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THE MASSIVE STAR NEWSLETTER

formerly known as the hot star newsletter

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CONTENTS OF THIS NEWSLETTER:

Abstracts of 1 submitted papers

The VLT-FLAMES Tarantula Survey. XIV: On the nature of O,V z stars in 30 Doradus

Abstracts of 1 conference proceedings

Rotational properties of the O-type star population in the Tarantula region

Jobs

POSTDOCTORAL POSITION IN MASSIVE STARS

Meetings

The Space Photometry Revolution
Eta Carina Coordination Meeting January 9, 10, 2014:

News

Call for organizing the next massive star meeting (2017)

Dear colleagues,

this is a reminder that the Organizing Committee of the Massive Star Working Group will consider proposals for the organization of the next Massive Star Symposium before October 15.

after the fantastic meeting in Rhodes (thanks to Alceste Bonanos and
Danny Lennon as organizers) we have to start preparing the next
Massive Stars Meeting. We foresee that this meeting will probably take place in 2017.

With this call the Organizing Committee of our Massive Stars Working Group
invites any interested people to send an email before next October 15th
communicating his/her interest in organizing the next meeting.
The email shall be sent to me as chair of the OC (ahd-at-iac.es).

We do not want that anyone spends too much time and effort with
the proposals. A short email indicating the willingness to organize the meeting
with some comments about the adequacy of the proposed place will
be enough.

The OC will consider all proposals and select one of the proposed places
before end of the year, based on criteria like:
- the meeting location (traditionally, our group prefers locations near a beach where
a relaxed atmosphere favours personal contacts)
- the availability of hotels with large conference rooms (at least 200 people)
and meeting facilities at affordable prices

- the support of a local astronomical community
- the balance of locations hosting our meetings

best regards,
Artemio Herrero
chair of the Organizing Committee of the IAU Massive Stars Working Group

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Back to contents

PAPERS

Abstracts of 20 accepted papers

UV diagnostic of porosity-free mass-loss estimates in B stars

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We seek to establish evidence in UV P Cygni line profiles that the signs of wind clumping and porosity vary with velocity. We aim to demonstrate empirically that while at most wind velocities optically thick clumps cover only a fraction of the stellar surface, close to the terminal velocity where narrow absorption components (NACs) appear in UV lines the covering factor is approximately unity. SEI line-synthesis models are used to determine the radial optical depths of blue and red components of the SiIV 1400 resonance line doublet in a sample of 12 B0 to B4 supergiants. We focus on stars with well developed NACs and relatively low terminal velocity so that the SiIV doublet components can be treated as radiatively decoupled and formed independently. For all 12 stars the mean optical depth ratio of the blue to red components is closer to ~ 2 (i.e. the ratio of oscillator strengths) in the NACs than at intermediate and lower velocities. The product of mass-loss rate and Si^3+ ion fraction calculated from the NAC optical depths is a factor of ~ 2 to 9 higher compared to mass-loss values sampled at ~ 0.4 to 0.6 of the terminal velocity. Since the wind effectively becomes `smooth' at the high NAC velocities and the column density is uniformly distributed over the stellar disk, the optical depths of the NACs are not seriously affected by porosity and this feature thus provides the most reliable measurement of mass-loss rate in the UV lines. Applications of this result to the weak-wind problem of late O-dwarf stars and the ``PV mass loss discordance'' in early O supergiants are discussed.

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Weblink: http://arxiv.org/abs/1309.2095

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Back to contents

Catalogue of particle-accelerating colliding-wind binaries

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Massive systems made of two or more stars are known to be the site for interesting physical processes - including at least in some cases - particle acceleration. Over the past decade, this topic motivated a particular effort to unveil the properties of these systems and characterize the circumstances responsible for the acceleration of particles and the potential role of pre-supernova massive stars in the production of high energy particles in our Galaxy. Although previous studies on this topic were mostly devoted to processes in general, or to a few individual objects in particular, a unified target-oriented census of particle-accelerating colliding-wind binaries (hereafter PACWBs) does not exist yet. This paper aims at making a general and unified census of these systems, emphasizing their main properties. A general discussion includes energetic considerations along with wind properties in relation with non-thermal emission processes that are likely at work in colliding-wind binaries. Finally, some guidelines for future observational and theoretical studies are drawn.

