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THE MASSIVE STAR NEWSLETTER

formerly known as the hot star newsletter

*

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News

IAU Working Group --> New IAU Massive Stars Commission

dear friends,
this is our last Massive Star Newsletter as an IAU Working Group. The next will be the first one distributed under the new IAU Commission on Massive Stars. On behalf of the Organizing Committee I would like to thank all people that contributed to the success of the Working Group and its Newsletter, its preparation and distribution. Thanks to all former chairs and members of the Organizing Committee, the editors of the Newsletter, Philippe Eenens and Raphael Hirschi, and the Universidad Nacional Autonoma de Mexico team that supports its distribution and our webpage. Thanks finally to all members of the Working Group for its daily effort in favour of this exciting field of massive stars.

with best regards,
Artemio Herrero,
chair, on behalf of the Massive Stars Working Group

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New Massive Stars Commission -- Reminder

dear friends,
this is a kind remind for those of you interested in joining the new Massive Stars Commission but that still didn't. Do it asap, as the registration closes after May, 15. To register you have to be an official IAU member and follow the instructions sent by General Secretary on his email from April 29.

with best regards,
Artemio Herrero,
chair, on behalf of the Massive Stars Working Group

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PAPERS

Abstracts of 14 accepted papers

Radiation-driven winds of hot luminous stars XVIII. The unreliability of stellar and wind parameter determinations from optical vs. UV spectral analysis of selected central stars of planetary nebulae and the possibility of some CSPNs as single-star supernova Ia progenitors

T. L. Hoffmann, A. W. A. Pauldrach, and C. B. Kaschinski

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Context. The uncertainty in the degree to which radiation-driven winds of hot stars might be affected by small inhomogeneities in the density leads to a corresponding uncertainty in the determination of the atmospheric mass loss rates from the strength of optical recombination lines and – since the mass loss rate is not a free parameter but a function of the stellar parameters mass, radius, luminosity, and abundances – in principle also in the determination of these stellar parameters. Furthermore, the optical recombination lines also react sensitively to even small changes in the density structure resulting from the (often assumed instead of computed) velocity law of the outflow. This raises the question of how reliable the parameter determinations from such lines are.
Aims. The currently existing severe discrepancy between CSPN (central stars of planetary nebulae) stellar and wind parameters derived from model fits to the optical spectra and those derived using hydrodynamically consistent model fits to the UV spectra is to be reassessed via a simultaneous optical/UV analysis using a state-of-the-art model atmosphere code.
Methods. We have modified our hydrodynamically consistent model atmosphere code with an implementation of the usual ad-hoc treatment of clumping (small inhomogeneities in the density) in the wind. This allows us to re-evaluate, with respect to their influence on the appearance of the UV spectra and their compatibility with the observations, the parameters determined in an earlier study that had employed clumping in its models to achieve a fit to the observed optical spectra.
Results. The discrepancy between the optical and the UV analyses is confirmed to be the result of a missing consistency between stellar and wind parameters in the optical analysis. While clumping in the wind does significantly increase the emission in the optical hydrogen and helium recombination lines, the influence of the density (velocity field) is of the same order as that of moderate clumping factors.Moderate clumping factors leave the UV spectra mostly unaffected, indicating that the influence on the ionization balance, and thus on the radiative acceleration, is small. Instead of the erratic behavior of the clumping factors claimed fromthe optical analyses, our analysis based on the velocity field computed from radiative driving yields similar clumping factors for all CSPNs, with a typical value of f_cl = 4. With and without clumping, wind strengths and terminal velocities consistent with the stellar parameters from the optical analysis give spectra incompatible with both optical and UV observations, whereas a model that consistently implements the physics of radiation driven winds achieves a good fit to both the optical and UV observations with a proper choice of stellar parameters. The shock temperatures and the ratios of X-ray to bolometric luminosity required to reproduce the highly ionized Ovi line in the FUSE spectral range agree with those known from massive O stars (LX/Lbol ~ 10-7 . . . 10-6), again

confirming the similarity of O-type CSPN and massive O star atmospheres and further strengthening the claim that both have identical wind driving mechanisms.
Conclusions. The similarity of the winds of O-type CSPNs and those of massive O stars justifies using the same methods based on the dynamics of radiation-driven winds in their analysis, thus supporting the earlier result that several of the CSPNs in the sample have near-Chandrasekhar-limit masses and may thus be possible single-star progenitors of type Ia supernovae.

Reference: Publication in A&A.
Pre-print available on astro-ph.
Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/1307.2948

Comments: 17 figures, and 3 tables

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B fields in OB stars (BOB): FORS2 spectropolarimetric follow-up of the two rare rigidly rotating magnetosphere stars HD23478 and HD345439

S. Hubrig(1), M. Schoeller(2), L. Fossati(3), T. Morel(4), N. Castro(3), L.M. Oskinova(5), N. Przybilla(6), S.S. Eikenberry(7), M.F. Nieva(6), N. Langer(3), the BOB collaboration

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Massive B-type stars with strong magnetic fields and fast rotation are very rare and pose a mystery for theories of star formation and magnetic field evolution. Only two such stars, called sigma Ori E analogues, were known until recently. A team involved in APOGEE, one of the Sloan Digital Sky Survey III programs, announced the discovery of two additional rigidly rotating magnetosphere stars, HD23478 and HD345439. The magnetic fields in these newly discovered sigma Ori E analogues have not been investigated so far.

In the framework of our ESO Large Programme and one normal ESO programme, we carried out low-resolution FORS2 spectropolarimetric observations of HD23478 and HD345439.

In the measurements of hydrogen lines, we discover a rather strong longitudinal magnetic field of up to 1.5kG in HD23478 and up to 1.3kG using the entire spectrum. The analysis of HD345439 using four subsequent spectropolarimetric subexposures does not reveal a magnetic field at a significance level of 3sigma. On the other hand, individual subexposures indicate that HD345439 may host a strong magnetic field that rapidly varies over 88 minutes. The fast rotation of HD345439 is also indicated by the behaviour of several metallic and He I lines in the low-resolution FORS2 spectra that show profile variations already on this short time-scale.

Reference: Accepted for publication as a letter to A&A.
Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/1505.02447

Comments:

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The flux-weighted gravity-luminosity relationship of blue supergiant stars as a constraint for stellar evolution

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The flux-weighted gravity-luminosity relationship (FGLR) of blue supergiant stars (BSG) links their absolute magnitude to the spectroscopically determined flux-weighted gravity log(g/Teff^4). BSG are the brightest stars in the universe at visual light and the application of the FGLR has become a powerful tool to determine extragalactic distances.
Observationally, the FGLR is a tight relationship with only small scatter. It is, therefore, ideal to be used as a constraint for stellar evolution models. The goal of this work is to investigate whether stellar evolution can reproduce the observed FGLR and to develop an improved foundation of the FGLR as an extragalactic distance indicator. We use different grids of stellar models for initial masses between 9 and 40 Msun, for metallicities between Z=0.002 and 0.014, with and without rotation, computed with various mass loss rates during the red supergiant phase. For each of these models we discuss the details of post-main sequence evolution and construct theoretical FGLRs by means of population synthesis models which we then compare with the observed FGLR.In general, the stellar evolution model FGLRs agree reasonably well with the observed one. There are, however, differences between the models, in particular with regard to the shape and width (scatter) in the flux-weighted gravity-luminosity plane. The best agreement is obtained with models which include the effects of rotation and assume that the large majority, if not all the observed BSG evolve towards the red supergiant phase and only a few are evolving back from this stage. The effects of metallicity on the shape and scatter of the FGLR are small. The shape, scatter and metallicity dependence of the observed FGLR are well explained by stellar evolution models. This provides a solid theoretical foundation for the use of this relationship as a robust extragalactic distance indicator.

Reference: Astronomy and Astrophysics, in press
Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/1505.00603

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A Modern Search for Wolf-Rayet Stars in the Magellanic Clouds. II. A Second Year of Discoveries

Philip Massey (1), Kathryn F. Neugent (1), Nidia Morrell (2)

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The numbers and types of evolved massive stars found in nearby galaxies provide an exacting test of stellar evolution models. Because of their proximity and rich massive star populations, the Magellanic Clouds have long served as the linchpins for such studies. Yet the continued accidental discoveries of Wolf-Rayet (WR) stars in these systems demonstrate that our knowledge is not as complete as usually assumed. Therefore, we undertook a multi-year survey for WRs in the Magellanic Clouds. Our results from our first year (reported previously) confirmed nine new LMC WRs. Of these, six were of a type never before recognized, with WN3-type emission combined with O3-type absorption features. Yet these stars are 2-3 magnitudes too faint to be WN3+O3~V binaries. Here we report on the second year of our survey, including the discovery of four more WRs, two of which are also WN3/O3s, plus two ``slash" WRs. This brings the total of LMC WRs known to 152, 13 (8.2%) of which were found by our survey, which is now ~60% complete. We find that the spatial distribution of the WN3/O3s is similar to that of other WRs in the LMC, suggesting that they are descended from the same progenitors. We call attention to the fact that five of the 12 known SMC WRs may in fact be similar WN3/O3s rather than the binaries they have often been assumed to be. We also discuss our other discoveries: a newly found Onfp-type star, and a peculiar emission-line object. Finally, we consider the completeness limits of our survey.

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

Weblink: http://arxiv.org/abs/1505.06265

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An infrared diagnostic for magnetism in hot stars

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Magnetospheric observational proxies are used for indirect detection of magnetic fields in hot stars in the X-ray, UV, optical, and radio wavelength ranges. To determine the viability of infrared (IR) hydrogen recombination lines as a magnetic diagnostic for these stars, we have obtained low-resolution (R~1200), near-IR spectra of the known magnetic B2V stars HR 5907 and HR 7355, taken with the Ohio State Infrared Imager/Spectrometer (OSIRIS) attached to the 4.1m Southern Astrophysical Research (SOAR) Telescope. Both stars show definite variable emission features in IR hydrogen lines of the Brackett series, with similar properties as those found in optical spectra, including the derived location of the detected magnetospheric plasma. These features also have the added advantage of a lowered contribution of stellar flux at these wavelengths, making circumstellar material more easily detectable. IR diagnostics will be useful for the future study of magnetic hot stars, to detect and analyze lower-density environments, and to

detect magnetic candidates in areas obscured from UV and optical observations, increasing the number of known magnetic stars to determine basic formation properties and investigate the origin of their magnetic fields.

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

Weblink: http://arxiv.org/abs/1505.01739

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Revisiting the Rigidly Rotating Magnetosphere model for σ Ori E - II. Magnetic Doppler imaging, arbitrary field RRM, and light variability

M. E. Oksala, O. Kochukhov, J. Krticka, R. H. D. Townsend, G. A. Wade, M. Prvak, Z. Mikulasek, J. Silvester, S. P. Owocki

Observatoire de Paris-Meudon, University of Delaware, Astronomical Insitute ASCR, Uppsala Univeristy, University of Wisconsin-Madison, RMC, Masaryk Univeristy, Queen's University

The initial success of the Rigidly Rotating Magnetosphere (RRM) model application to the B2Vp star sigma Ori E by Townsend, Owocki & Groote (2005) triggered a renewed era of observational monitoring of this archetypal object. We utilize high-resolution spectropolarimetry and the magnetic Doppler imaging (MDI) technique to simultaneously determine the magnetic configuration, which is predominately dipolar, with a polar strength Bd = 7.3-7.8 kG and a smaller non-axisymmetric quadrupolar contribution, as well as the surface distribution of abundance of He, Fe, C, and Si. We describe a revised RRM model that now accepts an arbitrary surface magnetic field configuration, with the field topology from the MDI models used as input. The resulting synthetic Ha emission and broadband photometric observations generally agree with observations, however, several features are poorly fit. To explore the possibility of a photospheric contribution to the observed photometric variability, the MDI abundance maps were used to compute a synthetic photospheric light curve to determine the effect of the surface inhomogeneities. Including the computed photospheric brightness modulation fails to improve the agreement between the observed and computed photometry. We conclude that the discrepancies cannot be explained as an effect of inhomogeneous surface abundance. Analysis of the UV light variability shows good agreement between observed variability and computed light curves, supporting the accuracy of the photospheric light variation calculation. We thus conclude that significant additional physics is necessary for the RRM model to acceptably reproduce observations of not only sigma Ori E, but also other similar stars with significant stellar wind-magnetic field interactions.

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

Weblink: http://arxiv.org/abs/1505.04839

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Simultaneous X-ray and optical spectroscopy of the Oef supergiant lambda Cep

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Probing the structures of stellar winds is of prime importance for the understanding of massive stars. Based on their optical spectral morphology and variability, the stars of the Oef class have been suggested to feature large-scale structures in their wind. High-resolution X-ray spectroscopy and time-series of X-ray observations of presumably-single O-type stars can help us understand the physics of their stellar winds. We have collected XMM-Newton observations and coordinated optical spectroscopy of the O6Ief star lambda Cep to study its X-ray and optical variability and to analyse its high-resolution X-ray spectrum. We investigate the line profile variability of the He II 4686 and H-alpha emission lines in our time series of optical spectra, including a search for periodicities. We further discuss the variability of the broadband X-ray flux and analyse the high-resolution spectrum of lambda Cep using line-by-line fits as well as a code designed to fit the full high-resolution X-ray spectrum consistently. During our observing campaign, the He II lambda 4686 line varies on a timescale of ~18 hours. On the contrary, the H-alpha line profile displays a modulation on a timescale of 4.1 days which is likely the rotation period of the star. The X-ray flux varies on time-scales of days and could in fact be modulated by the same 4.1 days period as H-alpha, although both variations are shifted in phase. The high-resolution X-ray spectrum reveals broad and skewed emission lines as expected for the X-ray emission from a distribution of wind-embedded shocks. Most of the X-ray emission arises within less than 2 R* above the photosphere.

Reference: Astronomy & Astrophysics, in press
Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/1505.07714

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Tight asteroseismic constraints on core overshooting and diffusive mixing in the slowly rotating pulsating B8.3V star KIC 10526294

Ehsan Moravveji ^{1}, Conny Aerts ^{1,2}, Peter I. Papics ^{1}, Santiago Andres Triana ^{1}, Bram Vandoren ^{1}

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KIC 10526294 was recently discovered to be a very slowly rotating and slowly pulsating late B-type star. Its 19 consecutive dipole gravity modes constitute a series with almost constant period spacing. This unique collection of identified modes probes the near-core environment of this star and holds the potential

to reveal the size and structure of the overshooting zone above the convective core, as well as the mixing properties of the star.

We revisit the asteroseismic modelling of this star with specific emphasis on the properties of the core overshooting, while considering additional diffusive mixing throughout the radiative envelope of the star.

We pursued forward seismic modelling based on adiabatic eigenfrequencies of equilibrium models for eight extensive evolutionary grids tuned to KIC 10526294 by varying the initial mass, metallicity, chemical mixture, and the extent of the overshooting layer on top of the convective core. We examined models for both OP and OPAL opacities and tested the occurrence of extra diffusive mixing throughout the radiative interior.

We find a tight mass-metallicity relation within the
ranges M from 3.13 to 3.25 M_sun and Z from 0.014 to 0.028. We deduce that an exponentially decaying diffusive core overshooting prescription
describes the seismic data better than a step function formulation and derive a value of f_ov between 0.017 and 0.018. Moreover, the inclusion of extra diffusive mixing with a value of log D_{mix} between 1.75 and 2.00 dex (with D_{mix} in cm^2/sec) improves the goodness-of-fit based on the observed and modelled frequencies by a factor 11 compared to the case where no extra mixing is considered, irrespective of the (M,Z) combination within the allowed seismic range.

The inclusion of diffusive mixing in addition to core overshooting is essential to explain the structure in the observed period spacing pattern of this star. Moreover, for the input physics and chemical mixtures we investigated, we deduce that an exponentially decaying prescription for the core overshooting is to be preferred over a step function, regardless of the adopted mixture or choice of opacity tables. Our best models for KIC 10526294 approach the seismic data to a level that they can serve future inversion of its stellar structure.

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

Weblink: http://adsabs.harvard.edu/abs/2015arXiv150506902M

Comments: :-)

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Massive stars in the W33 giant molecular complex

Maria Messineo(1,2), J. Simon Clark(3), Donald F. Figer(4), Rolf-Peter Kudritzki(5,11), Francisco Najarro(6), R. Michael Rich(7), Karl M. Menten(1), Valentin D. Ivanov(8,9), Elena Valenti(9), Christine Trombley(4), C.-H. Rosie Chen(1), Ben Davies(10)

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Rich in HII regions, giant molecular clouds are natural laboratories to study massive stars and sequential star formation. The Galactic star forming complex W33 is located at l=~12.8deg and at a distance of 2.4 kpc, has a size of ~10 pc and a total mass of (~0.8 - ~8.0) X 10^5 Msun. The integrated radio and IR luminosity of W33 - when combined with the direct detection of methanol masers, the protostellar object W33A, and protocluster embedded within the radio source W33 main - mark the region out as a site of vigorous ongoing star formation. In order to assess the long term star formation history, we performed an infrared spectroscopic search for massive stars, detecting for the first time fourteen early-type stars, including one WN6 star and four O4-7 stars. The distribution of spectral types suggests that this population formed during the last ~2-4 Myr, while the absence of red supergiants precludes extensive star formation at ages 6-30 Myr. This activity appears distributed throughout the region and does not appear to have yielded the dense stellar clusters that characterize other star forming complexes such as Carina and G305. Instead, we anticipate that W33 will eventually evolve into a loose stellar aggregate, with Cyg OB2 serving as a useful, albeit richer and more massive, comparator. Given recent distance estimates, and despite a remarkably similar stellar population, the rich cluster Cl 1813-178 located on the north-west edge of W33 does not appear to be physically associated with W33.

Reference: 2015, ApJ, 805, 110
Status: Manuscript has been accepted

Weblink: http://cdsads.u-strasbg.fr/abs/2015ApJ...805..110M

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Tentative insight into the multiplicity of the persistent dust maker WR106 from X-ray observations

De Becker, M.

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This paper presents the results of the analysis of the very first dedicated X-ray observation with XMM-Newton of WR106. This carbon-rich WC9d Wolf-Rayet star belongs to the category of persistent dust makers (WCd stars). The issue of the multiplicity of these dust makers is pivotal to understand the dust formation process, and in this context X-ray observations may allow to reveal an X-ray emission attributable to colliding-winds in a binary system. The main result of this analysis is the lack of detection of X-rays coming from WR106. Upper limits on the X-ray flux are estimated, but the derived numbers are not sufficient to provide compelling constraints on the existence or not of a colliding-wind region. Detailed inspection of archive data bases reveals that persistent dust makers have been poorly investigated by the most sensitive X-ray observatories. Certainly, the combination of several approaches to indirectly constrain their multiplicity should be applied to lift a part of the veil on the nature of these persistent dust makers.

Reference: 2015, New Astronomy, in press
Status: Manuscript has been accepted

Weblink: http://orbi.ulg.ac.be/handle/2268/182251

Comments:

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Long-term XMM-Newton investigation of two particle-accelerating colliding-wind binaries in NGC6604: HD168112 and HD167971

De Becker, M.

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The long-term (over more than one decade) X-ray emission from two massive stellar systems known to be particle accelerators is investigated using XMM-Newton. Their X-ray properties are interpreted taking into account recent information about their multiplicity and orbital parameters. The two targets, HD168112 and HD167971 appear to be overluminous in X-rays, lending additional support to the idea that a significant contribution of the X-ray emission comes from colliding-wind regions. The variability of the X-ray flux from HD168112 is interpreted in terms of varying separation expected to follow the 1/D rule for adiabatic shocked winds. For HD167971, marginal decrease of the X-ray flux in September 2002 could tentatively be explained by a partial wind eclipse in the close pair. No long-term variability could be demonstrated despite the significant difference of separation between 2002 and 2014. This suggests the colliding-wind region in the wide orbit does not contribute a lot to the total X-ray emission, with a main contribution coming from the radiative shocked winds in the eclipsing pair. The later result provides evidence that shocks in a colliding-wind region may be efficient particle accelerators even in the absence of bright X-ray emission, suggesting particle acceleration may operate in a wide range of conditions. Finally, in hierarchical triple O-type systems, thermal X-rays do not necessarily constitute an efficient tracer to detect the wind-wind interaction in the long period orbit.

Reference: 2015, MNRAS, 451, 5589-5599
Status: Manuscript has been accepted

Weblink: http://orbi.ulg.ac.be/handle/2268/182374

Comments:

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Observational signatures of convectively driven waves in massive stars

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We demonstrate observational evidence for the occurrence of convectively driven internal gravity waves (IGW) in young massive O-type stars observed with high-precision CoRoT space photometry. This evidence results from a comparison between velocity spectra based on 2D hydrodynamical simulations of IGW in a differentially-rotating massive star and the observed spectra.We also show that the velocity spectra caused by IGW may lead to detectable line-profile variability and explain the occurrence of macroturbulence in the observed line profiles of OB stars. Our findings provide predictions that can readily be tested by including a sample of bright slowly and rapidly rotating OB-type stars in the

scientific programme of the K2 mission accompanied by high-precision spectroscopy and their confrontation with multi-dimensional hydrodynamic simulations of IGW for various masses and ages.

Reference: ApJ Letters, in press
Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/1505.06648

Comments:

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X-rays from the oxygen-type Wolf-Rayet binary WR30a

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We present an analysis of XMM-Newton X-ray data of WR30a (WO+O), a close massive binary that harbours an oxygen-rich Wolf-Rayet star. Its spectrum is characterized by the presence of two well-separated broad peaks, or `bumps', one peaking at energies between 1 and 2 keV and the other between 5 and 7 keV. A two-component model is required to match the observed spectrum. The higher energy spectral peak is considerably more absorbed and dominates the X-ray luminosity. For the currently accepted distance of 7.77 kpc, the X-ray luminosity of WR30a is L_X > 10^{34} erg s^{-1}, making it one of the most X-ray luminous WR+O binary amongst those in the Galaxy with orbital periods less than ~20 d. The X-ray spectrum can be acceptably fitted using either thermal or nonthermal models, so the X-ray production mechanism is yet unclear.

Reference: Monthly Notices of the Royal Astronomical Society
Status: Manuscript has been accepted

Weblink: http://xxx.lanl.gov/abs/1506.04634

Comments:

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Asymmetric supernova remnants generated by Galactic, massive runaway stars

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After the death of a runaway massive star, its supernova shock wave interacts with the bow shocks produced by its defunct progenitor, and may lose its spherical symmetry before expanding into the local interstellar medium (ISM). We investigate whether the initial mass and space velocity of these progenitors can be associated with asymmetric supernova remnants. We run hydrodynamical models of supernovae exploding in the pre-shaped medium of moving Galactic core-collapse progenitors. We find that bow shocks that accumulate more than about 1.5 Mo generate asymmetric remnants. The shock wave collides 160-750 yr up to 830-4900 yr after the supernova with these bow shocks then located at about 1.35-5 pc from the center of the explosion. It expands freely into the ISM whereas it is channelled into the region of undisturbed wind material moving in the opposite direction. This applies to an initially 20 Mo progenitor moving with velocity 20 km/s and to our initially 40 Mo progenitor. These remnants generate mixing of ISM gas, stellar wind and supernova ejecta that is particularly important upstream from the center of the explosion. Their lightcurves are dominated by emission from optically-thin cooling and by X-ray emission of the shocked ISM gas. We find that these remnants are likely to be observed in the [OIII] 5007 spectral line emission or in the soft energy-band of X-rays. Finally, we discuss our results in the context of observed Galactic supernova remnants such as 3C391 and the Cygnus Loop.

Reference: Meyer D. et al., MNRAS (450) 2015
Status: Manuscript has been accepted

Weblink: http://cdsads.u-strasbg.fr/abs/2015MNRAS.450.3080M

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MEETINGS

Waves inside Stars: Theory, Simulations, Observational Signatures, and Lab Experiments

Monday 31 August 2015

Venue: Freiburg

Waves inside Stars: Theory, Simulations, Observational Signatures, and Lab Experiments

Splinter session, Monday 31 August, 10h - 12h30, during

SOLARNET III / HELAS VII / SpaceInn Conference "The Sun, the stars, and solar-stellar relations"

http://www.iac.es/congreso/solarnet-3meeting/

Organisers:

Tamara Rogers (Newcastle University, UK)
Conny Aerts (Leuven University, B)

Abstract:

Waves are as ubiquitous in stars as they are on Earth. Just as on Earth, waves can transport angular momentum and mix species within stellar interiors, steering their rotational and chemical evolution. Waves also set up standing modes which can be observed through helio- and asteroseismology. Helioseismology has revolutionized our picture of the Sun, constraining the internal rotation profile and convective undershooting in the solar interior. Asteroseismology is not far behind, recently constraining core-envelope differential rotation and core convective overshooting in more massive stars. Indeed, the observations of waves through helio- and asteroseismology places the tightest constraints on the dynamical evolution those same waves induce.

This 2.5 hour splinter session aims to bring together researchers doing theory, simulations, and observations of waves in stars (gravity, pressure and mixed) with the hope that the synergy between the three (often disparate) fields could lead to tests and comparisons which would further our understanding of stellar interiors. Moreover, we include also studies of wave generation by convection in laboratory experiments to search for connections between those and stellar physics. We begin this session with four short talks on each of the sub-topics and will then continue with a guided discussion on how these fields can work together to advance our understanding.

Programme: Monday 31 August, 10:00 - 12:30

10:00 - 10:30 Theory: Stephane Mathis (Saclay, France)
10:30 - 11:00 Simulations: Tami Rogers (Newcastle, UK)
11:00 - 11:15 Observational Signatures: Conny Aerts (Leuven, B)
11:15 - 11:30 Lab Experiments: Santiago Andres Triana (Leuven, B)

11:30 - 11:45 Short Coffee Break

11:45 - 12:25 Guided discussion, participants are encouraged to bring 1 slide
12:25 - 12:30 Summary of Synergies & Future Steps

Weblink: http://www.iac.es/congreso/solarnet-3meeting/

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