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THE MASSIVE STAR NEWSLETTER

formerly known as the hot star newsletter

*

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Jose Groh (Trinity College Dublin)

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PAPERS

Abstracts of 10 accepted papers

Fundamental parameters of massive stars in multiple systems: The cases of HD17505A and HD206267A

F. Raucq(1), G. Rauw(1), L. Mahy(2), S. Simon-Diaz(3,4)

(1) Liege University, Belgium
(2) KU Leuven, Belgium
(3) IAC, Tenerife, Spain
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Many massive stars are part of binary or higher multiplicity systems. The present work focusses on two higher multiplicity systems: HD17505A and HD206267A. Determining the fundamental parameters of the components of the inner binary of these systems is mandatory to quantify the impact of binary or triple interactions on their evolution. We analysed high-resolution optical spectra to determine new orbital solutions of the inner binary systems. After subtracting the spectrum of the tertiary component, a spectral disentangling code was applied to reconstruct the individual spectra of the primary and secondary. We then analysed these spectra with the non-LTE model atmosphere code CMFGEN to establish the stellar parameters and the CNO abundances of these stars. The inner binaries of these systems have eccentric orbits with e ~ 0.13 despite their relatively short orbital periods of 8.6 and 3.7 days for HD17505Aa and HD206267Aa, respectively. Slight modifications of the CNO abundances are found in both components of each system. The components of HD17505Aa are both well inside their Roche lobe, whilst the primary of HD206267Aa nearly fills its Roche lobe around periastron passage. Whilst the rotation of the primary of HD206267Aa is in pseudo-synchronization with the orbital motion, the secondary displays a rotation rate that is higher. The CNO abundances and properties of HD17505Aa can be explained by single star evolutionary models accounting for the effects of rotation, suggesting that this system has not yet experienced binary interaction. The properties of HD206267Aa suggest that some intermittent binary interaction might have taken place during periastron passages, but is apparently not operating anymore.

Reference: A&A, in press
Status: Manuscript has been accepted

Weblink: https://arxiv.org/abs/1803.00243

Comments:

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A Runaway Yellow Supergiant Star in the Small Magellanic Cloud

Kathryn Neugent (1,2), Phil Massey (1), Nidia Morrell (3), Brian Skiff (1), Cyril Georgy (4)

1 - Lowell Observatory; 2 - University of Washington; 3 - Las Campanas Observatory; 4 - Geneva

University

We recently discovered a yellow supergiant (YSG) in the Small Magellanic Cloud (SMC) with a heliocentric radial velocity of ~300 km/s which is much larger than expected for a star in its location in the SMC. This is the first runaway YSG ever discovered and only the second evolved runaway star discovered in a different galaxy than the Milky Way. We classify the star as G5-8I, and use de-reddened broad-band colors with model atmospheres to determine an effective temperature of 4700+/-250K, consistent with what is expected from its spectral type. The star's luminosity is then L/Lo ~ 4.2+/-0.1, consistent with it being a ~30Myr 9Mo star according to the Geneva evolution models. The star is currently located in the outer portion of the SMC's body, but if the star's transverse peculiar velocity is similar to its peculiar radial velocity, in 10Myr the star would have moved 1.6 degrees across the disk of the SMC, and could easily have been born in one of the SMC's star-forming regions. Based on its large radial velocity, we suggest it originated in a binary system where the primary exploded as a supernovae thus flinging the runaway star out into space. Such stars may provide an important mechanism for the dispersal of heavier elements in galaxies given the large percentage of massive stars that are runaways. In the future we hope to look into additional evolved runaway stars that were discovered as part of our other past surveys.

Reference: AJ
Status: Manuscript has been accepted

Weblink: https://arxiv.org/abs/1803.02859

Comments:

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Subsonic structure and optically thick winds from Wolf-Rayet stars

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Mass loss by stellar wind is a key agent in the evolution and spectroscopic appearance of massive main sequence and post-main sequence stars. In Wolf–Rayet stars the winds can be so dense and so optically thick that the photosphere appears in the highly supersonic part of the outflow, veiling the underlying subsonic part of the star, and leaving the initial acceleration of the wind inaccessible to observations. Here we investigate the conditions and the structure of the subsonic part of the outflow of Galactic Wolf–Rayet stars, in particular of the WNE subclass; our focus is on the conditions at the sonic point of their winds. We compute 1D hydrodynamic stellar structure models for massive helium stars adopting outer boundaries at the sonic point. We find that the outflows of our models are accelerated to supersonic velocities by the radiative force from opacity bumps either at temperatures of the order of 200 kK by the iron opacity bump or of the order of 50 kK by the helium-II opacity bump. For a given mass-loss rate, the diffusion approximation for radiative energy transport allows us to define the temperature gradient based purely on the local thermodynamic conditions. For a given mass-loss rate, this implies that the conditions in the subsonic part of the outflow are independent from the detailed physical conditions in the supersonic part. Stellar atmosphere calculations can therefore adopt our hydrodynamic models as ab initio input for

the subsonic structure. The close proximity to the Eddington limit at the sonic point allows us to construct a Sonic HR diagram, relating the sonic point temperature to the luminosity-to-mass ratio and the stellar mass-loss rate, thereby constraining the sonic point conditions, the subsonic structure, and the stellar wind mass-loss rates of WNE stars from observations. The minimum stellar wind mass-loss rate necessary to have the flow accelerated to supersonic velocities by the iron opacity bump is derived. A comparison of the observed parameters of Galactic WNE stars to this minimum mass-loss rate indicates that these stars have their winds launched to supersonic velocities by the radiation pressure arising from the iron opacity bump. Conversely, stellar models which do not show transonic flows from the iron opacity bump form low-density extended envelopes. We derive an analytic criterion for the appearance of envelope inflation and of a density inversion in the outer sub-photospheric layers.

Reference: A&A, in press
Status: Manuscript has been accepted

Weblink: https://arxiv.org/abs/1803.03033

Comments:

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Polarization simulations of stellar wind bow shock nebulae. I. The case of electron scattering

Manisha Shrestha^1, Hilding R. Neilson^2, Jennifer L. Hoffman^1, Richard Ignace^3

1-University of Denver, 2-University of Toronto, 3-East Tennessee State University

Bow shocks and related density enhancements produced by the winds of massive stars moving through the interstellar medium provide important information regarding the motions of the stars, the properties of their stellar winds, and the characteristics of the local medium. Since bow shock nebulae are aspherical structures, light scattering within them produces a net polarization signal even if the region is spatially unresolved. Scattering opacity arising from free electrons and dust leads to a distribution of polarized intensity across the bow shock structure. That polarization encodes information about the shape, composition, opacity, density, and ionizsation state of the material within the structure. In this paper we use the Monte Carlo radiative transfer code SLIP to investigate the polarization created when photons scatter in a bow shock-shaped region of enhanced density surrounding a stellar source. We present results for electron scattering, and investigate the polarization behaviour as a function of optical depth, temperature, and source of photons for two different cases: pure scattering and scattering with absorption. In both regimes we consider resolved and unresolved cases. We discuss the implications of these results as well as their possible use along with observational data to constrain the properties of observed bow shock systems. In different situations and under certain assumptions, our simulations can constrain viewing angle, optical depth and temperature of the scattering region, and the relative luminosities of the star and shock.

Reference: MNRAS in press
Status: Manuscript has been accepted

Weblink: https://arxiv.org/abs/1712.04958

Comments:

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Co-existence and switching between fast and Omega-slow wind solutions in rapidly rotating massive stars

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Most radiatively-driven massive star winds can be modelled with m-CAK theory resulting in so called fast solution. However, those most rapidly rotating among them, especially when the stellar rotational speed is higher than ~ 75% of the critical rotational speed, can adopt a different solution called Omega-slow solution characterized by a dense and slow wind. Here, in this work we study the transition region of the solutions where the fast solution changes to the Omega-slow. Using both time-steady and time-dependent numerical codes, we study this transition region for different equatorial models of B-type stars. In all the cases, at certain range of rotational speeds, we found a region where the fast and Omega-slow solution can co-exist. We find that the type of solution obtained in this co-existence region depends heavily on the initial conditions of our models. We also test the stability of the solutions within the co-existence region by performing base density perturbations in the wind. We find that under certain conditions, the fast solution can switch to a Omega-slow solution, or vice versa. Such solution switching may be a possible contributor of material injected into the circumstellar environment of Be stars, without requiring rotational speeds near critical values.

Reference: accepted for publication in MNRAS
Status: Manuscript has been accepted

Weblink: https://arxiv.org/abs/1803.07572

Comments:

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Very Massive Stars: a metallicity-dependent upper-mass limit, slow winds, and the self-enrichment of Globular Clusters

Jorick S. Vink

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One of the key questions in Astrophysics concerns the issue of whether there exists an upper-mass limit to stars, and if so, what physical mechanism sets this limit, which might also determine if the upper-mass limit is metallicity (Z) dependent. We argue that mass loss by radiation-driven winds mediated by line opacity is one of the prime candidates setting the upper-mass limit. We present mass-loss predictions (dM/dt_wind) from Monte Carlo radiative transfer models for relatively cool (Teff = 15kK) inflated very massive stars (VMS) with large Eddington Gamma factors in the mass range 100-1000 Msun as a function of metallicity down to 1/100 Z/Zsun. We employ a hydrodynamic version of our Monte Carlo method, allowing us to predict the rate of mass loss (dM/dt_wind) and the terminal wind velocity (vinf) simultaneously. Interestingly, we find wind terminal velocities (vinf) that are low (100-500 km/s) over a wide Z-range, and we propose that the slow winds from VMS are an important source of self-enrichment in globular clusters. We also find mass-loss rates (dM/dt_wind), exceeding the typical mass-accretion rate (dM/dt_accr) of 0.001 Msun/yr during massive-star formation. We express our mass-loss predictions as a function of mass and Z, finding log dM/dt = -9.13 + 2.1 log(M/Msun) + 0.74 log(Z/Zsun) (Msun/yr). Even if stellar winds would not directly halt & reverse mass accretion during star formation, if the most massive stars form by stellar mergers stellar wind mass loss may dominate over the rate at which stellar growth takes place. We therefore argue that the upper-mass limit is effectively Z-dependent due to the nature of radiation-driven winds. This has dramatic consequences for the most luminous supernovae, gamma-ray bursts, and other black hole formation scenarios at different Cosmic epochs.

Reference: Astronomy & Astrophysics
Status: Manuscript has been accepted

Weblink: https://arxiv.org/abs/1803.08042

Comments: Accepted by A&A

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Searching for cool dust: ii. Infrared imaging of the OH/IR supergiants, NML Cyg, VX Sgr, S Per and the normal red supergiants RS Per and T Per

Michael S. Gordon[1], Roberta M. Humphreys[1], Terry J. Jones[1], Dinesh Shenoy[1], Robert D. Gehrz[2], L. Andrew Helton[2], Massimo Marengo[3], Philip M. Hinz[4], William F. Hoffman[4]

1. University of Minnesota, 2. USRA-SOFIA, 3. Iowa State Univsersity, 4. University of Arizona

New MMT/MIRAC(9–11μm),SOFIA/FORCAST(11–37μm), and Herschel/PACS (70 and 160μm) infrared(IR) imaging and photometry is presented for three famous OH/IR red supergiants(NML Cyg, VX Sgr, and S Per) and two normal red supergiants (RS Per and T Per). We model the observed spectral energy distributions (SEDs) using radiative transfer code DUSTY. Azimuthal average profiles from the SOFIA/FORCAST imaging, in addition to dust mass distribution profiles from DUSTY, constrain the mass-loss histories of these supergiants. For all of our observed supergiants, the DUSTY models suggest that constant mass-loss rates do not produce enough dust to explain the observed infrared emission in the stars' SEDs. Combining our results with Shenoy et al.(2016) (Paper I) we find mixed results with some red supergiants showing evidence for variable and high mass-loss events while others have constant mass loss over the past few thousand years.

Reference: AJ, in press
Status: Manuscript has been accepted

Weblink: https://arxiv.org/abs/1708.00018

Comments: To appear in the Astronomical Journal

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Lucky Spectroscopy, an equivalent technique to Lucky Imaging. Spatially resolved spectroscopy of massive close visual binaries using the William Herschel Telescope

J. Maíz Apellániz (1), R. H. Barbá (2), S. Simón-Díaz (3,4), A. Sota (5), E. Trigueros Páez (1,6), J. A. Caballero (1), E. J. Alfaro (5)

(1) CAB, (2) ULS, (3) ULL, (4) IAC, (5) IAA, (6) UA

CONTEXT: Many massive stars have nearby companions whose presence hamper their characterization through spectroscopy. AIMS: We want to obtain spatially resolved spectroscopy of close massive visual binaries to derive their spectral types. METHODS: We obtain a large number of short long-slit spectroscopic exposures of five close binaries under good seeing conditions, select those with the best characteristics, extract the spectra using multiple-profile fitting, and combine the results to derive spatially separated spectra. RESULTS: We demonstrate the usefulness of Lucky Spectroscopy by presenting the spatially resolved spectra of the components of each system, in two cases with separations of only ~0.3". Those are delta Ori Aa+Ab (resolved in the optical for the first time) and sigma Ori AaAb+B (first time ever resolved). We also spatially resolve 15 Mon AaAb+B, zeta Ori AaAb+B (both previously resolved with GOSSS, the Galactic O-Star Spectroscopic Survey), and eta Ori AaAb+B, a system with two spectroscopic B+B binaries and a fifth visual component. The systems have in common that they are composed of an inner pair of slow rotators orbited by one or more fast rotators, a characteristic that could have consequences for the theories of massive star formation.

Reference: Accepted for publication in A&A
Status: Manuscript has been accepted

Weblink: https://arxiv.org/abs/1804.03133

Comments:

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Spin rates and spin evolution of O components in WR+O binaries

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Despite 50 years of extensive binary research we must conclude that the Roche lobe overflow/mass transfer process that governs close binary evolution is still poorly understood. It is the scope of the present paper to lift the edge of the veil by studying the spin-up and spin-down processes of the O-type

components of WR+O binaries. We critically analyzed the available observational data of rotation speeds of the O-type components in WR+O binaries. By combining a binary evolutionary code and a formalism that describes the effects of tides in massive stars with an envelope in radiative equilibrium, we computed the corresponding rotational velocities during the Roche lobe overflow of the progenitor binaries. In all the WR+O binaries studied, we find that the O-type stars were affected by accretion of matter during Roche lobe overflow (RLOF) of the progenitor. This means that common envelope evolution, which excludes any accretion onto the secondary O star, has not played an important role in explaining WR+O binaries. Moreover, although it is very likely that the O-type star progenitors were spun up by mass transfer, many ended the RLOF (and mass transfer) phase with a rotational velocity that is significantly smaller than the critical rotation speed. This may indicate that during the mass transfer phase there is a spin-down process that is of the same order, although significantly less, than that of the spin-up process. We propose a Spruit-Tayler type dynamo spin-down suggested in the past to explain the rotation speeds of the mass gainers in long-period Algols.

Reference: Astronomy and Astrophysics
Status: Manuscript has been accepted

Weblink: arXiv: 1711.05989

Comments:

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A search for Galactic runaway stars using Gaia Data Release 1 and Hipparcos proper motions

J. Maíz Apellániz (1), M. Pantaleoni González (1,2), R. H. Barbá (3), S. Simón-Díaz (4,5), I. Negueruela (6), D. J. Lennon (7), A. Sota (8), E. Trigueros Páez (1,6)

(1) CAB, CSIC-INTA, (2) UCM, (3) ULS, (4) IAC, (5) ULL, (6) UA, (7) ESA, (8) IAA

CONTEXT.The first Gaia Data Release (DR1) significantly improved the previously available proper motions for the majority of the Tycho-2 stars. AIMS. We want to detect runaway stars using Gaia DR1 proper motions and compare our results with previous searches. METHODS. Runaway O stars and BA supergiants are detected using a 2-D proper-motion method. The sample is selected using Simbad, spectra from our GOSSS project, literature spectral types, and photometry processed using CHORIZOS. RESULTS. We detect 76 runaway stars, 17 (possibly 19) of them with no prior identification as such, with an estimated detection rate of approximately one half of the real runaway fraction. An age effect appears to be present, with objects of spectral subtype B1 and later having travelled for longer distances than runaways of earlier subtypes. We also tentatively propose that the fraction of runaways is lower among BA supergiants that among O stars but further studies using future Gaia data releases are needed to confirm this. The frequency of fast rotators is high among runaway O stars, which indicates that a significant fraction of them (and possibly a majority) is produced in supernova explosions.

Reference: Accepted for publication in A&A
Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/1804.06915

Comments:

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CLOSED JOB OFFERS

Post-doctoral position in stellar physics in Tartu Observatory, Estonia

Anna Aret

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Estonia

Applications are invited for a post-doctoral position in the Department of Stellar Physics of Tartu Observatory, University of Tartu. The successful applicant will work with Drs. Indrek Kolka, Laurits Leedjärv and Anna Aret on investigating massive stars in post-main sequence evolution phases, their pulsation habits, and mass-loss behaviour. The ideal candidate will have a background in stellar physics (massive star evolution, stellar winds, and/or circumstellar discs) and have experience with observations (spectroscopy, photometry and/or interferometry), data reduction, and data analysis of optical and/or infrared data. The applicant must hold a PhD degree in the field (max 6 years from PhD) by the date of employment.

Tartu Observatory is the largest professional astronomical organization in Estonia conducting research in the fields of astronomy, remote sensing, and space technology. It is located in Tõravere, approximately 20 km out of Tartu. The main building of Tartu Observatory has been completely renovated in 2011 - 2012, providing a modern research environment. The department offers excellent computing facilities and fast internet connection. In 2015, Estonia became a full member of the European Space Agency. The Department of Stellar Physics operates a 1.5m telescope with a single-slit spectrograph, 0.6m and 0.3m telescopes with CCD photometers.

Salary will be based on the domestic level and it includes health insurance. Starting salary will be in the range 1700 - 2400 EUR. See http://www.numbeo.com/cost-of-living/comparison.jsp to compare cost of living.

The appointment is initially for one year, an extension for another year is expected upon satisfactory scientific performance. The preferred starting date shall be between June 1st 2018 and September 1st 2018 but can be negotiated.

Applicants should submit:
1) a curriculum vitae with a full publication list,
2) a statement of interest (max. 2 pages),
3) a summary of the research experience (max. 2 pages).
Applicants must also provide the names and contact details of two referees who would be prepared to send confidential recommendation letters should they be requested to do so. The selection committee will send out requests for such letters for those applicants on the short-list after an initial ranking. The short-listed applicants will be invited for an interview (live or via Skype). Applications can be submitted before finishing PhD, in which case a statement from the supervisor stating the planned date of the defence should be included.

The application materials should be sent by email to: info@to.ee (subject: "postdoc 2018", pdf file please), to arrive no later than 23:59 EET on April 15, 2018. Interviews will be held during May 2018 and the selected candidate will be contacted at the latest by May 31, 2018.

Additional information may be obtained by contacting Dr. Anna Aret (anna.aret@to.ee).

Attention/Comments:

Weblink: https://www.to.ee/eng/vacancies/post_doctoral_position_in_stellar_physics

Email: anna.aret@to.ee

Deadline: April 15, 2018

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Two PhD positions in stellar physics at Geneva Observatory

Georges Meynet

Geneva University

Applications are invited for 2 PhD student positions in theoretical and computational astrophysics at the Department of Astronomy of the University of Geneva to start in fall 2018. The successful candidates will work within the group of Prof. Georges Meynet on the fields of the evolution of massive stars and star-planet interactions

The potential research projects are along two different lines of research. A first line is focused on the physics of massive stars with a strong emphasis on the nature of the core collapse supernova progenitors. A second line will focus on smaller initial mass stars, studying various effects in relation with star-planet interactions and asteroseismology. In both lines of researches, nucleosynthetic aspects will be explored (for instance chemical composition of the ejecta for the core-collapse supernovae, change of the surface abundances of stars engulfing planet).

The Geneva Observatory and the associated Laboratory of Astrophysics of the Swiss Federal Institute of Technology in Lausanne (EPFL) carry out observational, interpretative, and theoretical research in the fields of extra-solar planets, stellar physics, high energy astrophysics, galaxy evolution and dynamics, and observational cosmology, providing a rich and vibrant research environment.

These PhD projects will run in parallel to the COST Action entitled “Chemical Elements as Tracers of the Evolution of the Cosmos” (ChETEC, see http://www.chetec.eu for more details). The ChETEC COST Action will offer great opportunities (training, networking, collaborations with both academic and industrial partners) for the successful candidate.

Applications are invited from candidates with a solid background in physics or astronomy and should consist of a cover letter explaining the motivation for seeking a PhD in theoretical and computational astrophysics and especially the aforementioned research fields, a statement outlining any research experience so far (<1 page each), a CV, and a copy of the Bachelor and Master academic record (exams, theses, and grades). Candidates should also provide names and e-mail addresses of at least two references. Applications should be sent as a single PDF file to georges.meynet@unige.ch

Complete applications received by 15 May 2018 will receive full consideration, but the search will remain open until the positions are filled. Preliminary inquiries may be addressed via e-mail to georges.meynet@unige.ch

Included Benefits:

Generous Salary (~50’000-60’000 CHF), Standard Swiss Social Security, Accident Insurance, Pension contributions, Maternal leave and access to family support programs (see: http://www.snf.ch/en/funding/supplementary-measures/flexibility-grant/Pages/default.aspx#)

Attention/Comments:

Weblink: http://www.unige.ch/sciences/astro/en/research/stars/

Email: georges.meynet@unige.ch

Deadline: 15 May 2018

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