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Back to contents

Self-Sealing Shells: Blowouts and Blisters on the Surfaces of Leaky Wind-Blown-Bubbles and Supernova Remnants

J.M. Pittard

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Blowouts can occur when a dense shell confining hot, high pressure, gas ruptures. The venting gas inflates a blister on the surface of the shell. Here we examine the growth of such blisters on the surfaces of wind-blown-bubbles (WBBs) and supernova remnants (SNRs) due to shell rupture caused by the Vishniac instability. On WBBs the maximum relative size of the blister ($R_{rm bstall}/R$) is found to grow linearly with time, but in many cases the blister radius will not exceed 20 per cent of the bubble radius. Thus blowouts initiated by the Vishniac instability are unlikely to have a major effect on the global dynamics and properties of the bubble. The relative size of blisters on SNRs is even smaller than on WBBs, with

blisters only growing to a radius comparable to the thickness of the cold shell of SNRs. The small size of the SNR blowouts is, however, in good agreement with observations of blisters in the Vela SNR. The difference in relative size between WBB and SNR blisters is due to the much higher speed at which gas vents out of WBBs, which translates into a greater energy flux through a rupture of a given size from interior gas of a given pressure. Larger blisters are possible if shell ruptures are bigger than expected.
We expect the observed velocity structure of SNR shells to be affected by the presence of blisters until the shell is no longer susceptible to ruptures, since the initial expansion of blisters is faster than the ongoing expansion of the shell.

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Back to contents

The VLT-FLAMES Tarantula Survey XII. Rotational velocities of the single O-type stars

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% context heading (optional)
% {} leave it empty if necessary resultsssss
{The 30 Doradus (30,Dor) region of the Large Magellanic Cloud, also known as the Tarantula Nebula, is the nearest starburst region. It contains the richest population of massive stars in the Local Group and it is thus
the best possible laboratory to investigate open questions in the formation and evolution of massive stars.}
% aims heading (mandatory)
{Using ground based multi-object optical spectroscopy obtained in the framework of the VLT-FLAMES Tarantula Survey (VFTS), we aim to establish the (projected) rotational velocity distribution for a sample of 216 presumably single O-type stars in 30 Dor. The size of the sample is large enough to obtain statistically significant information and to search for variations among sub-populations -- in terms of spectral type, luminosity class, and spatial location -- in the field of view.}
% methods heading (mandatory)
{We measured projected rotational velocities, vrot, by means of a Fourier transform method and a profile fitting
method applied on a set of isolated spectral lines. We also used an iterative deconvolution procedure to infer the probability density,
$rm{P(veq)}$, of the equatorial rotational velocity, veq.}
% results heading (mandatory)
{The distribution of vrot shows a two-component structure: a peak around 80~kms
and a high-velocity tail extending up to sim600 kms. This structure is also present in the inferred distribution $rm{P(veq)}$
with around 80% of the sample having 0 $<$ veq, $leq, 300$~kms and the other 20% distributed in the high-velocity
region. The presence of the low-velocity peak is consistent with that found in other studies for late O- and early B-type stars. }
% conclusions heading (optional), leave it empty if necessary
{Most of the stars in our sample rotate with a rate less than 20% of their break-up velocity.
For the bulk of the sample, mass-loss in a stellar wind and/or envelope expansion is not efficient enough to significantly spin down these stars within the first few Myr of evolution. If massive-star formation results in stars rotating at birth with a large fraction of their break-up velocities, an alternative
braking mechanism, possibly magnetic fields, is thus required to explain the present day rotational properties of the O-type stars in 30,Dor. The presence of a sizeable population of fast rotators is compatible with recent population synthesis computations that investigate the influence of binary evolution
on the rotation rate of massive stars. Despite the fact that we have excluded stars that show significant radial velocity variations, our sample may have remained contaminated by post-interaction binary products.
The fact that the high-velocity tail may be preferentially (and perhaps even exclusively), populated by post-binary interaction products, has important implications for the evolutionary origin of systems
that produce gamma-ray bursts.
}

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Back to contents

Modelling the asymmetric wind of the luminous blue variable binary MWC 314

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We present a spectroscopic analysis of MWC 314, a luminous blue variable (LBV) candidate with an extended bipolar nebula. The detailed spectroscopic variability is investigated to determine if MWC 314 is a massive binary system with a supersonically accelerating wind or a low-mass B[e] star. We compare the spectrum and spectral energy distribution to other LBVs (such as P Cyg) and find very similar physical wind properties, indicating strong kinship.
We combine long-term high-resolution optical spectroscopic monitoring and V-band photometric observations to determine the orbital elements and stellar parameters and to investigate the spectral variability with the orbital phases. We develop an advanced model of the large-scale wind-velocity and wind-density structure with 3-D radiative transfer calculations that fit the orbitally modulated P Cyg profile of He I lamb5876, showing outflow velocities above 1000 km/s.
We find that MWC 314 is a massive semi-detached binary system of ~1.22 AU, observed at an inclination angle of i=72.8 deg. with an orbital period of 60.8 d and e=0.23. The primary star is a low-vsini LBV candidate of m1=39.6 Msun and R1=86.8 Rsun. The detailed radiative transfer fits show that the geometry of wind density is asymmetric around the primary star with increased wind density by a factor of 3.3, leading the orbit of the primary. The variable orientation causes the orbital modulation that is observed in absorption portions of P Cyg wind lines. Wind accretion in the system produces a circumbinary disc.
MWC 314 is in a crucial evolutionary phase of close binary systems, when the massive primary star has its H envelope being stripped and is losing mass to a circumbinary disk. MWC 314 is a key system for studying the evolutionary consequences of these effects.

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Back to contents

The Ionized Nebula surrounding the Red Supergiant W26 in Westerlund 1

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We present Halpha images of an ionized nebula surrounding the M2-5Ia red supergiant (RSG) W26 in the massive star cluster Westerlund 1. The nebula consists of a circumstellar shell or ring ~0.1pc in diameter and a triangular nebula ~0.2pc from the star that in high-resolution Hubble Space Telescope images shows a complex filamentary structure. The excitation mechanism of both regions is unclear since RSGs are too cool to produce ionizing photons and we consider various possibilities. The presence of the nebula, high stellar luminosity and spectral variability suggest that W26 is a highly evolved RSG experiencing extreme levels of mass-loss. As the only known example of an ionized nebula surrounding a RSG W26 deserves further attention to improve our understanding of the final evolutionary stages of massive stars.

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Back to contents

Macroclumping as solution of the discrepancy between H-alpha and P v mass loss diagnostics for O-type stars

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Recent studies of O-type stars demonstrated that discrepant mass-loss rates are obtained when different diagnostic methods are employed - fitting the unsaturated UV resonance lines (e.g. P v) gives drastically lower values than obtained from the H-alpha emission. Wind inhomogeneity (so-called ``clumping'') may be the main cause for this discrepancy. In a previous paper, we have presented 3-D Monte-Carlo calculations for the formation of scattering lines in a clumped stellar wind. In the present paper we select five O-type supergiants (from O4 to O7) and test whether the reported discrepancies can be resolved this way. In the first step, the analyses start with simulating the observed

spectra with Potsdam Wolf-Rayet (PoWR) non-LTE model atmospheres. The mass-loss rates are adjusted to fit best to the observed H-alpha emission lines. For the unsaturated UV resonance lines (i.e. P v) we then apply our 3-D Monte-Carlo code, which can account for wind clumps of any optical depths (``macroclumping''), a non-void inter-clump medium, and a velocity dispersion inside the clumps. The ionization stratifications and underlying photospheric spectra are adopted from the PoWR models. From fitting the observed resonance line profiles, the properties of the wind clumps are constrained. Our results show that with the mass-loss rates that fit H-alpha (and other Balmer and He II lines), the UV resonance lines (especially the unsaturated doublet of P v) can also be reproduced without problem when macroclumping is taken into account. There is no need to artificially reduce the mass-loss rates, nor to assume a sub-solar phosphorus abundance or an extremely high clumping factor, contrary to what was claimed by other authors. These consistent mass-loss rates are lower by a factor of 1.3 to 2.6, compared to the mass-loss rate recipe from Vink et al. Macroclumping resolves the previously reported discrepancy between H-alpha and P v mass-loss diagnostics.

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Weblink: http://arxiv.org/abs/1310.0449

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Back to contents

Dynamics of H II regions around exiled O stars

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At least 25 per cent of massive stars are ejected from their parent cluster, becoming runaways or exiles, travelling with often-supersonic space velocities through the interstellar medium (ISM). Their overpressurised H II regions impart kinetic energy and momentum to the ISM, compress and/or evaporate dense clouds, and can constrain properties of both the star and the ISM. Here we present one-, two-, and (the first) three-dimensional simulations of the H II region around a massive star moving supersonically through a uniform, magnetised ISM, with properties appropriate for the nearby O star Zeta Oph. The H II region leaves an expanding overdense shell behind the star and, inside this, an underdense wake that should be filled with hot gas from the shocked stellar wind. The gas column density in the shell is strongly influenced by the ISM magnetic field strength and orientation. H-alpha emission maps show the H II region remains roughly circular, although the star is displaced somewhat from the centre of emission. For our model parameters, the kinetic energy feedback from the H II region is comparable to the mechanical luminosity of the stellar wind, and the momentum feedback rate is >100X larger than that from the wind and about 10X larger than the total momentum input rate available from radiation pressure. Compared to the star's eventual supernova explosion, the kinetic energy feedback from the H II region over the star's main sequence lifetime is >100X less, but the momentum feedback is up to 4X larger. H II region dynamics are found to have only a small effect on the ISM conditions that a bow shock close to the star would encounter.

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Back to contents

Constraints on decreases in Eta Carinae's mass loss from 3D hydrodynamic simulations of its binary colliding winds

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Recent work suggests that the mass-loss rate of the primary star (Eta A) in the massive colliding wind binary Eta Carinae dropped by a factor of 2-3 between 1999 and 2010. We present results from large- (r=1545au) and small- (r=155au) domain, 3D smoothed particle hydrodynamic (SPH) simulations of Eta Car's colliding winds for 3 Eta A mass-loss rates (2.4, 4.8, and 8.5 x 10^-4 M_sun/yr), investigating the effects on the dynamics of the binary wind-wind collision (WWC). These simulations include orbital motion, optically thin radiative cooling, and radiative forces. We find that Eta A's mass-loss rate greatly affects the time-dependent hydrodynamics at all spatial scales investigated. The simulations also show that the post-shock wind of the companion star (Eta B) switches from the adiabatic to the radiative-cooling regime during periastron passage. This switchover starts later and ends earlier the lower the value of Eta A's mass-loss rate and is caused by the encroachment of the wind of Eta A into the acceleration zone of Eta B's wind, plus radiative inhibition of Eta B's wind by Eta A. The SPH simulations together with 1D radiative transfer models of Eta A's spectra reveal that a factor of 2 or more drop in Eta A's mass-loss rate should lead to substantial changes in numerous multiwavelength observables. Recent observations are not fully consistent with the model predictions, indicating that any drop in Eta A's mass-loss rate was likely by a factor < 2 and occurred after 2004. We speculate that most of the recent observed changes in Eta Car are due to a small increase in the WWC opening angle that produces significant effects because our line-of-sight to the system lies close to the dense walls of the WWC zone. A modest decrease in Eta A's mass-loss rate may be responsible, but changes in the wind/stellar parameters of Eta B cannot yet be fully ruled out. We suggest observations during Eta Car's next periastron in 2014 to further test for decreases in Eta A's mass-loss rate. If Eta A's mass-loss rate is declining and continues to do so, the 2014 X-ray minimum should be even shorter than that of 2009.

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Back to contents

Revealing the Asymmetry of the Wind of the Variable Wolf-Rayet Star WR1 (HD4004) Through Spectropolarization

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In this paper, high quality spectropolarimetric observations of the Wolf-Rayet (WR) star WR1 (HD 4004) obtained with ESPaDOnS at the Canada-France-Hawaii Telescope are presented. All major emission lines present in the spectrum show depolarization in the relative Stokes parameters Q/I and U/I. From the behavior of the amount of line depolarization as a function of line strength, the intrinsic continuum light polarization of WR1 is estimated to be P/I = 0.443% ± 0.028% with an angle of θ = –26.2 deg. Although such a level of polarization could in principle be caused by a wind flattened by fast rotation, the scenario in which it is a consequence of the presence of corotating interaction regions (CIRs) in the wind is preferred. This is supported by previous photometric and spectroscopic observations showing periodic variations with a period of 16.9 days. This is now the third WR star thought to exhibit CIRs in its wind that is found to have line depolarization. Previous authors have found a strong correlation between line depolarization and the presence of an ejected nebula, which they interpret as a sign that the star has relatively recently reached the WR phase since the nebula are thought to dissipate very fast. In cases where the presence of CIRs in the wind is favored to explain the depolarization across spectral lines, the above-mentioned correlation may indicate that those massive stars have only very recently transited from the previous evolutionary phase to the WR phase.

Reference: St-Louis, N. 2013, ApJ, 777, 9
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Back to contents

Progenitors of supernova Ibc: a single Wolf-Rayet star as the possible progenitor of the SN Ib iPTF13bvn

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Core-collapse supernova (SN) explosions mark the end of the tumultuous life of massive stars. Determining the nature of their progenitors is a crucial step towards understanding the properties of SNe. Until recently, no progenitor has been directly detected for SN of type Ibc, which are believed to come from massive stars that lose their hydrogen envelope through stellar winds and from binary systems where the companion has stripped the H envelope from the primary. Here we analyze recently reported observations of iPTF13bvn, which could possibly be the first detection of a SN Ib progenitor based on pre-explosion images. Very interestingly, the recently published Geneva models of single stars can reproduce the observed photometry of the progenitor candidate and its mass-loss rate, confirming a

recently proposed scenario. We find that a single WR star with initial mass in the range 31-35 Msun fits the observed photometry of the progenitor of iPTF13bvn. The progenitor likely has a luminosity of log (L/Lsun)~5.55, surface temperature ~45000 K, and mass of ~10.9 Msun at the time of explosion. Our non-rotating 32 Msun model overestimates the derived radius of the progenitor, although this could likely be reconciled with a fine-tuned model of a more massive (between 40 and 50 Msun), hotter, and luminous progenitor. Our models indicate a very uncertain ejecta mass of ~8 Msun, which is higher than the average of the SN Ib ejecta mass that is derived from the lightcurve (2-4 Msun). This possibly high ejecta mass could produce detectable effects in the iPTF13bvn lightcurve and spectrum. If the candidate is indeed confirmed to be the progenitor, our results suggest that stars with relatively high initial masses (>30 Msun) can produce visible SN explosions at their deaths and do not collapse directly to a black hole.

Reference: Groh, Georgy and Ekstrom 2013, A&A 558, 1
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Back to contents

WR 138: new results from X-ray and optical spectroscopy

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Context. Massive-binary evolution models predict that some systems will go through an evolutionary phase where the original primary has become a supernova and left a compact object behind that then orbits a Wolf-Rayet (hereafter, WR) star. WR 138 is an X-ray bright WR star that has been described as a triple system, including a compact companion in a short-period orbit.
Aims. Our goal is to search for spectroscopic evidence of a compact companion around WR 138.
Methods. We used optical and X-ray spectra to search for signatures of a compact companion, which can be revealed by systematic variations in WR optical spectral lines induced by orbital motion of the compact companion or by hard, luminous X-rays from accretion onto this companion.
Results. The optical spectra display emission-line profile variations that are most probably caused by clumps inside the stellar winds. The radial velocities do not vary on a short time-scale compatible with the suggested orbital period of a putative compact companion. The X-ray spectra are found to be normal for a WN5-6+OB system with no indication of accretion by a compact companion.
Conclusions. There is no evidence for the presence of a compact companion, and we therefore conclude that WR 138 is a normal long-period (P~1521 d) eccentric WR+OB system.

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Back to contents

Classical Be Stars: Rapidly Rotating B Stars with Viscous Keplerian Decretion Disks

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In the past decade, a consensus has emerged regarding the nature of classical Be stars: They are very rapidly rotating main sequence B stars, which, through a still unknown, but increasingly constrained process, form an outwardly diffusing gaseous, dust-free Keplerian disk. In this work, first the definition of Be stars is contrasted to similar classes, and common observables obtained for Be stars are introduced and the respective formation mechanisms explained. We then review the current state of knowledge concerning the central stars as non-radially pulsating objects and non-magnetic stars, as far as it concerns large scale, i.e., mostly dipolar, global fields. Localized, weak magnetic fields remain possible, but are as of yet unproven. The Be phenomenon, linked with one or more mass ejection processes, acts on top of a rotation rate of about 75% of critical or above. The properties of the process can be well constrained, leaving only few options, most importantly, but not exclusively, non-radial pulsation and small scale magnetic fields. Of these, it is well possible that all are realized: In different stars, different processes may be acting. Once the material has been lifted into Keplerian orbit, memory of the details of the ejection process is lost, and the material is governed by viscosity. The disks are fairly well understood in the theoretical framework of the viscous decretion disk model. This is not only true for the disk structure, but as well for its variability, both cyclic and secular. Be binaries are reviewed under the aspect of the various types of interactions a companion can have with the circumstellar disk. Finally, extragalactic Be stars, at lower metallicities, seem more common and more rapidly rotating.

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

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Back to contents

The Massive Star Population in M101. I. The Identification and Spatial Distribution of the Visually Luminous Stars

Skyler Grammer and Roberta M. Humphreys

University of Minnesota

An increasing number of non-terminal giant eruptions are being observed by modern supernova and transient surveys. But very little is known about the origin of these giant eruptions and their progenitors, many of which are presumably very massive, evolved stars. Motivated by the small number of progenitors positively associated with these giant eruptions, we have begun a survey of the evolved massive star populations in nearby galaxies. The nearby, nearly face on, giant spiral M101 is an excellent laboratory for studying a large population of very massive stars. In this paper, we present BVI photometry obtained from archival HST/ACS WFC images of M101. We have produced a catalog of luminous stars with photometric errors <10% for V < 24.5 and 50% completeness down to V ~ 26.5 even in regions of

high stellar crowding. Using color and luminosity criteria we have identified candidate luminous OB type stars and blue supergiants, yellow supergiants, and red supergiants for future observation. We examine their spatial distributions across the face of M101 and find that the ratio of blue to red supergiants decreases by two orders of magnitude over the radial extent of M101 corresponding to 0.5 dex in metallicity. We discuss the resolved stellar content in the giant star forming complexes NGC 5458, 5453, 5461, 5451, 5462, and 5449 and discuss their color-magnitude diagrams in conjunction with the spatial distribution of the stars to determine their spatio-temporal formation histories.

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Back to contents

Non-thermal radio emission from O-type stars. V. 9 Sgr

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The colliding winds in a massive binary system generate synchrotron emission due to a fraction of electrons that have been accelerated to relativistic speeds around the shocks in the colliding-wind region. We studied the radio light curve of 9 Sgr = HD 164794, a massive O-type binary with a 9.1-yr period. We investigated whether the radio emission varies consistently with orbital phase and we determined some parameters of the colliding-wind region. We reduced a large set of archive data from the Very Large Array (VLA) to determine the radio light curve of 9 Sgr at 2, 3.6, 6 and 20 cm. We also constructed a simple model that solves the radiative transfer in the colliding-wind region and both stellar winds. The 2-cm radio flux shows clear phase-locked variability with the orbit. The behaviour at other wavelengths is less clear, mainly due to a lack of observations centred on 9 Sgr around periastron passage. The high fluxes and nearly flat spectral shape of the radio emission show that synchrotron radiation dominates the radio light curve at all orbital phases. The model provides a good fit to the 2-cm observations, allowing us to estimate that the brightness temperature of the synchrotron radiation emitted in the colliding-wind region at 2 cm is at least 4 x 10^8 K. The simple model used here already allows us to derive important information about the colliding-wind region. We propose that 9~Sgr is a good candidate for more detailed modelling, as the colliding-wind region remains adiabatic during the whole orbit thus simplifying the hydrodynamics.

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Back to contents

Stellar mass-loss near the Eddington limit. Tracing the sub-photospheric layers of classical Wolf-Rayet stars

G. Gräfener and J.S. Vink

Armagh Observatory

Towards the end of their evolution hot massive stars develop strong stellar winds and appear as emission line stars, such as WR stars or LBVs. The quantitative description of the mass loss in these important pre-SN phases is hampered by unknowns such as clumping and porosity due to an in-homogeneous wind structure, and by an incomplete theoretical understanding of optically thick stellar winds. In this work we investigate the conditions in deep atmospheric layers of WR stars to find out whether these comply with the theory of optically thick winds, and whether we find indications of clumping in these layers. We use a new semi-empirical method to determine sonic-point optical depths, densities, and temperatures for a large sample of WR stars of the carbon (WC) and oxygen (WO) sequence. Based on an artificial model sequence we investigate the reliability of our method and its sensitivity to uncertainties in stellar parameters. We find that the WR stars in our sample obey an approximate relation with P_rad/P_gas~80 at the sonic point. This 'wind condition' is ubiquitous for radiatively driven, optically thick winds, and sets constraints on possible wind/envelope solutions affecting radii, mass-loss rates, and clumping properties. Our results suggest that the presence of an optically thick wind may force many stars near the Eddington limit to develop clumped, radially extended sub-surface zones. The clumping in these zones is most likely sustained by the non-linear strange-mode instability, and may be the origin of the observed wind clumping. The properties of typical late-type WC stars comply with this model. