland), M. Uzundag, G.A.Kumari, S.Zola, S. Scaringi, K.Jarosik

Cataclysmic variables (CVs) are interacting close binary systems where a white dwarf (WD) is the accreting primary. The mass losing secondary, a hydrogen-reach donor usually is a Main Sequence star. These systems typically exhibit a significant photometric variations and encompass a broad range of classes, such as nova-like CVs, dwarf novae, classical novae, intermediate polars among others. They provide opportunities to study both equilibrium and non-equilibrium accretion discs, the evolution of binary stars in their late stages, aiding in the understanding of X-ray binaries and black holes. In this project, we present new CV candidates discovered during our search for variable hot subdwarfs. Given that many types of CVs occupy the same regions of the Gaia Color-Magnitude diagram (CMD) as hot subdwarfs (Abril et al. 2020), our search yielded a number of CV candidates. The objective of this work was detection of new CV sources and analysis of their light curves. We utilized the Culpan et al. catalog (2022) of hot subdwarf candidates and data from the TESS telescope, restricting our search to candidates brighter than 17 TESS magnitudes. As the result of our search we present Gaia color-magnitude diagram featuring known and the newly found CV stars in our 303 candidate sample, along with their light curves.

[P4.7] Most extremely low mass white dwarfs with non-degenerate companions are inner binaries of hierarchical triples

Felipe Lagos-Vilches (University of Warwick), Mercedes Hernandez, Matthias R. Schreiber, Steven G. Parsons, B.T. Gansicke

Extremely-low-mass white dwarfs (ELM-WDs) with non-degenerate companions are believed to originate from solar-type main-sequence binaries undergoing stable and semi-conservative Roche lobe overflow mass transfer when the ELM-WD progenitor is at (or close to) the termination of the main-sequence. This implies that the orbital period of the binary at the onset of the first mass transfer phase must have been $\lesssim$ 3 - 5 days. This prediction in turn suggests that most of these binaries should have tertiary companions since $\approx$ 90 per cent of solar-type main-sequence binaries in that period range are inner binaries of hierarchical triples. We here present high-angular-resolution images of the binary TYC 6992-827-1, consisting of an ELM-WD with an sub-giant (SG) companion, confirming the presence of a tertiary companion. We show that TYC 6992-827-1, along with its sibling TYC 8394-1331-1 (whose triple companion was detected via radial velocity variations), are descendants of EL CVn-type binaries (pre-ELM WDs with A/F main-sequence companions), also known for having tertiary companions.

[D4.5] Empirical Decomposition of Binary Spectra: Precision Techniques Using Observed and Synthetic Spectra

Peter Nemeth (Astroserver.org), Dr Joris Vos, Francisco Molina, Mauricio Cabezas

Composite stellar spectra are treasure troves of astronomical data, enabling precision studies of binaries and multiples. However, achieving such precision requires specialized methodologies to address the high level of degeneracy encoded in the spectral data. One method to mitigate this issue is to analyze one component of the system and apply theoretical models, such as stellar evolution models, and orbital properties to determine the binary parameters. Such an approach is presented at EuroWD24 by Francisco Molina. Alternatively, synthetic spectral models of both components can be combined to reproduce the observed spectral properties and spectral energy distributions. Then, various constraints can be applied, such as stellar radii derived from eclipses, orbital separation from astrometry, or stellar rotation rates from independent measurements. The methodology is suitable for decomposing a binary from a single observed spectrum, which is advantageous when limited observing time is available. When multiple measurements become available and the orbital period is covered, wavelength space decomposition combined with Fourier disentangling can reveal both the binary orbital parameters and the members' spectral properties. We present a purely spectroscopic empirical decomposition of hot subdwarf - main-sequence binary composite spectra, utilizing high-resolution VLT/UVES spectra, where only the mass ratio is known from radial velocity measurements. The methodology is suitable for white dwarf composite spectra as well. This approach has significant implications for advancing our understanding of stellar evolution, improving the accuracy of stellar parameter measurements, and refining models of binary star systems.

[D4.6] A Survey for Radio Emission from White Dwarfs in the VLA Sky Survey

Ingrid Pelisoli (University of Warwick), Laura Chomiuk, Jay Strader, T. R. Marsh, Elias Aydi, Kristen C. Dage, Rebecca Kyer, Isabella Molina, Teresa Panurach, Ryan Urquhart, Thomas J. Maccarone, R. Michael Rich, Antonio C. Rodriguez, E. Breedt, A. J. Brown, V. S. Dhillon, M. J. Dyer, Boris. T. Gaensicke, J. A. Garbutt, M. J. Green, M. R. Kennedy, P. Kerry, S. P. Littlefair, James Munday, S. G. Parsons

Radio emission has been detected from tens of white dwarfs, in particular in accreting systems. Additionally, radio emission has been predicted as a possible outcome of a planetary system around a white dwarf. We searched for 3 GHz radio continuum emission in 846,000 candidate white dwarfs previously identified in Gaia using the Very Large Array Sky Survey (VLASS) Epoch 1 Quick Look Catalogue. We identified 13 candidate white dwarfs with a counterpart in VLASS within 2”. Five of those were found not to be white dwarfs in follow-up or archival spectroscopy, whereas seven others were found to be chance alignments with a background source in higher-resolution optical or radio images. The remaining source, WDJ204259.71+152108.06, is found to be a white dwarf and M-dwarf binary with an orbital period of 4.1 days and long-term stochastic optical variability, as well as luminous radio and X-ray emission. For this binary, we find no direct evidence of a background contaminant, and a chance alignment probability of only $\sim$2 per cent. However, other evidence points to the possibility of an unfortunate chance alignment with a background radio and X-ray emitting quasar, including an unusually poor Gaia DR3 astrometric solution for this source. With at most one possible radio emitting white dwarf found, we conclude that strong (¿ 1-3 mJy) radio emission from white dwarfs in the 3 GHz band is virtually nonexistent outside of interacting binaries.

[P4.8] Discovery of the first halo white dwarf + L subdwarf wide binary

Roberto Raddi (Universitat Politecnica de Catalunya), Z. H. Zhang, A. J. Burgasser, R. L. Smart, M. C. Gálvez-Ortiz, H. R. A. Jones, S. Baig, N. Lodieu, B. Gauza, Ya. V. Pavlenko, Y. F. Jiao, Z. K. Zhao, S. Y. Zhou and D. J. Pinfield

We report on the discovery of the first white dwarf + L subdwarf binary, VVV 1256-62AB, a gravitationally-bound system located 75.6 pc away with a projected separation of 1375 au. The primary is acool DC white dwarf with a hydrogen dominated atmosphere with a $T_{\rm eff}$ of 4440 $\pm$ 250 K and a total age of 10.5 (+2.7/-2.0) Gyr according to white dwarf model fitting. The secondary is an sdL3 subdwarf with a metallicity of [M/H] = -0.72 (i.e. [Fe/H] = -0.81) and $T_{\rm eff}$ = 2298 K based on atmospheric model fitting of its optical to near infrared spectrum, and it likely has a mass just above the stellar/substellar boundary. The subsolarmetallicity of the L subdwarf and the system’s total space velocity of 406 km/s indicates membership in the Galactic halo. This is the first white dwarf + L subdwarf subdwarf binary to have a well-constrained age, making it an ideal benchmark of metal-poor ultracool dwarf atmospheres and evolution.

[P4.9] A multiwavelength study of the dwarf nova V1838 Aql. Where is the bow shock?

Sergio Humberto Ramirez (University of Warwick), Juan Venancio Hernandez SantistebanBoris Gänsicke

We present a multiwavelength study of V1838 Aql in quiescence. This object showed extended emission around the source interpreted as a bow-shock in previously published observations. Our new Deep Hα imaging and VLA radio observations do not exhibit any sign from the bow shock. Our follow-up VLT X-Shooter observations show a clear signature from the white dwarf as well as emission lines coming from the accretion disc; particularly double-peaked Balmer emission, and other Ca II and Mg I lines. Several absorption features from the secondary star are also present, in particular the K I lines at 12,436 Å and 12,528 Å. A radial velocity analysis yields an orbital period of 79 $\pm$ 0.8min and semi-amplitudes K1 = 31$\pm$ 1 km/s and K2 = 200$\pm$ 50 km/s, implying a mass ratio of q=M2/M1= 0.16 $\pm$ 0.05. These results are suggestive of a pre-bounce object with the mass of the secondary well over the hydrogen burning limit. However, we find that our mass accretion rate estimate is of the order of 10^{-11}; a factor of $\sim$ 50 smaller than the expected mass transfer rate for pre-bounce objects , and in better agreement with that of period bouncers. We implement a Doppler Tomography analysis to gain insight into the origin of the observed inconsistencies.

[D4.7] J0526+5934: a peculiar ultra-short period double white dwarf

Alberto Rebassa-Mansergas (Universitat Politècnica de Catalunya), Mark Hollands, Steven Parsons, Leandro Althaus, Ingrid Pelisoli, Puji Irawati, Roberto Raddi, María Camisassa, Santiago Torres

In this poster we present J0526+5934 as the sixth ultra-short period detached double white dwarf currently known. We analyse optical spectra together with time-series photometry of the visible component to constrain the orbital and stellar parameters. We also employ evolutionary sequences for low-mass white dwarfs to derive independent values of the primary mass.

[D4.8] Tracing Late-Stage Binary Evolution: S-Process Abundances in MS-WD Binaries

Param Rekhi (Weizmann Institute of Science), Sagi Ben-Ami, Na'ama Hallakoun, Sahar Shahaf

We report a study of the s-process elemental abundance of 58 MS-WD binaries derived from the Gaia non-single star catalogue and having high resolution spectroscopy from the GALAH survey. Our sample belongs to a largely unexplored population of MS-WD binaries having orbital separations of around 1 AU and a range of eccentricities - a population that is not reproduced by current binary evolution models. As a star progresses through the asymptotic giant branch (AGB) phase before it forms a white dwarf, shell burning generates heavy elements such as Ba, Y and Zr through the slow neutron capture (s-) process. As AGB stars have radii of the order of 1 AU, similar to the orbital separations in our population, these binaries are expected to have undergone some mass transfer, which should have lead to circularization of their orbits and a change in their orbital radius. Abundances of s-process elements on the primaries can act as tracers of the mass transfer history of these systems, providing a key to this puzzle. Our study finds around half our sample to show enhanced levels of s-process elements, with the abundances broadly correlated to the WD mass. We further find systems with s-process overabundance tend to be more circular than those without. We also find strong correlations between the abundances of Ba, Y, La and Zr, with progressively weaker correlations to abundances of Nd, Sm and Ce. We note, however, that our limited sample size constrains our results to be indicative rather than conclusive. Towards this end, we are in the process of obtaining additional high-resolution spectra for more of our sample, which will enable a more detailed and stronger understanding of late-stage binary evolution.

[P4.10] Dead Ringers: A Pulsation Explanation for Supersoft X-Ray Oscillations

Jarrett Rosenberg (University of Wisconsin-Madison), Richard Townsend, Bill Wolf

X-ray monitoring over the past couple of decades has revealed that some novae exhibit variability, with periods ranging from tens of seconds to an hour, throughout the supersoft phase. While the supersoft X-ray oscillations (SSXOs) with periods greater than 5 minutes have been linked to the rotation of a magnetized white dwarf, the origin of short period (10s of seconds) SSXOs remains a mystery. Using MESA with `wd_builder`, we have constructed a model of a 1.3 solar mass CO white dwarf (matching mass and composition estimates of RS Oph, a recurrent nova with a twice-measured 35s SSXO period) going through outburst and the subsequent supersoft phase. Using GYRE to calculate the dipole ($l = 1$) oscillation modes of the WD, we find that the envelope modes go through a series of avoided crossings with a core-trapped mode whose 35s period remains constant throughout the supersoft phase. Using a classical analog to the quantum-mechanical Landau-Zener effect, we determine that approximately 60 % of the initial energy stays in the 35s mode as avoided crossings are traversed, with the remainder leaking into the envelope where it can stimulate the observed variability. This core mode is a promising explanation for the origin of SSXOs, provided the outburst can energize the mode.

[P4.11] Compton scattering and ionized absorber effects on the X-ray emission of the two IPs systems

Elif Şafak (UPC), Şölen Balman

We present high-sensitivity broadband X-ray spectral and spin modulation analysis for two Intermediate Polar(IP) sources, J17195-4100 and IGR J15094-6649, by combining NuSTAR and XMM-Newton archived data. We reveal significant effects of Compton reflection and ionized absorber in both IP systems. We also found spin modulation in hard X-rays, implying electron scattering. Consistent with previous studies, we observed energy-dependent spin modulation in the IGR J15094-6649 source, indicating the presence of a photoelectric absorber whereas in IGR J17195-4100, we mostly find constant pulsed fraction in the NuStar band consistent with electron scattering. The two IP systems can be well described by Compton reflection and the presence of ionized and neutral absorbers along with a multi-temperature plasma at 35 keV and 27 keV, and the ionization parameter ($\log \xi$) of the ionized medium at 1.22 and 1.09, respectively. The X-ray luminosity of IGRJ17195-4100 and IGR J15094-6649 were obtained as 8.6×10^{33} erg s^{-1} and 8.3×10^{33} erg s^{-1}, respectively.

[P4.12] Novae in the eROSITA All Sky Survey

Gloria Sala (UPC-IEEC), Frank Haberl (MPE), Axel Schwope (AIP), Chandreyee Maitra (MPE), Jochen Greiner (MPE), Robert Willer (MPE)

Nova explosions are thermonuclear events on top of an accreting white dwarf in a cataclysmic variable (CV) or a symbiotic system. The nova event results in the increase of the optical luminosity by 7-8 orders of magnitude. That makes the nova outburst detectable at any distance in the Galaxy, in the Local Group and even beyond the Local Group. However, due to the resulting distance distribution of novae, the host system remains unknown for most cases. Accretion powers X-rays in the host system once the mass transfer is resumed and the white dwarf starts to accrete again. We search for old nova host systems in the German data of the eROSITA survey. A total of 31 old novae are identified, with about 2/3 of the identifications being new detections in the X-rays of the old nova systems. Several of them are IP candidates, so increasing the fraction of known novae outbursts occurring in magnetic systems.

[P4.13] Discovery of two period-bounce low-state polars

Gracjan Sienkiewicz (University of Warwick), Tim Cunningham & Ilaria Caiazzo

Two cataclysmic variable systems, WDJ-1820 and WDJ-1907, were identified as low-state polars with cool brown dwarf companions. Interpolation of 1D pure-hydrogen non-local thermodynamic equilibrium (NLTE) spectra combined with Pan-STARRS data enabled us to create Spectral Energy Distribution (SED) fits, yielding best fit parameters for each white dwarf. Extinction models were employed to account for dust-induced reddening effects, while the combination of BT-Dusty brown dwarf models with SED fits constrained the brown dwarf temperatures. Making use of archival JHK photometry from 2MASS and UKIDSS, and targeted WIRC J-band photometry, we confirm that the companions are consistent with effective temperatures less that 1,500 K. Comparing mass-radius relations of brown dwarfs across different ages with their Roche-Lobe radii at various periods revealed that WDJ-1820 and WDJ-1907 are systems consistent with Roche-Lobe overflow.

- **Physical Parameters of Accreting White Dwarfs in Cataclymic Variabless in CVsles**

Edward M. Sion (Villanova University), Patrick Godon

Since the advent of Gaia combined with Hubble Space Telescope COS and STIS spectroscopy, extensive new physical properties of accreting white dwarfs in cataclysmic variables have been obtained. This review is focused upon new robust white dwarf masses, as well as surface temperatures, chemical abundances and rotational velocities of accreting cataclysmic variable degenerates. We find that the N/C anomaly and supra-solar abundances of Al are present both in CVs with evolved donors and CVs with unevolved donors. Our results up to now are summarized along with phyiscal interpretations.

[P4.14] Soft X-ray emission from the classical nova AT 2018bej

Andrey Tavleev (Institut für Astronomie und Astrophysik Tübingen (IAAT), Eberhard Karls Universität Tübingen), L. Ducci, V. F. Suleimanov, K. Werner

Classical novae are known to demonstrate a supersoft X-ray source (SSS) state following outbursts. This state is associated with residual thermonuclear burning on the white dwarf (WD) surface. We performed a spectral analysis of the supersoft X-ray phase of the classical nova AT 2018bej, which was observed in X-rays by the eROSITA and XMM-Newton telescopes. To describe the spectrum we calculated high-gravity hot LTE model atmospheres of hot WDs with chemical compositions typical for nova SSS phases, focusing specifically on carbon abundance. The code developed by Suleimanov et al. (2024) was used for this aim. The 0.3-0.6 keV analysis yields a WD temperature $T_{\rm eff} \sim$ 600 kK, gravity logg $\sim$ 8.3-8.4 and a WD radius R $\sim$ 8000-8700 km, which gives luminosity $L \sim 6$–6.5×10^{37} erg/s. The derived WD mass is estimated to be $\sim$1.1*Msun. We traced a minor evolution of the source on a half-year timescale accompanied by a decrease in carbon abundance, decrease in temperature and increase in radius, and concluded that LTE model atmospheres are applicable for analysing X-ray spectra of classical novae during their SSS stage.

- **Polarimetric Observations Confirm V1082 Sgr as an Intermediate Polar with a 20.82-Hour Orbital Period**

Gagik Tovmassian (UNAM, Instituto de Astronomia/visiting Brera Observatory), Claudia Vilega Rodrigues - INPE, Isabel Lima

V1082 Sgr is a peculiar cataclysmic variable star characterized by an exceptionally long orbital period of 20.82 hours. Despite numerous studies, the true nature of this object remains debated. Our polarimetric observations have revealed a circular polarization in its radiation with a period of approximately 2 hours, confirming its classification as an intermediate polar. In this contribution, we present detailed results of these observations, develop models of the magnetic white dwarf in V1082 Sgr, and discuss the implications of our findings for understanding the star's nature and behavior.

[D4.9] Deriving the mass distribution of hot subdwarfs based on their cool companions

Joris Vos (Astronomical Institute of the Czech Academy of Sciences, 25165, Ondrejov, Czech Republic), Fransisco Molina, Alexey Bobrick, Maja Vuckovic

Obtaining the masses of hot subdwarf (sdB) stars can be challenging as their surface gravities and radii can be difficult to accurately derive. Here we present a new method to derive the masses of hot subdwarfs in wide binaries with solved orbital parameters. The atmospheric parameters of the main sequence (MS) companions are derived from spectral analysis and a photometric SED fit to derive the radius. These parameters are then matched to theoretical stellar evolution tracks from the MIST database to determine the mass of the MS companions. Using the mass ratio, the mass distribution of the sdB stars is calculated. We tested this methods on a sample of single stars exhibiting solar like oscillations where masses were derived from astroseimology, and on a sample of eclipsing binaries. Both tests confirm a roughly 5 % error in mass, showing that this is a reliable method that can also be used to derive masses of binary white dwarfs with MS companions. The derived mass distribution of sdBs shows significant differences with published theoretical distributions, with a large overabundance of heavy sdBs.

[D4.10] Irradiation of the Donor Star Elongates Post-Outburst Supersoft Phase of Classical Novae

Bill Wolf (University of Wisconsin – Eau Claire), Sam Hearden

Classical novae most often occur in cataclysmic variable systems with orbital periods on the order of a few hours. After the optical peak of a nova, the white dwarf shines brightly as a source of supersoft X-rays for weeks to years with a luminosity on the order of 10^4 solar luminosities. The high luminosity combined with a small orbital separation leads to intense irradiation of the donor star, driving more rapid mass transfer that is decoupled from the evolution of the binary. We present binary star MESA simulations of this effect, demonstrating that accounting for irradiation can significantly enhance the duration of the supersoft phase, potentially bootstrapping a steadily burning supersoft source.

White dwarf Dust Disks and Planetary Systems

[D5.1] Sub-stellar companions and debris disks around white dwarfs: single, double... triple and quadruple-peaked emission lines.

Nicola Gentile Fusillo (Universita‘ degli Studi di Trieste), Felipe Lagos-Vilches, Boris Gaensicke, Christopher Manser

Around 1-3 percent of white dwarfs exhibit IR-excess indicative of the presence of a dusty planetary debris disk. However, a similar IR signal can also arise from the presence of a sub-stellar companion, and in the case of small, low-mass bodies, the IR-excess can be almost indistinguishable from the contribution of a debris disk. Spectroscopic observations of these systems are normally enough to break any degeneracy. In binary systems, for instance, the spectrum will often show single-peaked sharp emission lines originating from the irradiated surface of the companion. Conversely, a debris disk system will show absorption lines resulting from metal accretion and only display emission lines if the debris-disk has a significant gaseous component. In these rare cases the emission lines exhibit double-peaked profiles characteristic of a flat gas disk in Keplerian rotation. However, today this simple picture is beginning to blur and crack as our ongoing follow-up of IR-excess white dwarfs is uncovering a diverse array of exotic systems. I will highlight some of these recent discoveries, including updates on WDJ1328-1450 previously identified as a quadruple-peak system, and introducing never-seen-before triple-peaked emission line systems. These peculiar white dwarfs are pushing our understanding of debris disks outside of the parameter space we considered so far, prompting us to imagine new configurations like multiple disks, complex disk geometries and the co-existence of disks and companions.

[D5.2] In Search of Post-Main-Sequence Planetary Systems: Analysis of variability of White Dwarfs in Gaia

Javier Gómez Martínez (Universidad Complutense de Madrid / European Space Agency (ESA)), Markus Kissler-Patig

With the expansion of exoplanet research, the quest for planetary systems beyond the main-sequence has started. In particular, we are interested to probe whether planetary system exist around white dwarfs. In this project, we will analyze the variability of white dwarfs in Gaia catalogue using different techniques including some machine learning algorithms to classify white dwarf spectra in order to find interesting objects that could host planetary systems.

[P5.1] Transiting Planetary Debris around White Dwarfs: New Discoveries and Emerging Dichotomies

Joseph Guidry (Boston University), JJ Hermes (Boston University), Zach Vanderbosch (Caltech)

While more than 30 % of white dwarf stars are estimated to be accreting disrupted planetary material from their metal-polluted spectra, the detection of this debris in transit has been elusive. Light curves from the Zwicky Transient Facility, Gaia, and TESS are now driving the discovery of more transiting systems towards polluted white dwarfs. We showcase new follow-up photometry surveying transits from orbital periods as short as 4.5-hours up to hundreds of days. These discoveries illuminate a dichotomy of either ”short” (near the tidal disruption radius) or ”long” (100s of days or longer) recurrence timescales. Separately, there are two distinct cases of light curve morphologies: systems showing extended phases out of transit versus systems that appear to be continuously transited by debris. We believe measuring the orbital periods of transiting debris will be a key to better understanding the broader phenomenon of white dwarf metal pollution. Observing transits across a distribution of periods with a variety of light curve morphologies could help constrain the dynamics of both evolved debris disks and objects just beginning to undergo tidal disruption, and thus place more limits on the still incomplete roadmap to pollution onto white dwarf photospheres.

[D5.3] WD 1054-226 and its complex transiting signals

Judith Korth (Lund University), Alexander Mustill, Eva Villaver

White dwarfs (WDs) serve as dense remnants of stars, offering insights into elemental abundances and the bulk composition of celestial bodies. Traces of heavy elements detected in WD atmospheres, such as silicon, iron, and oxygen, suggest accretion from planets or asteroids (Jura & Young, 2014). One way to bring those elements into the white dwarf's atmosphere is by planets or asteroids coming very close to the white dwarf so that they are accreted into the white dwarf. In some systems, we can see some leftovers from those processes directly: disc of dust around the white dwarf can be photometrically observed as shown by Farihi et al. (2022) in the case of the white dwarf WD 1054-226. Notably, the presence of dust rings around WDs, like WD 1054-226, reveals intricate structures and periodic patterns, hinting at interactions with orbiting bodies. Transiting WD systems, a recent discovery, present a unique challenge in understanding their long-term evolution. Rapid changes observed in infrared brightness over years suggest dynamic processes within the discs, possibly due to sublimation or collisions of large bodies (Xu et al., 2018). Extended monitoring of these systems promises insights into the evolution of orbiting bodies and the accretion processes onto WDs. We will present the results of photometric follow-up observations of WD 1054-226 using the Las Cumbres Observatory, the MuSCAT2 instrument installed at Teide, and the Otto Struve telescope at McDonald Observatory. The new ground-based observations are combined with new photometric observations by TESS, extending the previous baseline shown in Farihi et al. (2022).

[P5.2] The Challenges and Pitfalls in Deciphering The Chemical Composition of WD1145+017's Disintegrating Planetesimal

Érika Le Bourdais (Université de Montréal), Patrick Dufour, Siyi Xu

Debris disks orbiting white dwarfs are formed from disrupted planetesimals that become trapped in the star's gravitational field and are later accreted. They provide an insightful window into the fate of planetary systems. WD1145+017 stands out as a particularly captivating white dwarf since we can observe the real-time disintegration of a rocky body. I present the newest gas disk model for this system using the radiative transfer code SYNSPEC to reproduce the high-resolution spectroscopic data taken over the last eight years with the HST COS and Keck HIRES instruments. Additionally, I discuss how the disk complicates chemical abundance determination and its interpretation regarding the polluting body composition.

[D5.4] Can tidal evolution lead to close-in planetary bodies around white dwarfs?

Yuqi Li (University of Cambridge), Amy Bonsor, Oliver Shorttle, Laura Rogers and Zach Vanderbosch

Transit-like dips in the light curves of white dwarfs such as WD 1145+017 potentially reveal transiting disintegrating planetesimals and ongoing accretion, raising the question about the formation mechanism of these short period planetesimals undergoing mass loss. We propose that tidal evolution is a feasible route producing short period planetesimals scattered barely outside the Roche limit around the host white dwarf. Our model predicts that (nearly) circularized orbits, associated with small pericentre distance and rapid tidal evolution, dominate the transiting population. Meanwhile, the accompanied tidal heating that may induce melting and volcanism, despite collisions, partial tidal disruption, sublimation, potentially leads to the release gas/dust, occulting the white dwarf and ultimately being accreted.

[P5.3] Unveiling the effects of star-planet tidal interactions in the dynamical evolution of one-planet systems

Raúl Felipe Maldonado Sánchez (Instituto de Radioastronomía y Astrofísica), Jesús A. Toalá, Janis B. Rodríguez-González, Daniel Tamayo

We present the dynamical evolution of one-planet systems orbiting a 1 and a 3 Msun stars under the influence of tidal forces with the objective to understand the role of the stellar tidal Love number k2 in the system dynamics. We perform several numerical simulations using the publicly available N-body packages REBOUND and REBOUNDx to compute the star-planet tidal-interaction testing Earth- and Jupiter-like planets at different initial separations. Following the detail evolution of the star from the main sequence to the white dwarf phase computed with the stellar evolution code MESA, we are able to calculate the evolution of the Love number which is simultaneously evolved with the stellar radius and mass. By comparing with simulations where constant values of k2 are used through the whole stellar evolution, we find that the larger the Love number is, the sooner the planet is pulled toward the star, regardless the star and planet mass. Additional simulations show the strong dependence of the star-planet tidal interaction with the planet mass by finding that the distance to avoid tidal engulfment is larger for massive planets in contrast to their lower mass counterparts and the planet's fate is mainly determined in the red giant phase for a 1 Msun star while the planet survival in a 3 Msun star is primarily decided during the thermally pulsating asymptotic giant phase.

[P5.4] Exploring the gas-dust-planetesimal interplay in white dwarf debris discs

Rafael Martinez-Brunner (The University of Warwick)

Planetary material which approaches a white dwarf breaks up and accumulates into a disc at the outer edge of the WD's Roche sphere. 60+ WD debris discs are known so far. Mounting and increasingly detailed observations of these discs show peculiar features: non-axisymmetric geometrical structure, sudden flux variations, accompanying disintegrating planetesimals, and Gas and dust accretion. However, a theoretical understanding of these features is critically lacking. Significant attempts have been made, but almost none include a key factor: the gas-dust interactions. In that context, this project is the first detailed study of gas-dust interactions in white dwarf planetary debris discs with Smoothed-Particle Hydrodynamics (SPH). For the simulations, we use PHANTOM SPH, an open-access, well-tested, and easily modifiable code. Incorporating the combined evolution of gas and dust in these extreme environments is critical to understanding disc shape and their properties.

[P5.5] Unraveling the Properties of Infrared Excess White Dwarfs: Insights from HETDEX Observations and Spectral Analysis

Rudy Morales (Baylor University), Barbara G. Castanheira

Understanding the physical properties of white dwarfs is crucial for unraveling their evolutionary histories and their roles in stellar populations. In this study, we analyze a dataset composed of 31 HETDEX DA white dwarfs with infrared excess, eight of which have SDSS observed spectra. Our goal is to determine the effective temperature ($T_{\rm eff}$) and surface gravity (log-g) of each spectrum through the fitting of atmospheric models (Koester, 2010) to our observed data. Because of the infrared excess, we only use the absorption lines in the Balmer series to determine $T_{\rm eff}$ and log g. Employing a modified χ^2 method (Zhang, E-H., et al. 1986), we fitted the Balmer line profiles of the models to the observed data to find the best solutions for $T_{\rm eff}$ and log g for each of the 31 HETDEX observed spectra. In order to select the best solution amongst the families of solutions, we have compared our determinations to the SDSS colors. In this poster, we present our results for the WDs with infrared excess observed by HETDEX and our initial attempts to model the additional source.

[D5.5] Orbital dynamics of planetary systems after the Main Sequence

Alexander Mustill (Lund University)

There is growing evidence of planetary material close to white dwarfs, in the form of atmospheric pollution, close-in circumstellar discs, and a handful of photometric detections. These phenomena are at odds with a simple picture of planetary system evolution on the RGB and AGB, where planetary material within a few au is destroyed as the star increases in luminosity and radius, and the material is likely delivered to the WD through orbital evolution following the transition to the WD phase. This orbital evolution can be triggered by stellar mass loss on the AGB, which strengthens interactions between planets and minor bodies relative to the dominant stellar potential. I will briefly review the mechanisms for such dynamical evolution, and how it results in the formation of close-in discs and pollution of the WD. (See, e.g., Li, Mustill & Davies, 2021, 2022; Maldonado et al., 2021.)

- **Spectroscopic Follow-Up of Massive Metal Polluted White Dwarfs Candidates with LDT/DeVeny**

Lou Baya Ould Rouis (Boston University), JJ Hermes

UV spectra collected by the Hubble Space Telescope suggest that far fewer massive white dwarfs (above 0.8 solar masses) exhibit signs of remnant planetary systems compared to canonical-mass white dwarfs. On our path to constrain white dwarf planetary occurrence as a function of mass, we are searching for the most massive metal-polluted white dwarfs. We use the 4.3-meter Lowell Discovery Telescope and its DeVeny spectrograph to follow-up cool, massive white dwarfs that have been classified as metal polluted from low-resolution optical spectra from Gaia.

- **A MIRI Search for Planets and Dust around WD 2149+021**

  Sabrina Poulsen (University of Oklahoma), John Debes, Misty Cracraft, Susan E. Mullally, William T. Reach, Mukremin Kilic, Fergal Mullally, Loic Albert, Katherine Thibault, J. J. Hermes, Thomas Barclay, Elisa V. Quintana

  The launch of JWST has ushered in a new era of high-precision infrared astronomy, allowing us to probe nearby white dwarfs for cold dust, exoplanets, and tidally heated exomoons. While previous searches for these exoplanets have successfully ruled out companions as small as 7–10 Jupiter masses (MJup), no instrument prior to JWST has been sensitive to the likely more common sub-Jovian-mass planets around white dwarfs. In this paper, we present the first multiband photometry (F560W, F770W, F1500W, F2100W) taken of WD 2149+021 with the Mid-Infrared Instrument on JWST. After a careful search for both resolved and unresolved planets, we do not identify any compelling candidates around WD 2149+021. Our analysis indicates that we are sensitive to companions as small as $\sim$0.5 MJup outwards of 1 263 (28.3 au) and $\sim$1.0 MJup at the innermost working angle (0 654, 14.7 au) at 3 Gyr with 5σ confidence, placing significant constraints on any undetected companions around this white dwarf. The results of these observations emphasize the exciting future of sub-Jovian planet detection limits by JWST, which can begin to constrain how often these planets survive their host stars' evolution.

[P5.6] Searching for transiting White Dwarfs with the Large Array Survey Telescope (LAST).

Yarin Shani (Weizmann Institue of Science), Sagi Ben-Ami

We present the Large Array Survey Telescope (LAST) WD survey, a comprehensive campaign to monitor an extensive number of WDs in an attempt to detect transits by minor bodies. With a 350 sq. degrees, LAST can monitor an extensive number of WDs simultaneously. We discuss our survey strategy optimized for short and deep transit signatures, and present on-sky capabilities as determined in a preliminary survey of $650\,\text{deg}^2$. We present our data analysis technique, allowing us to identify candidates for follow-up observations, and discuss future plans and survey timeline.

White dwarfs in Open and Stellar Clusters

- **The cooling of white dwarfs in 47 Tuc**

  Leesa Fleury (University of British Columbia), Jeremy Heyl

  Globular clusters like 47 Tuc are useful environments for studying white dwarf cooling, providing populations of white dwarfs with well controlled parameters like birthrate and distance. I will present the results of a detailed analysis of the cooling of white dwarfs in 47 Tuc, comparing the predictions of cooling models to HST data to determine important parameters like the mass and envelope thickness of these white dwarfs and to test the treatment of element diffusion in stellar evolution code. A thorough understanding of these properties is important for accurately modelling white dwarf cooling and enables the cooling of white dwarfs to be used to indirectly search for evidence of novel particles such as axions, the emission of which from white dwarfs would provide an additional energy loss mechanism and thus affect the cooling rate. I will discuss how the existence of axions with a coupling to electrons would affect white dwarf cooling and will present new constraints on the axion-electron coupling from the cooling of white dwarfs in 47 Tuc.

[D6.1] Assessing the importance of dynamics in the population of detectable cataclysmic variables in globular clusters

Liliana Rivera Sandoval (University of Texas Rio Grande Valley (UTRGV))

Cataclysmic variables (CVs) are binary systems in which a white dwarf accretes matter from a non-degenerate companion. It has been thought that globular clusters (GCs) are efficient factories of CVs due to the large number of stellar interactions in these environments. In this work, I present an analysis of the available data on detectable CVs in Galactic GCs to assess the importance of dynamics in their formation and evolution. Our results challenge established correlations between the number of detectable CVs and different cluster parameters reported in prior studies. I will discuss the implications of these results for our understanding of the role of dynamical interactions for the population of detectable CVs and other compact binaries in GCs.

White dwarf Atmospheres, Chemical Composition, and Magnetic Fields

- **Many white dwarfs have a magnetic field symmetric about the rotation axis**

  Stefano Bagnulo (Armagh Observatory and Planetarium, UK), John D. Landstreet

  We report that among the magnetic white dwarfs that have been repeatedly observed with polarimetric techniques, half of them show little to no variability. This phenomenon may be explained with very long rotational periods, or with a magnetic structure nearly symmetric about the rotation axis. We propose that the correct explanation is the latter, and we show that field alignment occurs mainly after the beginning of the core crystalisation phase. We discuss the implications of our discovery in terms of the origin of the magnetic fields.

[P7.1] Janus has a thin hydrogen layer across its entire surface

Antoine Bédard (University of Warwick), Pier-Emmanuel Tremblay

Recently, Caiazzo et al. (2023, Nature, 620, 61) presented the discovery of Janus, a ”two-faced” white dwarf successively showing a pure hydrogen-line (DA) and pure helium-line (DB) spectrum over its rotation period of 15 minutes. This suggests a drastic variation in composition across the surface, perhaps due to a weak asymmetric magnetic field that affects element diffusion and/or mixing more strongly on one side than the other. However, further interpretation is hampered by the fact that standard atmosphere models fail to reproduce Janus' spectrum at all rotation phases, the observed lines appearing unusually broad and shallow. We demonstrate that this is the unique signature of a vertically chemically stratified atmosphere, where a very thin hydrogen layer floats on top of a helium layer. Considering the hydrogen layer mass M(H) as the only free parameter (while keeping $T_{\rm eff}$ and log g fixed at the photometric values), our stratified atmosphere models provide a much better fit to Janus' spectrum over the full rotation period. We find that M(H) varies monotonically across the surface, from $\sim 10^{-18}$ M* on the DA face (where hydrogen is optically thick) to $\sim 10^{-19)}$ M* on the DB face (where hydrogen is optically thin). We also show that this M(H) asymmetry translates into a UV and optical flux asymmetry that fully accounts for the observed photometric variability (at constant $T_{\rm eff}$). We therefore conclude that Janus has a thin hydrogen layer across its entire surface, and thus that the composition variation is less drastic than previously believed. We highlight the implications of our improved model for the astrophysical interpretation of Janus and for the potential discovery of other similar objects.

[D7.1] Laboratory Measurements of White Dwarf Line Shapes

Bart H. Dunlap (University of Texas at Austin)

Fundamental properties of white dwarf stars derived from spectral fits depend on the input atomic line shapes and are sensitive to how the profiles vary with density and temperature. Therefore, accurate model line profiles are necessary for determining accurate parameters from the fits. More broadly, astronomical flux calibration (in the UVOIR) relies on white dwarf standards whose fiducial model fluxes are determined by line fitting. Accurate input line profiles for white dwarf model spectra are, therefore, important not only for white dwarf science but for astronomy more generally. Using the world's most powerful X-ray source, the Z machine at Sandia National Labs, we are able to achieve the plasma conditions needed to measure spectral lines at white dwarf photospheric conditions. Here, we present our recent results for hydrogen Balmer lines and singly-ionized carbon lines, relevant to hot DQ white dwarfs.

[P7.2] New Ionized Carbon Line Shape Calculations for Use in Hot DQ White Dwarf Synthetic Spectra

Bryce Hobbs (The University of Texas at Austin), T. A. Gomez, M. H. Montgomery, Z. Berbel, J. White, D. E. Winget

Hot DQ class white dwarfs (WDs) are characterized by ionized carbon absorption lines dominating their visible spectra. Theory suggests that hot DQs are the products of double-degenerate mergers that did not ignite to become Type Ia supernovae. WD merger products are expected to have higher masses than average WDs, but their spectral mass determinations are unverified. They can be improved with more accurate atomic line shape calculations. Approximations used to calculate the carbon line shapes included in current hot DQ synthetic spectra break down at high electron densities, such as those deeper within the atmosphere. We present progress on a grid of ionized carbon line shapes for use within hot DQ synthetic spectra using a method better suited for these extreme electron densities. Investigations into the effect these new line shapes have on the synthetic spectra and on spectral mass determinations are underway.

[P7.3] Neutral broadening of spectral lines in cool DB white dwarfs

Detlev Koester (University of Kiel, Germany), S.O. Kepler

Spectroscopic analysis of cool DB white dwarfs often results in increasing surface gravities below $T_{\rm eff}$ = 16000K. We demonstrate that with standard van der Waals + resonance broadening theories with a small "enhancement factor" of 0.1dex to the broadening constant Gamma6 the gravity remains approximately constant over the whole temperature range.

[D7.2] The faction of calcium white dwarfs along the cooling sequence

Carlos López-Sanjuan (Centro de Estudios de Física del Cosmos de Aragón (CEFCA)), C. López-Sanjuan, P. -E. Tremblay, M. W. O'Brien, D. Spinoso, et al.

The presence of metals in the atmosphere of cool white dwarfs is currently understood as the accretion of material from the ancient planetary system (disrupted planets, asteroids, comets) of the degenerate star. The presence of these metals is identified by absorption lines in the white dwarf spectrum. The most prominent absorption in the optical correspond to the CaII H+K line, whose equivalent width (EW) depends on both effective temperature ($T_{\rm eff}$) and atmospheric calcium abundance. This is convolved with the resolution and the signal-to-noise (S/N) of the spectrum, defining a minimum EW for detection which effectively sets an observational limit for calcium in white dwarfs. In addition, the target selection for the spectroscopic observations also impacts the calcium detectability. We used the Javalambre Photometric Local Universe Survey (J-PLUS) second data release (DR2) photometry in twelve optical bands (ugriz + 7 narrow) over 2176 deg^2 to estimate the fraction of white dwarfs with presence of CaII H+K absorption along the cooling sequence. We compared the J-PLUS photometry against theoretical models without polluting metals to estimate the equivalent width in the J0395 passband (EW_J0395), a proxy to detect calcium absorption. A total of 4399 white dwarfs with effective temperature $30000 > T_{\rm eff} > 5500$ K and mass $M > 0.45$ Msun were analyzed. Their EW_J0395 distribution was modeled using two populations, corresponding to polluted and non-polluted systems, to estimate the fraction of calcium white dwarfs ($f_{\rm Ca}$) as a function of $T_{\rm eff}$. The probability for each individual white dwarf of presenting calcium absorption, $p_{\rm Ca}$, was also computed. The comparison of EW_J0395 with both the measured Ca/He abundance and the identification of metal pollution from spectroscopy shows that EW_J0395 correlates with the presence of CaII H+K absorption. The fraction of calcium white dwarfs changes along the cooling sequence, increasing from $f_{\rm Ca} = 0$ at $T_{\rm eff}$ = 13500 K to $f_{\rm Ca} = 0.15$ at $T_{\rm eff}$ = 5500 K. This trend reflects the selection function of calcium white dwarfs in the optical. We compare our results with the fractions from the 40 pc spectroscopic sample and form Sloan Digital Sky Survey (SDSS) spectra. The J-PLUS trend is also present in the 40 pc sample, but SDSS has a deficit of metal-polluted objects at $T_{\rm eff} <$ 12000 K. Finally, we selected 39 white dwarfs with $p_{\rm Ca} > 0.99$. We found 20 with spectra from the literature and followed up six candidates. These 26 objects were confirmed as metal-polluted systems. The J-PLUS optical data provide a reliable statistical measurement for the presence of CaII H+K absorption in white dwarfs. We find a 15 % increase in the fraction of calcium white dwarfs from $T_{\rm eff} = 13500$ K to $T_{\rm eff}$ = 5500 K, providing their selection function in the optical from the total population of metal-polluted systems.

[P7.4] Alien Melting Behaviour: Monte Carlo Simulations of Neon in Strong Magnetic Fields and Under High Pressure

Elke Pahl (University of Auckland (UoA), NZ), Diana Yu (UoA), Gray Hunter (UoA), Stella Stopkowicz (Saarland University)

The melting behaviour of noble gases changes in huge magnetic fields of the order of 10^5 Tesla as can be found on magnetic white dwarfs. Could the influence of these strong field in combination with the high pressure environment lead to condensation of the light noble gases helium and neon? In strong magnetic fields, the chemistry and physics changes drastically - we find elliptically-shaped atoms and otherwise feeble molecular bonds of noble gases are strengthened by the so-called perpendicular paramagnetic bonding mechanism [1]. Increased binding energies will in turn lead to higher melting temperatures - we investigate the consequences of the combined effects from high pressures and strong magnetic field on the solid-liquid phase transition of neon and helium by means of parallel-tempering Monte Carlo simulations [2]. Our simulations are based on a representation of the potential energy surface using a many-body expansion for the energy. The needed dimer potential curves for helium and neon as functions of the strength of the magnetic field and the field's orientation with respect to the molecular axis were computed with MP2 and coupled-cluster approaches [1]. To guarantee ergodic sampling, we develop generalised boundary conditions and methods to monitor the exploration of configurational space. First simulations of neon in strong magnetic fields show strongly enhanced melting temperatures. This is explained not only by the enhanced binding strength but also by the smaller entropic changes due to a more structured liquid phase [3]. When combining with pressures in the order of 100 GPa, melting temperatures for helium and neon might exceed 10,000 Kelvin, temperatures that can be found on the oldest white dwarfs. References: [1] Lange, Kai K., et al. ”A paramagnetic bonding mechanism for diatomics in strong magnetic fields.” Science 337.6092 (2012): 327-331; Stopkowicz, Stella. ”Perspective: Coupled cluster theory for atoms and molecules in strong magnetic fields.” International Journal of Quantum Chemistry 118.1 (2018): e25391. [2] Pahl, Elke, et al. ”Accurate melting temperatures for neon and argon from ab initio Monte Carlo simulations.” Angew. Chem. Int. Ed 47.43 (2008): 8207-8210; Wiebke, Jonas, Elke Pahl, and Peter Schwerdtfeger. ”Melting at high pressure: Can first-principles computational chemistry challenge diamond-anvil cell experiments?” Angew. Chem. Int. Ed. 52.50 (2013); Yu, Diana, and Elke Pahl. ”Melting of atomic materials under high pressures using computer simulations.” Advances in Physics: X 8.1 (2023): 2235060. [3] E. Florez, S. Blaschke, F. Hampe, P. Schwerdtfeger, W. Klopper, T. Helgaker, A. Teale, S. Stopkowicz, E. Pahl. Melting of neon clusters in strong magnetic fields. to be published.

[P7.5] HighSpec - High-R spectrograph optimized for WD studies

Yahel Sofer Rimalt (Weizmann Institute of Science, Israel), Sagi Ben-Ami, Na'ama Hallakoun

We present HighSpec, a high-resolution (R$\sim$20,000) narrow-band spectrograph for the Multi-Aperture-Spectroscopic Telescope (MAST). HighSpec prioritizes sensitivity over bandpass. It offers three narrow-band (10-17nm) observing modes, chosen to enable detailed studies of the double WD population and polluted WDs, centered at the Ca II H&K, Mg b, and Hα lines. Each mode is supported by a highly optimized ion-etched grating, contributing to an end-to-end exceptional peak efficiency of $> 55\,\%$. With rapid switching between the observing modes, HighSpec facilitates detailed, long-term studies of over 6500 WDs. The initial campaign will focus on the 40 pc sample to ensure maximal completeness, with more than 700 observable targets. HighSpec is currently going through assembly and integration, with on-sky commissioning scheduled for the summer of 2025.

[P7.6] Analysis of Improved Stark-Broadened Profiles for Neutral Helium Lines

Patrick Tremblay (Université de Montréal), Alain beauchamp/pierre bergeron

The determination of physical parameters in white dwarfs has traditionally relied on either spectroscopic or photometric methods. Discrepancies observed in parameters obtained for DB white dwarfs from these methods prompted a re-evaluation of line profile broadening theory, specifically Stark broadening, employed in existing He I tables for optical wavelengths. Building upon the prior contributions of our research group, we have developed a new set of helium Stark-broadened line profiles, incorporating ion dynamics and lower-state mixing. Covering 15 spectral lines across densities from 1014 cm-3 to 1017.5 cm-3 and temperatures from 10,000 K to 40,000 K, this grid, along with previous data, will facilitate an in-depth exploration of the various physical components within the theory. This exploration aims to elucidate the relative impact of each aspect of the theory on the physical parameters describing white dwarf stars, particularly surface gravity and effective temperature. Key areas of investigation include wavelength grid resolution, the Hummer-Mihalas level dissolution approximation, and the influence of ion dynamics. Such an analysis is crucial for understanding the origin of the discrepancies between spectroscopic and photometric determinations of white dwarf physical parameters.

[P7.7] HST COS spectroscopy of the hypervelocity SN Ia runaway remnant J0927-6335

Klaus Werner (Universität Tübingen), Kareem El-Badry, Boris T. Gänsicke, Ken J. Shen

We present first results of a spectroscopic analysis of a recently obtained UV spectrum of J0927-6335. The hot WD ($T_{\rm eff}$=60,000 K, logg=7) is the fastest known Galactic hypervelocity star with a space velocity of about 2800 km/s and has a H- and He-deficient atmosphere dominated by carbon and oxygen (El-Badry et al. 2023, Werner et al. 2024). It is thought to be the surviving WD of the "Dynamically Driven Double-Degenerate Double-Detonation" (D6) SN Ia formation model. The UV spectrum shows clear evidence of iron and nickel pollution by the exploded WD companion.

- **Modeling Circumstellar Gas Emission around a White Dwarf Using cloudy**

Siyi Xu (Gemini Observatory/NOIRLab), Sherry Yeh , Laura. K. Rogers, Amy Steele, Erik Dennihy, Alexandra E. Doyle, P. Dufour, Beth L. Klein, Christopher J. Manser, Carl Melis, Tinggui Wang , Alycia J. Weinberger

The chemical composition of an extrasolar planet is fundamental to its formation, evolution, and habitability. In this study, we explore a new way to measure the chemical composition of the building blocks of extrasolar planets by measuring the gas composition of the disrupted planetesimals around white dwarf stars. As a first attempt, we used the photoionization code CLOUDY to model the circumstellar gas emission around white dwarf Gaia J0611-6931 under some simplified assumptions. We found that most of the emission lines are saturated, and the line ratios approach the ratios of thermal emission; therefore, only lower limits to the number density can be derived. Silicon is the best-constrained element in the circumstellar gas, and we derived a lower limit of $10^{10.3}$ cm^{-3}. In addition, we placed a lower limit on the total amount of gas to be 1.8×10^{19} g. Further study is needed to better constrain the parameters of the gas disk and connect it to other white dwarfs with circumstellar gas absorption.

White dwarf Progenitors; Central Stars of Planetary Nebulae, Hot-subdwarfs

[D8.1] Can interactions of white dwarfs explain single hot subdwarfs?

Stephan Geier (Institute for Physics and Astronomy, University of Potsdam, Germany), Matti Dorsch, Uli Heber, et al.

The observed properties of core helium-burning hot subdwarfs (sdO/Bs) are best explained by the stripping of a red giant through binary interactions. About two thirds of the sdO/Bs are in binary systems with properties consistent with such a scenario. One third, however, do not show any signs of binarity. Alternative binary formation scenarios have been proposed for those single sdO/Bs, which involve interactions of white dwarfs (WD). Here we confront two of those scenarios with most recent observational data: Mergers involving He-WDs and the disassociation of close sdO/B+WD binaries via thermonuclear supernovae.

[P8.1] The first detached, double eclipsing, double lined, and double degenerate system inside a Planetary Nebula

Nicole Reindl (Landessternwarte, Universität Heidelberg), David Jones, Todd Hillwig, Matti Dorsch, Nick Chornay, Max Pritzkuleit

Double degenerate (DD) systems with orbital periods of less than half a day will likely merge within a Hubble time, potentially leading to the formation of type Ia supernovae, highly magnetic white dwarfs, or stars with various exotic compositions. Freshly born DDs that are still surrounded by their ejected common envelope -visible as planetary nebulae (PNe)- provide one of the best means of exploring the formation of these systems. Yet, due to the absence of eclipses and the single-lined nature of most DD central stars, their system parameters can only be poorly constrained. Here we report on the discovery of the first detached, double eclipsing, and double-lined DD inside a PN that has an orbital period of less than 10h. We acquired extensive photometry and phased-resolved X-Shooter spectra of this unique system and present preliminary results of our radial-velocity measurements, non-LTE spectral modeling, as well as on multi-band light-curve fitting.

[P8.2] Binary pathways to PG1159 stars

Klaus Werner (Universität Tübingen), Antoine Bedard, Kareem El-Badry, Stephan Geier, Max Pritzkuleit, Thomas Rauch, Nicole Reindl

PG1159 stars are hydrogen-deficient (pre-)white dwarfs that are thought to be the outcome of a final helium-shell flash during single star evolution. However, we have recently identified two channels of binary-WD evolution that also result in PG1159 stars. The first channel is a binary-WD merger where a CO WD is disrupted and accreted by a He WD. The second channel is a runaway WD as a remnant of a SN Ia explosion. The surviving WD in this so-called “Dynamically Driven Double-Degenerate Double-Detonation” scenario should have a carbon-oxygen dominated atmosphere. We present spectroscopic results about these new binary channels.

Asteroseismology and Pulsating white dwarfs

[V9.1] PULSEY: Python Package for Modeling Stellar Pulsation

Andrew Ayala (CUNY Graduate Center/AMNH), Keaton Bell

PULSEY is a python program built on top of an existing package titled STARRY; a python tool which constructs 3-D spherical surface maps via an amalgamation of individual spherical harmonic modes. The summation of these individual modes produces a static 3-D map that can be inclined, rotated, and inserted into a binary system. Now with PULSEY, one can create periodic pulsation or time evolution of these 3-D surface maps by sinusoidally varying the amplitude of orthogonal spherical harmonic modes. With this new functionality, we can model observed stellar pulsation or photometric variability by periodically modulating spherical harmonic coefficients. Alongside this, the binary system functionality of the package allows for eclipse mapping of pulsation modes to break symmetries and degeneracies witnessed in observational data. There is also the potential to model asymmetric phenomena such as tidally tilted pulsations. As well, importing other packages such as GYRE and MSG can allow for the spectral modeling and analysis of resultant pulsation modes. Ultimately, PULSEY enables us to model eclipses of pulsating stars to identify the L and M values of the spherical harmonic patterns associated with individual pulsation modes observed in data.

[D9.5] Comparative analysis of mass determination methods for pulsating white dwarfs

Alejandro Hugo Córsico (University of La Plata), Leila M. Calcaferro, Murat Uzundag, Leandro G. Althaus, S. O. Kepler, Klaus Werner

Stellar mass determination poses a central challenge in stellar astrophysics. This study delves into the mass assessment of isolated pulsating white dwarf (WD) stars through spectroscopy, asteroseismology, and astrometry. Focusing on DAVs (pulsating H-rich atmosphere WDs), DBVs (pulsating He-rich atmosphere WDs), and GW Vir variables (pulsating hot C-, O-, and He-rich atmosphere WDs and pre-WDs), we rigorously compare the mass values derived from these diverse methods. Employing consistent WD models and evolutionary tracks, our analysis reveals broad agreement among methods for DAV stars, particularly for those with masses below 0.75 solar masses. However, significant discrepancies emerge for certain massive stars. Additionally, astrometric masses tend to surpass seismological and spectroscopic masses for DBV stars, while outliers are evident among GW Vir stars, indicating methodological disparities in mass determinations.

[D9.1] Using Asteroseismology to Investigate the Structure of Pulsating White Dwarf GD 358

Kaylee E. Grace (University of Delaware/Mount Cuba Astronomical Observatory), Judith L. Provencal

White dwarfs are the end stage of life for almost all stars in the universe. Most white dwarfs will pulsate at some point as they move along the white dwarf cooling track. These pulsations can be investigated using asteroseismology, an analysis method that allows us to use the g-mode oscillations in a white dwarf to probe its internal structure. The pulsating, helium atmosphere white dwarf GD 358 has been photometrically observed for over 40 years. After an analysis of Transiting Exoplanet Survey Satellite (TESS) data from 2020 - 2022, we notice that in higher order radial overtone (k) frequencies the $m = -1$ and $m = 1$ frequency multiplets are shifting towards and away from the central $m = 0$ frequency, sometimes changing within as short of a span as one month. For lower-order radial overtone frequencies, the $m = -1$ and $m = 1$ frequency multiplets are stable around the central $m = 0$ frequency. Five nights of ground-based observations were conducted in 2023 to investigate if these patterns continue and further explore the relationship between rotations and pulsations. We are currently investigating the relationship between parent and combination pulsation frequencies, where a combination frequency divided by the product of its parent frequencies should always come out to a constant for a white dwarf whose flux nonlinearities are second order. Looking forward, we expect both consecutive TESS sectors and a 5-night ground-based observing campaign in 2024.

[D9.2] Kepler and TESS weigh in on the purity of the DAV instability strip

JJ Hermes (Boston University)

Current theory holds that all hydrogen-dominated (DA) white dwarfs pulsate when they reach the appropriate effective temperature to develop a surface convection zone, starting at roughly 13,000 K. However, even relatively small-scale (tens of kilogauss) magnetic fields can suppress convection effectively enough to prevent the excitation of global pulsations. Kepler and TESS have now surveyed thousands of white dwarfs with enough precision to detect millimagnitude (part-per-thousand) pulsations. I will report on the status of the purity of the DAV instability strip thanks to Kepler, K2, and TESS monitoring.

[D9.3] The Blue Edge of the DB Instability Strip

Judith Provencal (University of Delaware and Mt. Cuba Astronomical Observatory), M. H. Montgomery, J. J. Hermes, A. Nitta, S.J. Kleinman, K. Grace, S. Savory, Z. Vanderbosch

The observed location of the helium atmosphere (DB) white dwarf instability strip in the temperature/log g plane is an indicator of the efficiency of helium convection in white dwarf atmospheres. The hot DB white dwarf PG0112+105, with a temperature of 30,000 K, was considered to mark the location of the blue edge of the DB instability strip. In 2017, the Kepler K2 mission provided confirmation that PG0112+105 was indeed a pulsating white dwarf and belonged inside the instability strip (Hermes et al. 2017). The empirical blue edge of the DB instability strip is now unknown. We received HST Cycle 30 time to obtain UV spectra of 6 hot DB white dwarfs with the goals of providing a definitive location of the empirical blue edge of the DB instability strip, and exploring the nature of the hot DBs inhabiting the "DB gap". We present here a first look at the spectra we currently have in hand. The final results of this study will 1) calibrate mixing length theory used in all stellar models, 2) validate 3D hydrodynamic simulations, 3) constrain contributions of different driving mechanisms initiating pulsations, and 4) improve our understanding of mixing and diffusion of various elements by white dwarf convection zones and during white dwarf cooling.

[D9.4] Asteroseismology of the Pulsating Extremely Low-mass White Dwarf SDSS J111215.82+111745.0

Jie Su (Yunnan Observatories, Chinese Academy of Sciences)

We analyzed the full set of seven periods observed on the pulsating extremely low-mass white dwarf SDSS J111215.82+111745.0. Subsequently, we performed asteroseismic modeling for this star, in which the H chemical profile was considered as a variable. The stellar parameters of M=0.1650±0.0137 solar masses and $T_{\rm eff} = 9750 \pm 560$ K were determined from the best-fit model, and the H/He chemical profiles were also delineated. Two short-period pulsations, 107.56 seconds and 134.275 seconds, were detected on this star, which are suspected to be p-mode pulsations. Both of the suspected p-modes are well represented in our best-fit model.

[P9.2] Asteroseismology of pulsating ultramassive white dwarfs

Murat Uzundag (KU Leuven), Francisco C. De Geronimo, Alberto Rebassa-Mansergas, Alex Brown, Alejandro Corsico

Ultra-massive white dwarfs (UMWDs) are expected to harbor oxygen-neon (ONe) or carbon-oxygen (CO) cores, depending on the previous history of their progenitors. These stars serve as excellent targets for studying various phenomena, including type Ia supernovae explosions, merger events, and the existence of high magnetic fields. In addition, they provide an excellent opportunity to test the crystallization theory. Asteroseismic studies on these objects would allow us to shed light on their inner chemical structure and then, on the history of their progenitors. In this project, we conduct a photometric survey using OSIRIS and HiPERCAM, both attached to the Gran Telescopio Canarias (GTC). The primary objective is twofold: to significantly expand the known population of pulsating UMWDs and to perform a comprehensive asteroseismological analysis of each detected pulsating UMWD, employing updated theoretical evolutionary/pulsational models. We expect to be able to obtain their seismological masses, effective temperatures, surface gravities, and the most important features of chemical structure of UMWDs. Our preliminary results reveal the existence of variability of two pulsating UMWDs within a sample of 13 stars. As our ongoing effort continues, we anticipate further discoveries. The high-quality data obtained from the GTC, complemented by observations from space missions such as TESS and PLATO, offers invaluable insights for advancing asteroseismological studies of UMWDs.

Automated Classification and Statistical Techniques in white-dwarf Research

[P10.1] Identifying new high-confidence polluted white dwarf candidates using Gaia XP spectra and Self-Organizing Maps

Xabier Pérez-Couto (Universidade da Coruña), Lara Pallas-Quintela, Minia Manteiga, Eva Villaver, and Carlos Dafonte

The detection of white dwarfs polluted with heavy elements is nowadays an effervescent field since they are a valuable tool for inferring physical properties of the planetary systems in their orbital neighbourhood. The Gaia space mission has provided us with an unprecedented amount of astrometric, photometric, and low resolution (XP) spectroscopic data for millions of newly discovered stellar sources. In order to use this data to find white dwarfs and to identify which ones have metals in their atmospheres, we propose here a methodology based on an unsupervised artificial intelligence technique called Self-Organizing Maps, to discover hidden treasures in the Gaia white dwarf sample. By applying this method to sources with available Gaia XP spectra, we obtained a clean sample of 66 337 white dwarfs. From them, we performed a spectral classification analysis obtaining similar metrics in precision and recall that those achieved with recent supervised machine learning techniques. As a result, we report the discovery of 399 high-confidence polluted white dwarfs not previously classified in the literature, by identifying in their low resolution spectra several metallic lines such as calcium, magnesium, sodium, litium, and potasium. We found that the majority of them are cool white dwarfs and, therefore, those metals had to be accreted mainly from planetary systems.

List of Participants

Aakash Bhat	aakashbhat7@gmail.com	University of Potsdam
Aayush Desai	adesai@ist.ac.at	ISTA
Abbigail Elms	abbigail.elms@warwick.ac.uk	University of Warwick
Abinaya Swaruba Rajamuthukumar	abinaya@mpa-garching.mpg.de	Max Planck Institute for Astrophysics
Adam Moss	adam.g.moss-1@ou.edu	University of Oklahoma
Aina Ferrer i Burjachs	aina.ferrer.burjachs@upc.edu	Universitat Politècnica de Catalunya
Ainhoa Zubiaur Arsuaga	ainhoa.zubars@gmail.com	Universitat Politècnica de Catalunya
Alberto Rebassa-Mansergas	alberto.rebassa@upc.edu	Universitat Politècnica de Catalunya
Alejandro Hugo Córsico	alejandrocorsico@gmail.com	University of La Plata
Alejandro Santos García	alejandro.santos.garcia@upc.edu	Universitat Politècnica de Catalunya
Alessandro Ederoclite	aederocl.astro@gmail.com	CEFCA
Alexander Mustill	alexander.mustill@fysik.lu.se	Lund University
Andrei-Alexandru Cristea	Andrei-Alexandru.Cristea@ist.ac.at	Institute of Science and Technology Austria
Alex Brown	alexjbrown.astro@gmail.com	Universitat Politècnica de Catalunya
Andrew Vanderburg	andrewv@mit.edu	MIT
Andrew Swan	andrew.swan@warwick.ac.uk	University of Warwick
Andrew Ayala	aayala@gradcenter.cuny.edu	CUNY Graduate Center/AMNH
Andrey Tavleev	tavleev@astro.uni-tuebingen.de	Institut für Astronomie und Astrophysik Tübingen
Andy Buchan	andy.buchan@warwick.ac.uk	University of Warwick
Anna-Maria Cutolo	anna-maria.cutolo@warwick.ac.uk	University of Warwick
Anna Francesca Pala	annafpala@gmail.com	European Space Agency
Antoine Bédard	antoine.bedard@warwick.ac.uk	University of Warwick
Antonio Marzoa	antonio.marzoa@upc.edu	Universitat Politècnica de Catalunya
Ashley Ruiter	ashley.ruiter@unsw.edu.au	University of New South Wales Canberra
Axel Sanz	axel.sanz@upc.edu	Universitat Politècnica de Catalunya
Ayaka Okuya	okuya226@gmail.com	National Astronomical Observatory of Japan
Barbara Castanheira	barbara_endl@baylor.edu	Baylor University
Bart Dunlap	bhdunlap@utexas.edu	University of Texas at Austin
Benjamin Kaiser	ben.kaiser@unc.edu	University of North Carolina at Chapel Hill
Bill Wolf	wolfwm@uwec.edu	University of Wisconsin – Eau Claire
Boris Gaensicke	boris.gaensicke@gmail.com	University of Warwick
Bryce Hobbs	brycehobbs@utexas.edu	The University of Texas at Austin
Camila Aros Bunster	arosbunster.cami@gmail.com	Universidad Técnica Federico Santa María
Carlos López San Juan	clsj@cefca.es	CEFCA
Christopher Manser	c.j.manser92@googlemail.com	Imperial College London
Chris Clemens	clemens@physics.unc.edu	University of North Carolina at Chapel Hill
Claudia Aguilera-Gómez	craguile@uc.cl	Pontificia Universidad Católica de Chile
Dan Maoz	danmaoz1@gmail.com	Tel Aviv University
Daniela Muñoz Giraldo	munoz-giraldo@astro.uni-tuebingen.de	Universität Tübingen
Daniel C. Mayes	dmayes@utexas.edu	University of Texas at Austin
Daniel Blatman	daniel.blatman1@mail.huji.ac.il	The Hebrew University
Dang Pham	dang.pham@mail.utoronto.ca	University of Toronto

David Miller	drmiller@phas.ubc.ca	University of British Columbia
David Wilson	david.wilson@lasp.colorado.edu	LASP
Detlev Koester	koester@astrophysik.uni-kiel.de	University of Kiel
Dewy Peters	dewypeters@gmail.com	University of Groningen
Douglas Tucker	dtucker@fnal.gov	Fermilab
Edward M. Sion	edward.sion@Villanova.edu	Villanova University
Elif Şafak	elsafak07@gmail.com	Universitat Politècnica de Catalunya
Elizabeth Jeffery	ejjeffer@calpoly.edu	California Polytechnic State University
Elke Pahl	Elke.Pahl@auckland.ac.nz	University of Auckland (UoA)
Emily Roberts	Emily.Roberts.1@warwick.ac.uk	University of Warwick
Emma Chickles	echickle@mit.edu	MIT
Enrique Miguel García Zamora	enriquegarciazamora@gmail.com	Universitat Politècnica de Catalunya
Érika Le Bourdais	erika.le.bourdais@umontreal.ca	Université de Montréal
Evan Bauer	evan.bauer.astro@gmail.com	Center for Astrophysics, Harvard & Smithsonian
Felipe Lagos-Vilches	felipe.lagos.vilches@gmail.com	University of Warwick
Fionntan Callan	f.callan@qub.ac.uk	University Belfast
Francisco De Geronimo	degeronimofrancisco@gmail.com	Instituto de Astrofisica de La Plata, CONICET-FCAGLP
Fran Jiménez-Esteban	fran.jimenez-esteban@cab.inta-csic.es	INTA-CSIC
Gagik Tovmasian	gag@astro.unam.mx	UNAM
Gerard Vauclair	gerard.vauclair@irap.omp.eu	Institut de Recherche en Astrophysique et Planétologie
Gloria Sala	gloria.sala@upc.edu	Universitat Politècnica de Catalunya
Gracjan Sienkiewicz	u2105041@live.warwick.ac.uk	University of Warwick
Gracyn Jewett	gjewett@ou.edu	University of Oklahoma
Harry Dawson	hdawson@uni-potsdam.de	University of Potsdam
Henry Sanford-Crane	henrysc@udel.edu	University of Delaware
Hiba tu Noor	zcaphtn@ucl.ac.uk	UCL
Ilaria Caiazzo	ilaria.caiazzo@ist.ac.at	Institute of Science and Technology
Ingrid Pelisoli	ingrid.pelisoli@warwick.ac.uk	University of Warwick
J. Allyn Smith	smithj@apsu.edu	Austin Peay State University
JJ Hermes	jjhermes@bu.edu	Boston University
Jay Farihi	j.farihi@ucl.ac.uk	University College London
James Garbutt	jagarbutt1@sheffield.ac.uk	Univeristy of Sheffield
James Munday	james.munday@warwick.ac.uk	University of Warwick
Jamie Williams	jamie.t.williams@warwick.ac.uk	University of Warwick
Jan van Roestel	j.c.j.vanroestel@uva.nl	University of Amsterdam
Jarrett Rosenberg	rosenberg25@wisc.edu	University of Wisconsin-Madison
Javier Gómez Martínez	gomezjavier168@gmail.com	Universidad Complutense de Madrid/ESA
Jie Su	sujie@ynao.ac.cn	Yunnan Observatories
Jeremy Heyl	heyl@phas.ubc.ca	University of British Columbia
Jordi Isern	isern@ieec.cat	ICE-CSIC/IEEC/RACAB
Joseph Guidry	jaguidry@bu.edu	Boston University
Joris Vos	joris.vos@uv.cl	Astronomical Institute of the Czech Academy of Sciences
Joshua Pollin	jpollin02@qub.ac.uk	Queen's University Belfast
Judith Korth	judith.korth@fysik.lu.se	Lund University
Judith Provencal	jlp@udel.edu	University of Delaware
Jurek Krzesinski	jerzy.krzesinski@uj.edu.pl	Astronomical Observatory, Jagiellonian University
Kareem El-Badry	kelbadry@caltech.edu	California Institute of Technology
Karolina Jarosik	k.jarosik@doctoral.uj.edu.pl	Astronomical Observatory of the Jagiellonian University
Kaylee Grace	kgrace@udel.edu	University of Delaware
Ken Shen	kenshen@astro.berkeley.edu	UC Berkeley
Klaus Werner	werner@astro.uni-tuebingen.de	Universität Tübingen
Kurtis Williams	Kurtis.Williams@tamuc.edu	Texas A&M University-Commerce
Laura Rogers	lr439@cam.ac.uk	University of Cambridge
Leandro Althaus	leandroalthaus@gmail.com	Universidad Nacional de La Plata-CONICET

Leesa Fleury	lfleury@phas.ubc.ca	University of British Columbia
Leila Calcaferro	leilacalcaferro@gmail.com	Instituto de Astrofísica de La Plata
Lientur Celedon	lientur.celedon@postgrado.uv.cl	Universidad de Valparaíso
Liliana Rivera Sandoval	liliana.riverasandoval@utrgv.edu	UTRGV
Lisa Blomberg	lblomber@caltech.edu	California Institute of Technology
Lou Baya Ould Rouis	lbor@bu.edu	Boston University
Mairi O'Brien	mairi.o-brien@warwick.ac.uk	University of Warwick
Maja Vuckovic	maja.vuckovic@uv.cl	Universidad de Valaraiso
Malia Kao	mlkao@utexas.edu	University of Texas at Austin
Manuel Barrientos	mbarrientos@ou.edu	University of Oklahoma
Margarita Hernanz	hernanz@ice.csic.es	ICE-CSIC
Maria Camisassa	maria.camisassa@upc.edu	Universitat Politècnica de Catalunya
Mariel Lares Martiz	laresm@erau.edu	Embry-Riddle Aeronautical University
Mariona Badenas-Agusti	mbadenas@mit.edu	Massachusetts Institute of Technology
Mario Cadelano	mario.cadelano@unibo.it	University of Bologna
Mark Hollands	mark.hollands@warwick.ac.uk	University of Warwick
Marta Gili Esteva	marta.gili@estudiantat.upc.edu	Universitat Politècnica de Catalunya
Martin Barstow	mab@leicester.ac.uk	University of Leicester
Matias Castro-Tapia	matias.castrotapia@mail.mcgill.ca	McGill University
Matthew Green	mjgreenastro@gmail.com	Max Planck Institute for Astronomy
Matthias R. Schreiber	matthias.schreiber@usm.cl	Universidad Tecnica Federico Santa Maria
Matti Dorsch	dorsch@uni-potsdam.de	University of Potsdam
Max Pritzkuleit	maxpri@astro.physik.uni-potsdam.de	University of Potsdam
Mercedes Stephania Hernandez	mercedes.hernandez@usm.cl	Universidad técnica Federico Santa María
Michael Montgomery	mikemon@astro.as.utexas.edu	University of Texas
Momin Khan	momin_khan1@baylor.edu	Baylor University
Mukremin Kilic	mukreminkilic@gmail.com	University of Oklahoma
Murat Uzundag	muratuzundag.astro@gmail.com	KU Leuven
Na'ama Hallakoun	naama.hallakoun@weizmann.ac.il	Weizmann Institute of Science
Natsuko Yamaguchi	nyamaguc@caltech.edu	California Institute of Technology
Nicola Gentile Fusillo	nicola.gentilefusillo@gmail.com	Università degli Studi di Trieste
Nicole Reindl	nreindl885@gmail.com	Universität Heidelberg
Nina Mackensen	Nina Mackensen	Zentrum für Astronomie Heidelberg
Odette Toloza	odette.toloza@usm.cl	Universidad Técnica Federico Santa María
Olivier Vincent	o.vincent@umontreal.ca	Université de Montréal
Param Rekhi	param.rekhi@weizmann.ac.il	Weizmann Institute of Science
Patrick Dufour	patrick.dufour@umontreal.ca	Université de Montréal
Patrick Tremblay	patrick.tremblay.12@umontreal.ca	Université de Montréal
Paul Ripoche	pripoche@alum.ubc.ca	University of British Columbia
Paula Izquierdo	Paula.Izquierdo-Sanchez@warwick.ac.uk	University of Warwick
Peter Nemeth	peter.nemeth@astroserver.org	Astroserver
Pier-Emmanuel Tremblay	pier.emmanuel.tremblay@gmail.com	University of Warwick
Pierre Bergeron	bergeron@astro.umontreal.ca	Université de Montréal
Rafael Martinez-Brunner	rafael.martinez@warwick.ac.uk	University of Warwick
Raquel Murillo Ojeda	rmurillo@cab.inta-csic.es	CSIC-INTA
Raúl Felipe Maldonado Sánchez	r.maldonado@irya.unam.mx	Instituto de Radioastronomía y Astrofísica
Robert Akshay	akshay.robert.22@ucl.ac.uk	University College London
Roberto Raddi	roberto.raddi@upc.edu	Universitat Politecnica de Catalunya
Rudy Morales	rudy_morales1@baylor.edu	Baylor University
Sabrina Poulsen	sabrina.r.poulsen-1@ou.edu	University of Oklahoma
Sagi Ben Ami	sagi.ben-ami@weizmann.ac.il	Weizmann Institute of Science
Sandino Estrada-Dorado	s.estrada@irya.unam.mx	Universidad Nacional Autónoma de México
Santiago Hernández Díaz	santiago.hernandez@student.uni-tuebingen.de	Eberhard Karls Universität Tübingen
Santiago Torres Gil	santiago.torres@upc.edu	Universitat Politècnica de Catalunya

Santiago Torres	santiago.torres@ist.ac.at	Institute of Science and Technology Austria
Sarah Casewell	slc25@le.ac.uk	University of Leicester
Semih Filiz	filiz@astro.uni-tuebingen.de	University of Tübingen
Sepideh Abdollahihashjin	sepideh.abdollahihashjin@ist.ac.at	Institute of Science and Technology Austria
Sergio Humberto Ramirez Ramirez	Sergio.Ramirez-Ramirez@warwick.ac.uk	University of Warwick
Simon Blouin	sblouin@uvic.ca	University of Victoria
Siyi Xu	siyi.xu@noirlab.edu	Gemini Observatory/NOIRLab
Snehalata Sahu	snehalatash30@gmail.com	University of Warwick
Souza Oliveira Kepler	kepler.oliveira@gmail.com	Universidade Federal do Rio Grande do Sul
Staszek Zola	staszekzola@gmail.com	Jagiellonian University
Stefano Bagnulo	stefano.bagnulo@armagh.ac.uk	Armagh Observatory and Planetarium
Stefan Jordan	jordan@ari.uni-heidelberg.de	University Heidelberg
Steffani Grondin	steffani.grondin@astro.utoronto.ca	University of Toronto
Stephan Geier	sgeier@astro.physik.uni-potsdam.de	University of Potsdam
Steven Savery	savery@udel.edu	University of Delaware
Steven Parsons	s.g.parsons@sheffield.ac.uk	University of Sheffield
Steven Kawaler	sdk@iastate.edu	Iowa State University
Stéphane Charpinet	stephane.charpinet@univ-tlse3.fr	IRAP, CNRS
Sunny Wong	tinlongsunny@ucsb.edu	University of California, Santa Barbara
Susanne Friedrich	sfriedr@mpe.mpg.de	Max-Planck-Institute for extraterrestrial Physics
Sylvie Vauclair	sylvie.vauclair@irap.omp.eu	Institut de Recherche en Astrophysique et Planétologie
Takatoshi Ko	ko-takatoshi@g.ecc.u-tokyo.ac.jp	The University of Tokyo
Tim Cunningham	tim.cunningham@cfa.harvard.edu	Harvard University
Xabíer Pérez-Couto	xabier.perez.couto@udc.es	Universidade da Coruña
Yahel Sofer Rimalt	yahel.sofer-rimalt@weizmann.ac.il	Weizmann Institute of Science
Yarin Shani	yarin-meir.shani@weizmann.ac.il	Weizmann Institue of Science
Yoav Ziv	yoavziv811@gmail.com	Tel Aviv University
Zach Vanderbosch	zvanderb@caltech.edu	CALTECH
Zhenwei Li	lizw@ynao.ac.cn	Yunnan Observatories, CAS

Local Information

Airports

The closest airport is Barcelona International Airport Josep Tarradellas located at El Prat de Llobregat (13 km from city center). The metro line L9S connects Barcelona Airport to the conference venue in a 45 min journey. Taxis cost 20-40 euros and take about 20 minutes. Night buses N17 and N18 connect the airport to the city center after midnight and are also included in the Integrated Fare System. Alternatively, Girona and Reus Airports are located 100 and 120 km away, respectively.

Transports

Barcelona is served by an integrated Fare System of trains, metro, buses, funiculars and trams. Tickets can be bought at automatic machines in metro and train stations. Tickets and fares:

- T-usual (RECOMMENDED): €21.35 Individual travel card allowing unlimited rides in trains, metro, buses, trams and funiculars within zone 1 during 1 month from first validation (all conference activities and main touristic attractions are within zone 1) INCLUDES AIRPORT METRO. You will be asked to write your passport or ID number when purchasing.
- T-casual: €12.15 Individual travel card allowing 10 journeys to be made in trains, metro, buses, trams and funiculars within zone 1. Once validated, each ticket can be used for 75 minutes. DOES NOT INCLUDE AIRPORT METRO
- Single ticket: €2.55 Ticket for a single ride within zone 1
- Airport ticket: €5.50 Single metro journey between the airport and the rest of the metro network.

The fast buses Aeorbús A1 and A2 are NOT integrated to the Fare System and their tickets must be purchased separately (they cost €7.25 euros for a single ride and €12.50 euros for a return ticket)

More information can be found at https://www.tmb.cat/en/barcelona-fares-metro-bus.

Exploring the city

With a population of 1.6 million within city limits, Barcelona is a vibrant metropolis nestled on the north-eastern coast of Spain. This city effortlessly combines rich history with a modern, cosmopolitan flair. Known for its stunning architecture, Barcelona boasts iconic landmarks such as Antoni Gaudí's masterpiece, the Sagrada Familia, and the whimsical Park Güell. The city's historic Gothic Quarter is a labyrinth of narrow streets, while the bustling Las Ramblas boulevard offers a taste of the city's bustling street life. With its Mediterranean coastline, Barcelona also offers beautiful beaches and a lively waterfront scene. Visitors can indulge in mouthwatering Catalan cuisine at bustling tapas bars, explore world-class museums and revel in the city's vibrant nightlife.

Weather

The weather in July can be very hot and humid, with little amplitude variation during the day. Temperatures can reach 35 degrees Celsius. Sporadic rain is not usual but cannot be discarded.

Conference Venue

The conference will be held in the Vèrtex Building at Universitat Politècnica de Catalunya (UPC-BarcelonaTech), Plaça d'Eusebi Güell, 6, 08034 Barcelona

Lunch

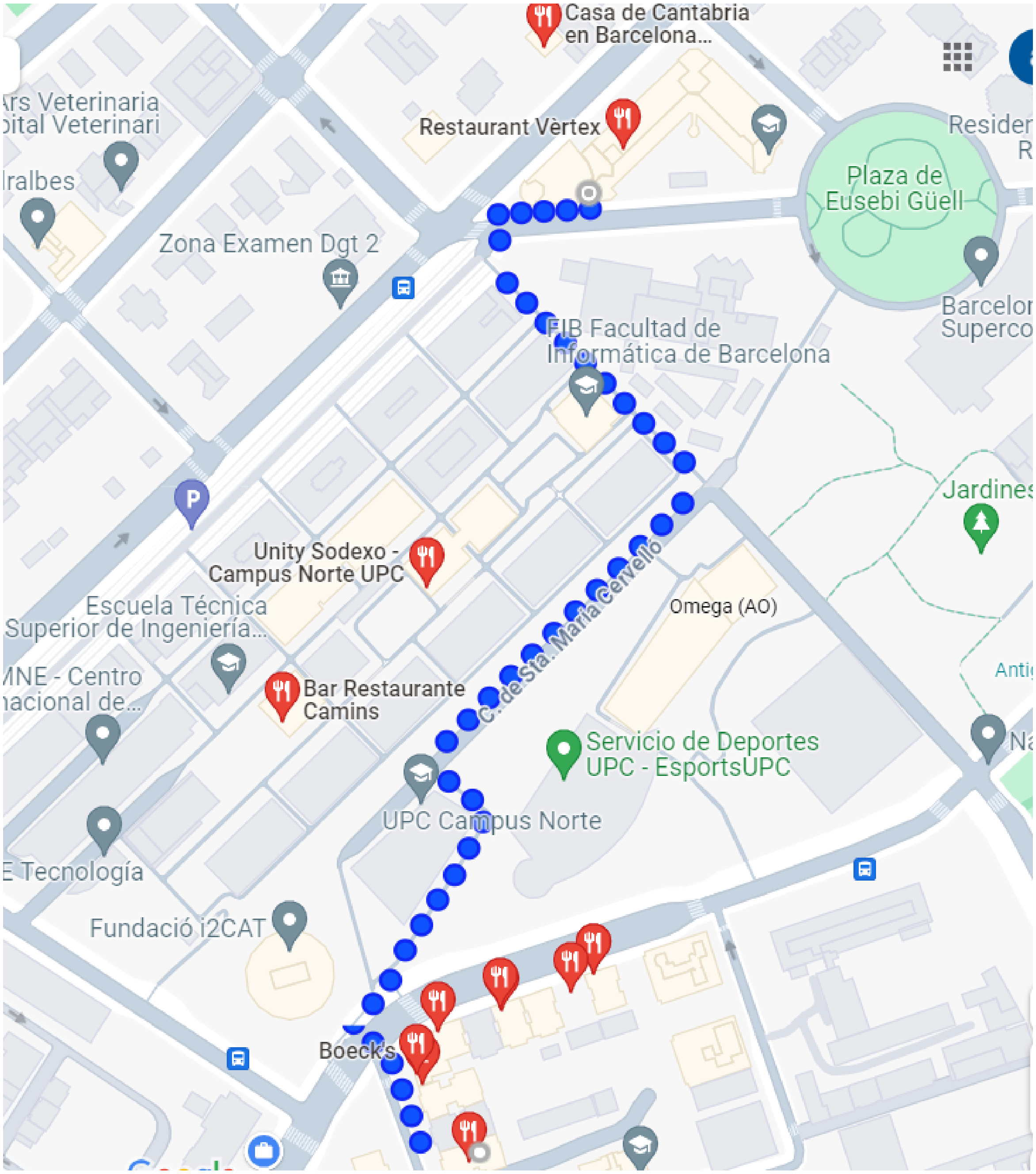
Lunch is not included in the registration fee. However, there are several restaurants located in the Campus Nord area.

Recommended restaurants

- Falafel Pedralbes (vegan street food). Address: Carrer de Jordi Girona, 12, Local 1, 08034 Barcelona. Phone number: 934 90 05 79 Menu: http://www.falafelvegano.com/
- Bite the Health (By Healthy Poke) (vegan street food). Address: Carrer de Jordi Girona, 10, 08034 Barcelona. Phone Number: 919 01 10 93
- Restaurante Tritón (Mediterranean food). Address: Carrer de l'Alfambra, 12, 08034 Barcelona. Phone number: 932 03 30 85 Menu: http://restaurantriton.com/
- Restaurant Vèrtex (Mediterranean food). Barcelona Knowledge Campus. Address: Carrer Sor Eulàlia d'Anzizu, 24, 08034 Barcelona
- Bar Restaurant Camins (Mediterranean food) UPC Campus Nord. Address: Carrer de Jordi Girona, 3, 08034 Barcelona. Phone Number: 608 06 62 82
- Casa de Cantabria en Barcelona (Mediterranean food). Address: C/ de Sor Eulàlia d'Anzizu, 45, Les Corts, 08034 Barcelona. Phone Number: 932 03 95 56
- Più Pasta (Italian food). Address: Carrer de Jordi Girona, 12, 08034 Barcelona. Phone Number: 626 45 67 30
- AltaglioBcn (Italian food). Address: Carrer de Jordi Girona, 6, 08034 Barcelona. Phone Number: 933 15 62 51 Menu: http://www.altagliobcn.com/
- Frankfurt's Pedralbes (Street food, sausages, burgers). Address: Carrer de Jordi Girona, 2-4, 08034 Barcelona. Phone Number: 932 05 27 17
- Frankfurts Leo Boeck BCN (Street food, sausages, burgers). Address: Carrer de l'Alfambra, 20, 08034 Barcelona. Phone Number: 933 60 70 21 Menu: http://www.leoboeck.com/bcn

Other recommended restaurants

- Santagloria Coffee & Bakery (Street food). Address: Passeig de Manuel Girona, 2, 08034 Barcelona.
- PHILOSOFIA Book Café (Street food). Address: Plaça de Pius XII, 4, 08028 Barcelona. Phone number: 935 08 10 30
- City Expresso Bar Bcn S L (Street food). Address: Av. de Pedralbes, 12, 08034 Barcelona. Phone number: 936 24 22 20
- SandwiChez Cap. Arenas (Street food). Address: Carrer del Capità Arenas, 3, 08034 Barcelona. Phone number: 932 05 73 23
- Crep Nova Pedralbes (Italian food). Address: Carrer del Dr. August Pi i Sunyer, 12, 08034 Barcelona. Phone number: 937 64 88 36



Location of the nearest restaurants.

- Restaurante La Tagliatella (Italian food). Address: Carrer del Dr. Ferran, 25-27, 08034 Barcelona.
- Barcelona Bugui Sl (Mediterranean food). Address: Avinguda Diagonal, 633 P, BA, 08028 Barcelona. Phone number: 933 30 51 17
- D'Street Poke & Bowls – DSTREET (Vegan food). Address: Carrer de Sabino Arana, 36, 08028 Barcelona. Phone number: 936 88 87 84
- beGreen Salad Company (Vegan food). Address: Avinguda Diagonal, 674, 08034 Barcelona. Phone number: 936 81 90 24

Social Events

Welcome Drinks and Registration

On Sunday July 7th from 6.30 to 8.30 p.m. we will serve a free welcome drink and you will be able to register in the patio of the Hotel Barcelona Catedral, Carrer dels Capellans, 4, Ciutat Vella, 08002. Meals and extra drinks will be available for purchasing at the hotel restaurant.

Catamaran Excursion

A one-hour catamaran ride along the coastline of the port of Barcelona is scheduled for Tuesday July 9th at 8 pm. The cost of the excursion is included in the registration fee (the approximate price per companion is 10€). The meeting point is ”Las Golondrinas Agency”, Moll de Drassanes SN (In front of the Columbus Monument) - 08039, Barcelona.

Conference Dinner

A delightful dinner at the Montjuïc mountain with stunning views of the city will be held on Wednesday July 10th, starting at 8.30 p.m. Mediterranean cuisine with touches of fusion. The conference dinner is included in the registration fee (the approximate price per companion is 60 €). The dinner will be served in the restaurant Xalet de Montjuïc, Avinguda Miramar, 31, Sants-Montjuïc, 08038. It is accessible by Funicular, which is included in the Integrated Fare System (see information in Local Transportation).

Code of Conduct

From its beginning, at the first European Workshop on White Dwarfs held in Kiel (Germany) in 1974, the spirit of tolerance, friendship, and respect has characterized these meetings. In the current edition, where we celebrate its 50th anniversary, such values have been continuously passed on to new generations as one of the greatest achievements of these meetings. Our community is proud to promoting the values of respect for diversity in its most wide and inclusive conception, and to enhance the collaboration and positive discussion of scientific ideas among all of our members , as the ultimate goal for achieving a proper and growing scientific community.

Our community, as members of the worldwide astronomical community, subscribes to the more specific guidelines of the IAU Code of Conduct.