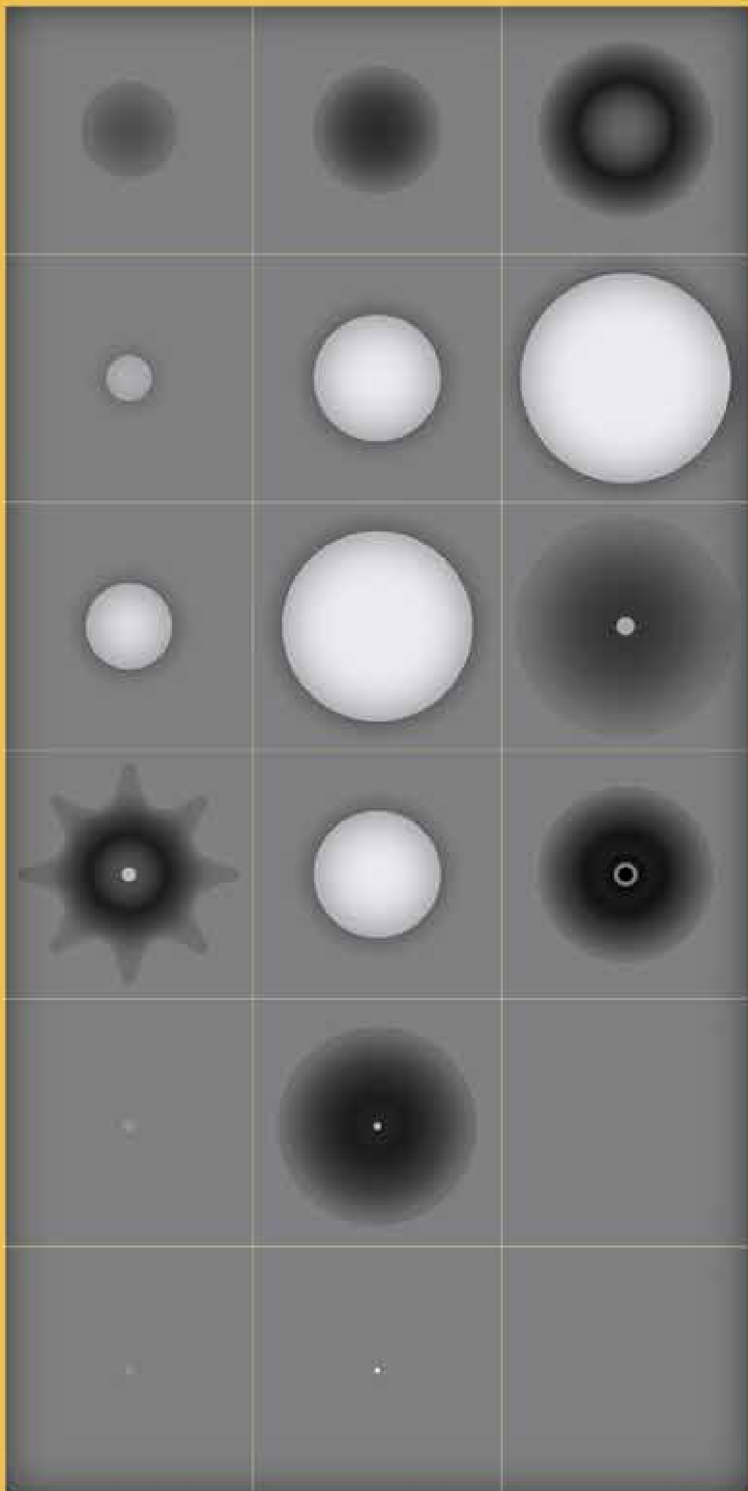
UNIVERSITY OF CAMBRIDGE
Institute of Astronomy

14 AUG
20 AUG
22

STARS 2020

ABSTRACTS



CONTENTS

04 Scientific Organising Committee | **05** Day 1 | **06** Day 2 | **07** Day 3 | **08** Day 4 | **09** Day 5

Monday 15 August
11 John Lattanzio

12 Ross Church - Invited Speaker: Details of stellar physics
13 Roel Lefever
14 Philipp Posiadlowski
15 Albrecht Kamlah

16 Rodolfo Smiljanic - Invited Speaker: Spectroscopy (Gaia-ESO, LAMOST)
17 Maude Gull
18 Thibault Merle
19 Floor van Leeuwen
20 Robert Izzard
21 Peter Eggleton

Tuesday 16 August
22 Jorick Vink - Invited Speaker: Stellar winds
23 Gautham Sabhahit
24 Matheus Bernini Peron
25 Silke Maes
26 Jolien Malfait

27 Cyril Georgy - Invited Speaker: Rotation, differential rotation and magnetic fields
28 Frank Robinson
29 Fabien Schneider
30 Shawasta Chowhury
31 Yan Gao

Wednesday 17 August
32 Marco Pignatari - Invited Speaker: Nucleosynthesis including spectra and meteoritic abundances
33 Alexander Hackett

Thursday 18 August
34 Silvia Toonen - Invited Speaker: Binary and Multiple Stars
35 Pavel Kroupa
36 Ayush Moharana
37 Jan Henneco
38 Natalie Rees
39 Onno Pols
40 Holly Preece
41 Janosz Dewberry
42 Sivan Ginzburg
43 Arnab Sakar
44 Hongwei Ge
45 Dandan Wei
46 Luda Kisseleva

47 Pascale Garaud - Invited Speaker: Extra mixing processes

Friday 19 August
48 Saskia Hekker - Invited Speaker: Asteroseismology
49 Warrick Ball
50 Michal Pawlak
51 Jim Fuller

52 Laurent Eyer - Invited Speaker: Accurate luminosities (Gaia)
53 Anke Arentsen
54 Soetkin Janssens
55 Henri Boffin
56 Xiao Wei Duan
57 Zhanwen Han

58 - **64** Poster Abstracts 1 to 62

Christopher Tout (co-Chair)
Zhanwen Han
Clare Worley
John Lattanzio
Gustavo Bruzual
Wyn Evans
Onno Pols
Avishai Gilkis

09:30 - 09:50
Christopher Tout
Welcome

09:50 - 10:30
John Lattanzio | **pg. 11** | **Remote Talk**
Peter Eggleton

10:30 - 11:00 • Tea & coffee, Hoyle foyer and marquee

11:00 - 11:20
Group photograph - Observatory building, main entrance

11:30 - 12:00
Ross Church | **Invited Speaker** | **pg. 12**
Mixing beyond the Schwarzschild boundaries

12:00 - 12:30
Roel Lefever | **pg. 13**
Deficits and improvements in the modelling of
Wolf-Rayet star atmospheres

12:30 - 14:00 • Lunch, Churchill College dining hall

14:00 - 14:20
Philipp Posiadlowski | **pg. 14**
The effects of binary evolution on the final fate of massive stars

14:20 - 14:40
Albrecht Kamlah | **pg. 15**
Direct N-body simulations of extremely massive and
initially rotating population III star clusters

14:40 - 15:20
Rodolfo Smiljanic | **Invited Speaker** | **pg. 16**
Spectroscopy

15:20 - 15:40
Maude Gull | **pg. 17**
A panchromatic study of massive stars in extremely
metal-poor local dwarf galaxy LeoA

15:40 - 16:00
Thibault Merle | **pg. 18**
A spectroscopic quadruple as a possible progenitor of
sub-Chandrasekhar type Ia supernovae

16:00 - 16:30 • Tea & coffee, Hoyle foyer and marquee

16:30 - 16:50
Floor van Leeuwen | **pg. 19**
Gaia observations of pre-main-sequence evolution in
OB associations and young clusters

16:50 - 17:10
Robert Izzard | **pg. 20**
Stars for schools

17:10 - 17:30
Peter Eggleton | **pg. 21**
To hell and back

18:00 • Posters

09:30 - 10:10
Jorick Vink | Invited Speaker | pg. 22
Stellar winds

10:10 - 10:30
Gautham Sabhahit | pg. 23
Mass loss implementation and temperature evolution of massive stars

10:30 - 11:00 • Tea & coffee, Hoyle foyer and marquee

11:00 - 11:20
Matheus Bernini Peron | pg. 24
Spectroscopic evidence for weaker clumping and X-ray Emission in Galactic cool B-supergiants

11:20 - 11:40
Silke Maes | pg. 25
AGB outflows & the effect of companions

11:40 - 12:30
Jolien Malfait | pg. 26
Shaping of AGB outflows by wind-companion interactions

12:30 - 14:00 • Lunch, Churchill College dining hall

14:00 - 14:40
Cyril Georgy | Invited Speaker | pg. 27
Rotation, differential rotation and magnetic fields

14:40 - 15:00
Frank Robinson | pg. 28
Simulating the outer layers of rapidly rotating stars

15:00 - 15:20
Fabien Schneider | pg. 29
Magnetogenesis in stellar mergers and common evelope events

15:20 - 15:40
Shawasta Chowhury | pg. 30
Stable hydrogen-burning limits in rapidly rotating very low mass objects

15:40 - 16:00
Yan Gao | pg. 31
Tertiary Tides: A New Tidal Process

16:00 - 16:30 • Tea & coffee, Hoyle foyer and marquee

16:30 - 17:30
Discussion

09:30 - 10:10
Marco Pignatari | **Invited Speaker** | **pg. 32**
Nucleosynthesis including spectra and meteoritic abundances

10:10 - 10:30
Alexander Hackett | **pg. 33**
Thorne Zytkow Objects

10:30 - 11:00 • Tea & coffee, Hoyle foyer and marquee

11:00 - 12:30
Star Spots - online slides
A series of short one slide presentations, a chance for the on-line attendees to give a 5 minute one-slide presentation and interact with the in-person attendees.

13:00 - 14:30 • Lunch, Churchill College dining hall

Free Afternoon - book an activity at the conference desk:

- **Mark Hurn - Institute of Astronomy Library Tour (Observatory)**
- **Robin Catchpole - heliostat viewing of the Sun (SPO)**
- **Punting (Scudamore's Punting Station, Granta Place)**
  See map (overleaf) for location details.

09:30 - 10:10
Silvia Toonen | **Invited Speaker** | **pg. 34**
The evolution of stellar triples

10:10 - 10:30
Pavel Kroupa | **pg. 35**
The initial distribution functions of binary stars

10:30 - 11:00 • Tea & coffee, Hoyle foyer and marquee

11:00 - 11:20
Ayush Moharana | **pg. 36**
Observational probe into evolution of compact heirarchical triples

11:20 - 11:40
Jan Henneco | **pg. 37**
Contact tracing of binary stars - from sub-solar
to high-mass components

11:40 - 12:00
Natalie Rees | **pg. 38**
Stellar evolutionary grids for interacting binary stars

12:00 - 12:30
Onno Pols | **pg. 39**
Coping with loss: stability of mass transfer from giant donor stars

12:30 - 14:00 • Lunch, Churchill College dining hall

14:00 - 14:20
Holly Preece | **pg. 40**
Forming sdB stars from heirarchical triples

14:20 - 14:40
Janosz Dewberry | **pg. 41**
Dynamical tides of rapidly rotating planets and stars

14:40 - 15:00
Sivan Ginzburg | **pg. 42**
Black widows as stellar evolution labs

15:00 - 15:20
Arnab Sakar | **pg. 43**
A unified model for the evolution of CVs and AM CVns

15:20 - 15:40
Hongwei Ge | **pg. 44**
The common envelope outcome - a case study on hot subdwarf B stars

15:40 - 16:00
Dandan Wei | **pg. 45**
Evolution and final fate of massive post-common-envelope binaries

16:00 - 16:30 • Tea & coffee, Hoyle foyer and marquee

16:30 - 17:30
Luda Kisseleva | **pg. 46**
Peter Eggleton and Triple Stars

17:30 - 18:00
Pascale Garaud | **Invited Speaker** | **pg. 47** | **Romote Talk**
Extra mixing processes

18:00 • Posters

09:30 - 10:10
Saskia Hekker | Invited Speaker | pg. 48
Asteroseismology

10:10 - 10:30
Warrick Ball | pg. 49
New models of the enigmatic
δ Sct pulsator HD 187547

10:30 - 11:00 • Tea & coffee, Hoyle foyer and marquee

11:00 - 11:20
Michal Pawlak | pg. 50
Long secondary period phenomenon
in the large sky surveys

11:20 - 11:50
Jim Fuller | pg. 51
The secret lives of pulsating stars:
Magnetism, mergers and multiplicity

11:50 -12:30
Laurent Eyer | Invited Speaker | pg. 52
Accurate luminosities

12:30 - 14:00 • Lunch, Churchill College dining hall

14:00 - 14:20
Anke Arentsen | pg. 53
On the frequency of carbon-enhanced
very metal-poor stars

14:20 - 14:40
Soetkin Janssens | pg. 54
Gaia insights in single-degenerate
massive binaries with a black hole

14:40 - 15:00
Henri Boffin | pg. 55
Learning the secret of the elixir of youth: a study of
blue stragglers with TESS and Gaia

15:00 - 16:00
Discussion

16:00 - 16:30 • Tea & coffee, Hoyle foyer and marquee

16:30 - 16:50
Xiao Wei Duan | pg. 56
Tracing stellar and interstellar shock
waves using collisional excitation effect

16:50 - 17:30
Zhanwen Han | pg. 57
Common envelope detection and binary populations

19:15 • Conference Dinner,
Churchill College dining hall

Topics:
Asteroseismology
Accurate luminosities (Gaia)
Nucleosynthesis including spectra and meteoritic abundances
Spectroscopy (Gaia-ESO, LAMOST)
Stellar winds
Rotation, differential rotation and magnetic fields
Extra mixing processes
Detailed physics including reaction rates, equation of state and opacities
Binary and Multiple Stars

JOHN LATTANZIO

Peter Eggleton

The distribution functions of initial periods (IPF), eccentricities (IEF) and mass ratios (IQF) of binary stars are of significant importance because most stars form as binaries. These functions cannot be observed but are needed for initialising stellar populations. Thus, forming binary-rich embedded star clusters eject massive stars at a high rate, and older populations develop exotic stars through evolutionary processes involving hard binaries forged in clusters. This presentation explains how the IPF, IEF and IQF are constrained by combining Galactic-field star-count surveys with those in star-forming regions. At the same time, this “inverse dynamical population synthesis” extracts the typical properties of embedded star clusters. Synthesising galactic field populations from the ensembles of forming embedded clusters, predicts the binary fraction in massive elliptical galaxies to be 30 per cent, in very low-mass dwarf galaxies to be 80 per cent, while the Galactic-field comes out to have the observed binary fraction of field stars of 50 per cent.

NOTES

ROSS CHURCH

Simulating The Outer Layers Of Rapidly Rotating Stars

We present the results of a set of radiative hydrodynamic simulations of convection in the near-surface regions of a rapidly rotating star. The simulations use microphysics consistent with stellar models, and include the effects of realistic convection and radiative transfer. We ind that the overall effect of rotation is to reduce the strength of turbulence. The combination of rotation and radiative cooling creates a zonal velocity profile in which the motion of fluid parcels near the surface is independent of rotation. Their motion is controlled by the strong up and down flows generated by radiative cooling. The fluid parcels in the deeper layers, on the other hand, are controlled by rotation.

NOTES

ROEL LEFEVER (& TOMER SHENAR, ANDREAS SANDER, LUKA PONIATOWSKI, KARAN DSILVA & HELGE TODT)

Deficits and Improvements in the Modelling of Wolf-Rayet Star Atmospheres

Despite their low number, Wolf-Rayet (WR) stars serve as strong contributors to galactic ionization and enrichment and are believed to be the direct progenitors of stellar-mass black holes. Subject to a powerful radiation-driven stellar wind, these stars effectively push away their outer layers, obscuring them from sight. This causes the light observed from WR stars to originate from the stellar wind of the star. Hence, detailed modelling of the wind is paramount understand how the emergent WR-star spectrum forms. To construct these models, typically the beta-velocity law is used to describe the behaviour of the wind. The use of this pre-described velocity field has led to several discrepancies, the most striking of which is the large difference between deduced radii and expectations from stellar evolution modelling. In our study, we quantified this problem by computing and analysing WR-star winds, adopting several different wind velocity fields for stellar models with typical parameters. Our results demonstrate that these velocity fields have a profound impact on the spectrum of the star, to the extent that we could cover almost the entire range of WR spectral subclasses with the same stellar model, by only using different velocity fields. However, this degeneracy can be constrained by using UV P-Cygni lines. To overcome these discrepancies altogether, we turn to improved velocity descriptions obtained by consistently solving the hydrodynamic equation of motion.

NOTES

PHILIPP PODSIADLOWSKI (& FABIAN SCHNEIDER, BERNHARD MUELLER, EVA LAPLACE)

The Effects of Binary Evolution on the Final Fate of Massive Stars

The majority of massive stars are believed to be in close binaries where mass transfer between the binary components occurs. This can change the immediate presupernova envelope structure of stars in various ways and is almost certainly responsible for a large part of the observed diversity of supernova types and subtypes. However, binary interactions can also change the presupernova structure of the core and hence the final fate of iron core collapse or electron-capture supernova or forms a black hole (either prompt or by fallback). Here, we show the results of a systematic exploration of the fate of massive stars that have either been stripped by mass transfer, accreted from a companion or merged with a companion (all treated in a simplified phenomenologial manner) and compare this to single-star evolution. Using a phenomenological model for the supernova explosions (guided by realistic 3d simulations), we present the properties of the resulting supernovae and compact remnants (including remnant type, their mass and velocity kick). This has dramatic implications for binary population synthesis studies and hence the rates of potential merging binaries gravitational-wave detectors (such as aLIGO) can detect. E.g. stripped stars with initial masses up to 70 $M_{\odot}$ can produce successful supernovae and neutron-star remnants, and massive mergers may explode in an LBV phase.

NOTES

ALBRECHT KAMLAH (& ATARU TANIKAWA, MANUEL ARCA SEDDA, MIREK GIERSZ, NADINE NEUMAYER, RAINER SPURZEM)

Direct N-body Simulations Of Extremely Massive And Initially Rotating Population Iii Star Clusters

Population-III (Pop-III) star clusters with extremely low metallicity and very top-heavy initial mass function are possible birthplaces of seed black holes for galactic nuclei. Moreover, multi-generation mergers of black holes and other compact objects originating from these will be relevant gravitational wave (GW) detection events. In this talk, I present the results from a suite of eight direct N-body simulations with 1.01×10^5 particles using Nbody6++GPU of extremely massive Pop-III star clusters (log10(Z/Z*) = -8) that are initialized with rotating King model distributions. Our models feature primordial (hard) binaries, a continuous mass spectrum, and tidal mass loss induced by the overall gravitational field of the host galaxy. We include highly innovative stellar evolution fitting formulae for Pop-III stars in combination with state-of-the-art stellar evolution that affect all stars. Furthermore, in half of the simulations we include GW merger recoil kicks for the black holes. With our experimental setup we are in a unique position to disentangle the dependence of the formation of massive stars and (intermediate mass) black holes on several processes: initial star cluster bulk rotation, the presence of gravitational wave merger recoil kicks and the impact of the new stellar evolution fitting formulae. I will also discuss the impact of all the above on the global, dynamical evolution of the star cluster and focus on the gravothermal-gravogyro catastrophe.

NOTES

RODOLFO SMILJANIC

Spectroscopy

Awaiting content.

NOTES

MAUDE GULL

Extremely Metal-Poor Local Group Dwarf Galaxy LeoA

Massive metal-poor stars are central to a broad range of astrophysics including cosmic reionization, chemical enrichment, and compact object formation. Here, I will present results of a joint HST UV/optical/IR photometric and Keck and MMT optical spectroscopic study of massive stars in the nearest low-metallicity star-forming galaxy Leo A (Z~5% Sun; D~1 Mpc). The majority of our spectroscopically observed OB-stars (~65%) are not near any known H II regions or clusters in Leo A. Furthermore a significant fraction (nearly 50%) of our spectroscopically observed OB stars show measurable signs of stellar (not nebular) emission, which suggests mass loss through winds, accretion, and a putative high degree of binary star interaction. This is in line with previous findings of enhanced binary activity and stellar feedback at sub-SMC metallicities. I present 6 Be stars, representing the first sub-SMC Be stars to have both photometric and spectroscopic analysis. I postulate that Be stars may contaminate parts of the core helium burning branch in the optical CMD. Our spectroscopic sample comprises a significant fraction of all known massive stars with high-quality optical spectra at sub-SMC metallicities.

NOTES

THIBAULT MERLE (& ADRIAN S. HAMERS; SOPHIE VAN ECK; ALAIN JORISSEN; MATHIEU VAN DER SWAELMEN; KAREN POLLARD; RODOLFO SMILJANIC; DIMITRI POURBAIX; TOMAŽ ZWITTER; GREGOR TRAVEN; GERRY GILMORE; SOFIA RANDICH; ANAÏS GONNEAU; ANNA HOURIHANE; GERMANO SACCO; C. CLARE WORLEY)

A Spectroscopic Quadruple As A Possible Progenitor Of Sub-Chandrasekhar Type Ia Supernovae

Stars often form in multiple systems and may follow a complex evolution involving mass transfer and collisions, leading to mergers that are possible progenitors of Type Ia supernovae (SN). Binaries have received much attention as possible progenitors of such explosions, but long-term gravitational effects in tight triple or quadruple systems could also play a key role. I will present the properties of the first spectroscopic quadruple (SB4) found within a star cluster: the 2+2 hierarchical system HD 74438. Its membership in the open cluster IC 2391 makes it the youngest (43 My) SB4 discovered so far and among the quadruple systems with the shortest outer orbital period. The eccentricity of the 6 y outer period is 0.46 and the two inner orbits, with periods of 20.5 d and 4.4 d, and eccentricities of 0.36 and 0.15, are not coplanar. Using an innovative combination of ground-based high resolution spectroscopy and Gaia/Hipparcos astrometry, we show that this system is undergoing secular interaction that likely pumped the eccentricity of one of the inner orbits higher than expected for the spectral types of its components. We compute the future evolution of HD 74438 by considering gravitational dynamics, stellar evolution, and binary interactions, and show that this system is an excellent candidate progenitor of sub-Chandrasekhar Type Ia supernova through white dwarf mergers. This specific type of SNIa better accounts for the chemical evolution of iron-peak elements in the Galaxy.

NOTES

FLOOR VAN LEEUWEN

Gaia Observations Of Pre-Main-Sequence Evolution In Ob Associations And Young Clusters

Awaiting content.

NOTES

ROBERT IZZARD & ANDY BRITTAIN

Stars for Schools

Astronomy is a primary route into undergraduate physics and mathematics. It opens doors to students fascinated by our Universe. Younger students similarly benefit from astronomy as a gateway to learning. In UK schools astronomy falls between the cracks of physics, mathematics and computing so is taught cursorily at best. To plug this gap we developed “Stars for Schools”. Combining our Window to the Stars graphical front-end to Peter Eggleton’s TWIN stellar-evolution code, it is a course for 14-18 yr old students which tackles real stellar-astrophysics problems. They learn to use the software by examining the physics of stellar interiors. Then we set short, diverse tasks that introduce Python coding. These improve students’ problem-solving skills through activities different to their usual curriculum. The software runs on a Raspberry Pi to reduce costs. Our pilot Stars for Schools project at Lady Eleanor Holles school resulted in excellent student feedback. They loved to use a professional stellar code that was “not dumbed down”. The combination of astrophysics and computing gave the students vital experience for subsequent university or job applications. “Stars for Schools” is also a great opportunity to mentor school students and build valuable relationships. We are working to expand the project to more schools and younger students, and to further the use of “Window to the Stars” for teaching and outreach, with the help of UK colleagues and the Royal Society.

NOTES

PETER EGGLETON

To Hell and Back

Awaiting content.

NOTES

JORICK VINK

Stellar Winds

Awaiting content.

NOTES

GAUTHAM SABHAHIT (& JORICK VINK, ERIN HIGGINS, ANDREAS SANDER)

Mass Loss Implementation And Temperature Evolution Of Very Massive Stars

The extreme winds of Very massive stars (VMS) not only dominate the evolution of such objects by continuously losing mass throughout their lifetime, but also influence the physics of the surrounding medium due to their strong ionising and mechanical feedback. Already during the main-sequence (MS) that spans nearly 90% of the entire lifetime, VMS can lose a large fraction of their initial mass due to their extremely high luminosities. Using the 1D code MESA we focus on the MS evolution of VMS with a new theoretically informed mass-loss recipe that naturally switches from an optically-thin O-star wind to an enhanced optically-thick Wolf-Rayet (WR) type wind above a certain model-independent 'transition' mass loss point. VMS with initial masses greater than 200 Msun undergo chemically homogeneous evolution throughout the MS, with mass loss being the single-most-important process. We find our VMS models to steeply drop in luminosity and evolve at nearly constant effective temperatures, that naturally explains the narrow range of observed temperatures of VMS in massive clusters such as the Arches Cluster in the Galaxy and the 30 Dor region in the LMC. This distinct behavior of a steeply dropping luminosity is shown to have a self-regulatory effect that keeps temperatures constant during the evolution. Our models are the first physically-motivated models for massive stars in the critical 100-300 Msun range that dominate the ionising flux and mechanical input into young clusters.

NOTES

MATHEUS BERNINI PERON (& WAGNER MARCOLINO, ANDREAS SANDER, JEAN CLAUDE BOURET)

Spectroscopic Evidence for Weaker Clumping and X-ray Emission in Galactic Cool B-Supergiants

After living their lives as OB dwarfs, massive stars quickly evolve off the main sequence. In this regime, we find the B supergiants (BSGs), which lie on the cool end of the line-driven wind regime. Studying them is paramount to improving our knowledge of the physics of hot stellar winds and high-mass stellar evolution. In this work, we focus on analyzing the less studied cooler BSGs - i.e. with temperatures below the so-called Bi-Stability Jump region - using CMFGEN and PoWR models including the effects of clumping and shock-heated X-rays in the wind. By including these effects, we manage to reproduce the combined UV and optical spectra of our sample stars, overcoming previous difficulties to reproduce the UV profiles of lines showing higher ionization stages. Our results indicate that both clumping and X-rays need to be taken into account for cooler BSGs, albeit on a different level than what is usually assumed for hotter stars. For our targets, we derive X-ray luminosities lower than the canonical ratio of 10^{-7} between L_x and L_{bol}. While this is in line with the lack of observed X-rays, we show that X-rays cannot be neglected in cooler BSGs. Our obtained clumping parameters further reveal significantly smoother winds in our targets, which confirms recent hydrodynamical simulations regarding cooler BSGs winds. Also, we discuss the potential consequences of our study for the treatment of B supergiants in stellar evolution.

NOTES

SILKE MAES

AGB outflows & the effect of companions

The evolution of AGB stars is controlled by a high mass loss. For decades, one has strived to derive an empirical relation that can predict the mass-loss rate starting from the properties of the AGB star. However, up until now, no such relation is found. Different mass-loss rate prescriptions are used in stellar evolution codes, leading to discrepancies in evolutionary tracks and AGB lifetime. But, recent high-resolution observations refute the common hypothesis that AGB outflows are spherically symmetric. The data exhibit a variety of 3D structures, believed to be caused by binary interaction. This inherent 3D morphology has not been accounted for in the majority of sample studies of AGB outflows. This not only adds complexity to this quest, but also systematic errors in hitherto derived mass-loss rates and expansion velocities. To account for the effect of asymmetry in AGB outflows on their expansion velocities and mass-loss rates, it is necessary to step aside from the 1D modelling. I will present 3D hydrodynamical simulations of the outflow of different AGB binary systems. I will show that companions are able to gravitationally affect the outflow. This does not only give rise to structure formation, but also the expansion velocity of the outflow is altered by the interaction. These novel results serve as a stepping stone for further research, where we aim to gradually implement more physics/chemistry to the model setup, in order to accurately predict AGB mass-loss rates.

NOTES

JOLIEN MALFAIT

Shaping of AGB Outflows By Wind-Companion Interactions

At the end of their lives, low and intermediate mass stars scatter their envelope throughout the interstellar medium via a stellar wind. For decades, modelling endeavours of these outflows have assumed that these winds are spherically symmetric. However, recent high-spatial resolution observations reveal that the winds of evolved stars typically possess a high degree of complexity, including spirals, disks, clumps, etc. With sophisticated 3D hydro-dynamical modelling tools, constructed with the SPH solver PHANTOM, we show how these structures can be formed by the gravitational interaction of one or multiple stellar or planetary companions with an AGB outflow, in various configurations. If neglecting the 3D structures and the impact of companions, systematic errors may occur in the estimate of critical stellar evolution parameters such as the mass-loss rate. The ultimate goal of our models is to compare them to high-resolution observations, to unravel how and by which binary/triple configuration the observed wind structures can be created. Therefore, we post-process our hydrodynamical models with the radiative transfer code MAGRITTE to create synthetic observations, and reveal the similarities with actual ALMA observations. Our new simulations hence offer us a novel gateway for understanding the complex wind structures of evolved stars, and thus for constraining the fundamental stellar and wind parameters, key ingredients for predicting their further evolution.

NOTES

CYRIL GEORGY

Rotation, Differential Rotation And Magnetic Fields

Awaiting content.

NOTES

FRANK ROBINSON (& JOEL TANNER, SARBANI BASU)

Simulating The Outer Layers Of Rapidly Rotating Stars

We present the results of a set of radiative hydrodynamic simulations of convection in the near-surface regions of a rapidly rotating star. The simulations use microphysics consistent with stellar models, and include the effects of realistic convection and radiative transfer. We ind that the overall effect of rotation is to reduce the strength of turbulence. The combination of rotation and radiative cooling creates a zonal velocity profile in which the motion of fluid parcels near the surface is independent of rotation. Their motion is controlled by the strong up and down flows generated by radiative cooling. The fluid parcels in the deeper layers, on the other hand, are controlled by rotation.

NOTES

FABIAN SCHNEIDER (& SEBASTIAN OHLMANN, PHILIPP PODSIADLOWSKI, FRIEDRICH ROEPKE, PATRICK ONDRATSCHEK, STEVEN BALBUS, RUEDIGER PAKMOR, VOLKER SPRINGEL)

Magnetogenesis In Stellar Mergers And Common-Envelope Events

Magnetic fields are ubiquitous in the Universe on all scales. In stars, about 10% of OBA stars have strong, large-scale surface magnetic fields whose origin remains a mystery since their discovery in 1947. Also among the remnants of OBA stars, there are sub-classes of highly-magnetic white dwarfs and neutron stars, the so-called polars and magnetars, respectively. Here, I will present 3D magnetohydrodynamic simulations of the coalescence of two massive main-sequence stars and of the common-envelope phase with a low-mass AGB star. In both cases, magnetic fields are strongly amplified and play important roles. The merged star resembles the magnetic star Tau Sco in terms of its magnetic field, status as blue straggler, slow rotation and other observed properties. If the high magnetisation persists until core collapse, the ensuing supernova explosion may be more energetic and magnetar formation seems possible. During the common-envelope phase, a fast, magnetically-driven, bipolar outflow is launched that shapes the ejected envelope and may hold the clue to understanding the diverse bipolar structures of (proto-)planetary nebulae. Whether the remaining core of the AGB star could evolve into a polar remains unclear. I will argue that field amplification in dynamical encounters of stars is a general mechanism to form strong magnetic fields, and may thus hold a clue to understanding the enigmatic fast radio bursts and other magnetically-powered transients.

NOTES

SHASWATA CHOWDHURY (& PRITAM BANERJEE, DEBOJYOTI GARAIN, TAPOBRATA SARKAR)

Stable Hydrogen-burning Limits in Rapidly Rotating Very Low Mass Objects

We present novel effects of uniform rapid stellar rotation on the minimum mass of stable hydrogen burning in very low mass stars, using an analytic model and relaxing the assumption of spherical symmetry. We obtain an analytic formula for the minimum mass of hydrogen burning as a function of the angular speed of stellar rotation. Further, we show the existence of a maximum mass of stable hydrogen burning in such stars, which is purely an artifact of rapid rotation. The existence of this extremum in mass results in a minimum admissible value of the stellar rotation period of 22 minutes, below which a very low mass object does not reach the main sequence, within the ambit of our model. For a given angular speed, we predict a mass range beyond which such an object will not evolve into a main-sequence star.

NOTES

FABIAN SCHNEIDER (& SEBASTIAN OHLMANN, PHILIPP PODSIADLOWSKI, FRIEDRICH ROEPKE, PATRICK ONDRATSCHEK, STEVEN BALBUS, RUEDIGER PAKMOR, VOLKER SPRINGEL)

Magnetogenesis In Stellar Mergers And Common-Envelope Events

Magnetic fields are ubiquitous in the Universe on all scales. In stars, about 10% of OBA stars have strong, large-scale surface magnetic fields whose origin remains a mystery since their discovery in 1947. Also among the remnants of OBA stars, there are sub-classes of highly-magnetic white dwarfs and neutron stars, the so-called polars and magnetars, respectively. Here, I will present 3D magnetohydrodynamic simulations of the coalescence of two massive main-sequence stars and of the common-envelope phase with a low-mass AGB star. In both cases, magnetic fields are strongly amplified and play important roles. The merged star resembles the magnetic star Tau Sco in terms of its magnetic field, status as blue straggler, slow rotation and other observed properties. If the high magnetisation persists until core collapse, the ensuing supernova explosion may be more energetic and magnetar formation seems possible. During the common-envelope phase, a fast, magnetically-driven, bipolar outflow is launched that shapes the ejected envelope and may hold the clue to understanding the diverse bipolar structures of (proto-)planetary nebulae. Whether the remaining core of the AGB star could evolve into a polar remains unclear. I will argue that field amplification in dynamical encounters of stars is a general mechanism to form strong magnetic fields, and may thus hold a clue to understanding the enigmatic fast radio bursts and other magnetically-powered transients.

NOTES

SHASWATA CHOWDHURY (& PRITAM BANERJEE, DEBOJYOTI GARAIN, TAPOBRATA SARKAR)

Stable Hydrogen-burning Limits in Rapidly Rotating Very Low Mass Objects

We present novel effects of uniform rapid stellar rotation on the minimum mass of stable hydrogen burning in very low mass stars, using an analytic model and relaxing the assumption of spherical symmetry. We obtain an analytic formula for the minimum mass of hydrogen burning as a function of the angular speed of stellar rotation. Further, we show the existence of a maximum mass of stable hydrogen burning in such stars, which is purely an artifact of rapid rotation. The existence of this extremum in mass results in a minimum admissible value of the stellar rotation period of 22 minutes, below which a very low mass object does not reach the main sequence, within the ambit of our model. For a given angular speed, we predict a mass range beyond which such an object will not evolve into a main-sequence star.

NOTES

YAN GAO

Tertiary Tides: A New Tidal Process

Awaiting content.

NOTES

MARCO PIGNATARI

Nucleosynthesis Including Spectra And Meteoritic Abundances

Awaiting content.

NOTES

ALEXANDER HACKETT

Thorne Zytkow Objects

Awaiting content.

NOTES

SILVIA TOONEN

The Evolution Of Stellar Triples

Awaiting content.

NOTES

PAVEL KROUPA

The Initial Distribution Functions Of Binary Stars

The distribution functions of initial periods (IPF), eccentricities (IEF) and mass ratios (IQF) of binary stars are of significant importance because most stars form as binaries. These functions cannot be observed but are needed for initialising stellar populations. Thus, forming binary-rich embedded star clusters eject massive stars at a high rate, and older populations develop exotic stars through evolutionary processes involving hard binaries forged in clusters. This presentation explains how the IPF, IEF and IQF are constrained by combining Galactic-field star-count surveys with those in star-forming regions. At the same time, this “inverse dynamical population synthesis” extracts the typical properties of embedded star clusters. Synthesising galactic field populations from the ensembles of forming embedded clusters, predicts the binary fraction in massive elliptical galaxies to be 30 per cent, in very low-mass dwarf galaxies to be 80 per cent, while the Galactic-field comes out to have the observed binary fraction of field stars of 50 per cent.

NOTES

**AYUSH MOHARANA (& K.G. HELMINIAK, F. MARCADON,
T. PAWAR, M. KONACKI, N. UKITA, E. KAMBE, AND H. MAEHARA)**

Observational Probe Into Evolution Of Compact Hierarchical Triples

Compact Hierarchical Triples (CHT) are systems where a tertiary star orbits an inner binary system with a period of fewer than 1000 days. If the inner binary is an eclipsing binary (EB), we can obtain the orbital, stellar, and atmospheric parameters of all three stars. These were supposedly rare systems but there has been a recent increase in detection using Eclipse Timing Variations (ETV) from space photometry. Though ETV studies provide us with information about the orbit and dynamics, we need a detailed study to probe the parameters necessary to understand the evolution of these systems. We present the synergies between various techniques (light curve modelling, radial velocities, spectral disentangling, spectral analysis, etc.) that we use to extract information from photometry and spectroscopy of CHT. I compare the mass, radius, age, metallicity, orbital architecture and possible dynamics of two CHT systems: BD+44 2258 and KIC 6525196. We find that KIC 6525196 can possibly be a co-planar system while BD+44 2258 seems to be a slightly inclined system. Numerical simulations show possibility of inclination variations of the inner binary but that does not affect the stellar evolution of the individual components of both the systems.

NOTES

JAN HENNECO (& FABIAN SCHNEIDER, SASKIA HEKKER, EVA LAPLACE)

Contact Tracing Of Binary Stars - from Sub-Solar to High-Mass Components

Stellar mergers produce massive single stars with potentially distinctive properties. These include rejuvenated blue stragglers, highly magnetized (massive) stars, and stars with peculiar chemical abundances and rotation rates. The actual merger phases can be detected as luminous red novae. Before the merging event itself, stars will enter a contact phase. However, entering such phase does not necessarily lead to a merger. Contact phases can be stable but also short lived. This is somewhat in analogy to common-envelope phases, which have a certain (currently unconstrained) survival rate for the involved binary. With the help of a large grid of detailed 1D binary models (~6000) spanning components masses from 0.5 to 20 solar masses, we assess which initial binary configurations might end up in a contact or common-envelope phase. Furthermore, by exploring the different driving mechanisms towards and the structure of the components at the onset of these phases, we aim to predict whether a merger will occur. Additionally, the extended mass range allows for comparisons between lower-mass and massive primary stars. A direct application of this work would be estimating the lifetime of contact phases by comparing with observed populations of binary stars.

NOTES

NATALIE REES

Stellar Evolution Grids for Interacting Binary Stars

Interactions within a binary system can have important consequences on the following evolution of the component stars. In particular, giant stars are likely to interact with a close companion by either mass transfer or common envelope evolution, which can result in a merger. This work will investigate the impact of changes in the mass of the star on the following evolution by producing models with varying envelope to core mass ratios. Full stellar evolution models will be produced using MESA and the results tabulated for use in the population synthesis code binary_c. More accurate calculations of populations of stars can be run by interpolating parameters from the tabulated grid. This talk will focus on the core helium burning phase, with results including the importance of degeneracy and the occurrence of core breathing pulses. Preliminary work on AGB models will also be shown with methods to evolve past instabilities and convergence problems. This is essential so that a grid of AGB models can be reliably run without human intervention.

NOTES

ONNO POLS

Coping With Loss: Stability Of Mass Transfer From Giant Donor Stars

Awaiting content.

NOTES

HOLLY PREECE

Forming sdB Stars From Hierarchical Triples

Hot subdwarf B (sdB) stars are core He burning stars with low mass H envelopes which occupy the extreme horizontal branch on the HR diagram. Proposed formation scenarios involve Roche lobe overflow, to strip an RGB star of its envelope, or merges involving He white dwarfs. Alongside the usual binary interactions, triple systems may also experience short-term dynamical instabilities triggered by mass-loss and eccentricity excitation via von Zeipel-Lidov-Kozai (ZLK) oscillations. Dynamical instabilities can cause ejections, collisions and exchanges. ZLK oscillations create high eccentricities in the inner orbit, potentially triggering mass transfer or collisions. This talk presents novel population synthesis calculations of sdB stars formed from hierarchical triples. We examine formation channels, orbital parameters of the sdB systems and initial conditions required to form an sdB from a hierarchical triple. We find we are able to create sdBs as singles, binaries and triple systems.

NOTES

JANOSZ DEWBERRY (& DONG LAI)

Dynamical Tides of Rapidly Rotating Planets and Stars

Tidal interactions play an important role in many astrophysical systems, but uncertainties regarding the tides of rapidly rotating stars and gaseous planets remain. I will describe recent research focused on the dynamical tidal response of rotating, centrifugally distorted planets and stars. We compute the frequency-dependent tidal Love numbers of polytropes with indices appropriate for gas giants and neutron stars, and rotation rates up to nearly the mass-shedding limit. We evaluate the potential relevance of inertial wave resonances with the tidal forcing provided by satellite moons or exoplanets, and provide an analytical explanation for anomalously large values of high-degree Love numbers measured by the spacecraft Juno for Jupiter. We also identify strong mode mixing associated with avoided crossings that occur in very rapid rotators, and explore the effects that this mixing can have on tidal interactions between stars and exoplanets on highly eccentric orbits. Analytical expressions for the properties of relevant oscillation modes tabulated in our work provide a simple method of computing the tidal response across a wide range of stellar and planetary rotation rates.

NOTES

SIVAN GINZBURG (& ELIOT QUATAERT)

Black Widows as Stellar Evolution Labs

Black widows are millisecond pulsars with low-mass companions (a few per cent the mass of the sun) on orbits of several hours. These companions are presumably the remnants of main-sequence stars that lost most of their mass through a combination of Roche lobe overflow and ablation by the pulsar's high-energy radiation. I will use both an analytical irradiated Hayashi track model and numerical MESA calculations to demonstrate how the unique boundary conditions of black widow companion stars cause them to inflate and deviate from the main sequence as they lose mass. I will then show how this venture from the main sequence, combined with the increasing number of detected black widows, offers a novel laboratory to test stellar evolution theories that have so far been calibrated only close to the main sequence. One specific example is the star's radiative core, which vanishes when the companion reaches a critical mass that strongly depends on the black widow's orbital period. This structural transition is thought to drastically alter the star's magnetic field and thus the rate of magnetic braking, which plays a crucial role in both single and binary stellar evolution. If time permits, I will also briefly discuss black widows with evolved companions that have exhausted most of the hydrogen in their cores.

NOTES

ARNAB SARKAR (& CHRISTOPHER TOUT)

A Unified Model For The Evolution Of CVs and AM CVns

With an updated equation of state implementation in the Cambridge stellar evolution code, we model the secular evolution of cataclysmic variables (CVs) using a double dynamo (DD) model wherein there is an interplay between two $\alpha-\Omega$ dynamos, one in the convective envelope and the other at the boundary of a slowly rotating shrinking radiative core and the growing convective envelope. We confirm that this model provides a physical formalism for the interrupted magnetic braking paradigm as well as a mechanism for extra angular momentum loss below the period gap. We construct the relative probability distribution of orbital periods using the white dwarf distribution in CVs and find that our model reproduces the period gap and the observed period minimum spike in CV distribution. We find good agreement of our modelled systems with those of empirical models and with observational data. In addition, we thoroughly analyze how the DD model leads to the evolution of AM CVn stars.

NOTES

HONGWEI GE (& CHRISTOPHER A TOUT, XUEFEI CHEN, ZHANWEN HAN)

Observational probe into evolution of Compact Hierarchical Triples *TITLE CHANGE*

Common envelope evolution (CEE) physics plays a fundamental role in the formation of binary systems, such as mergering stellar gravitational wave sources, pulsar binaries and type Ia supernovae. A precisely constrained CEE has become more important in the age of large surveys and gravitational wave detectors. We use an adiabatic mass-loss model to explore how the total energy of the donor changes as a function of the remnant mass. This provides a more self-consistent way to calculate the binding energy of the donor. For comparison, we also calculate the binding energy through integrating the total energy from the core to the surface. The outcome of CEE is constrained by total energy conservation at the point at which both component's radii shrink back within their Roche lobes. We apply our results to 142 hot subdwarf binaries. For shorter orbital period sdBs, the binding energy is highly consistent. For longer orbital period sdBs in our samples, the binding energy can differ by up to a factor of 2. The CE efficiency parameter β_{CE} becomes smaller than α_{CE} for the final orbital period $\log P_{orb}/d > -0.5$. We also find the mass ratios log q and CE efficiency parameters $\log \alpha_{CE}$ and $\log \beta_{CE}$ linearly correlate in sdBs, similarly to De Marco et al. (2011) for post-AGB binaries.

NOTES

DANDAN WEI

Evolution And Final Fate Of Massive Post-Common-Envelope Binaries

Awaiting content.

NOTES

LUDA KISSELEVA

Peter Eggleton and Triple Stars

Awaiting content.

NOTES

PASCALE GARAUD

Extra Mixing Processes

Awaiting content.

NOTES

SASKIA HEKKER

Asteroseismology

Awaiting content.

NOTES

WARRICK BALL & VICHI ANTOCI

New Models Of The Enigmatic δ Sct Pulsator HD 187547

Long, almost continuous brightness measurements of the δ Sct pulsator HD 187547, taken by NASA's Kepler telescope, revealed pulsations over an unusually wide range of frequency and that many of the star's pulsations appear as dense multiplets, rather than clear, single pulsation frequencies. It proved difficult to explain these multiplets using well-understood mechanisms like combination frequencies or rotational splitting. The star has remained a mystery. Recently, Bedding et al. recognized dozens of δ Sct pulsators, observed by NASA's TESS telescope, that, like HD 187547, also pulsate at many relatively high frequencies. This has led to a consistent picture of which observed frequencies correspond to which pulsations modes, which we are using to revisit Kepler's observations of HD 187547. I shall present early results using new stellar models that fit revised parameters, including Gaia's parallax measurement and a new large separation. These new models support the mode identification by Bedding et al. but re-open old questions about how these modes are excited and split into multiplets. Though the models can simultaneously fit seismic and non-seismic constraints, non-adiabatic pulsation models do not clearly predict excited modes in the observed range.

NOTES

MICHAŁ PAWLAK

Long Secondary Period Pheonomenon In The Large Sky Surveys

The long secondary period (LSP) is a phenomenon observed in significant fraction of pulsating red giants. While the origin of LSP remains unclear, the proposed explanations include binarity and non-radial pulsations. In this work I studied the known sample of the OGLE LSPs in the Magellanic Clouds and the newly identified sample of the Galctic LSPs from the ASAS-SN survey. I used the photometeric data combined with the astrometry from Gaia and spectroscopic data from the APOGEE, GALAH, and RAVE surveys, to investigate the properties of the LSP population. The LSP stars appear both on RGB and AGB, predominantly around the TRGB and the upper part of AGB, and seem to be on average more reddened than other giants. In the Galaxy, they have a spatial distribution that is more dispersed than the non-LSP giants, suggesting that they belong to an older population. Spectroscopically derived ages seem to confirm this. The LSP are also more C-rich than their non-LSP counterparts.

NOTES

JIM FULLER

The Secret Lives of Pulsating Stars: Magnetism, Mergers, and Multiplicity

Asteroseismology has made it difficult for stars to keep secrets. I will highlight several stellar surprises recently revealed by asteroseismic data. First, I will discuss updated insights for how internal magnetic fields convert gravity waves into Alfven waves, suppressing stellar pulsations in many red giant stars. Second, I will identify stars that are likely to be remnants of stellar mergers, as revealed by their abnormal pulsation spectra. Third, I will show how close binaries cause stellar pulsations to be tidally trapped, as detected in TESS data, and how we can potentially use this to our asteroseismic advantage.

NOTES

LAURENT EYER

Accurate Luminosities

Awaiting content.

NOTES

ANKE ARENTSEN

On The Frequency Of Carbon-Enhanced Very Metal-Poor Stars

Awaiting content.

NOTES

SOETKIN JANSSENS (& TOMER SHENAR, HUGUES SANA, ABEL SCHOOTEMEIJER, DOLEV BASHI, DOMINIC BOWMAN, JAIME VILLASENOR, JORIS DE RIDDER, JULIA BODENSTEINER, LAURENT MAHY, MATTHIAS FABRY, NORBERT LANGER, PABLO MARCHANT, SAHAR SHAHAF, SIMCHON FAIGLER, TOMOTHY VAN REETH, TSEVI MAZEH)

Gaia Insights In Single-Degenerate Massive Binaries With A Black Hole

Single-degenerate massive binaries containing a black hole (OB+BH) represent an important evolutionary phase on the pathway of becoming BH mergers. In the past two years, several OB+BHs were reported to exist on the basis of spectroscopic investigations. However, most reported OB+BH systems were later challenged by follow-up studies, demonstrating the extreme difficulty to identify BHs using spectroscopic data alone. On June 13th, the full third Gaia data release (DR3) will become publicly available, providing us with the first Gaia astrometric orbits of binary systems. While the astronomical community was awaiting DR3, we have developed a unique method that allows for the identification of OB+BH systems in the Gaia binary catalogue. Assuming a direct collapse and no kick upon BH formation, we estimated that 200 OB+BHs could be identified in DR3. Moreover, we showed that different BH-formation scenarios could lead to distinct period and eccentricity distributions. On June 13th, we will use our method on DR3 data. In my talk, I will present the results obtained from the Gaia DR3 data analysis. I will present the detected OB+BH binaries and discuss the implications of their discovery. I will also demonstrate that these OB+BHs contain information on the BH-formation scenario.

NOTES

HENRI BOFFIN

On The Frequency Of Carbon-Enhanced Very Metal-Poor Stars

Awaiting content.

NOTES

XIAO WEI DUAN

Gaia Insights In Single-Degenerate Massive Binaries With A Black Hole

Awaiting content.

NOTES

ZHANWEN HAN

Common Envelope Detection And Binary Populations

Awaiting content.

NOTES

PAGES: 53 - 63

EVA LAPLACE, FABIAN SCHNEIDER & PHILIPP PODSIADLOWSKI

Long secondary period pheonomenon in the large sky surveys *POSTER ABSTRACT?*

In the era of gravitational-wave (GW) sources and all-sky transient searches, understanding the stellar progenitors of supernovae and compact objects, and how binary interactions affect the final fate of massive stars, has become increasingly important. The formation of either black holes (BH) or neutron stars (NS) is not a simple function of the initial mass of a star. Instead, it depends on the core structure at the moment of explosion, often expressed in terms of the "compactness parameter", where high compactness is indicative of BH formation. This link is supported by the recent observation of a vanishing star, which could be the first observed direct progenitor of a BH, and is compatible with model predictions for a star with high compactness. We investigate the origin of variations in compactness as a function of mass and show that these depend on the timing and energetics of the nuclear burning fronts after core carbon burning. We demonstrate how binary mass transfer modifies the core structure and compactness of stars, and with it, the properties of core-collapse supernovae and compact objects. Finally, we discuss how these insights can be used to constrain uncertain stellar physics, in particular the C12(alpha, gamma) O16 reaction rate.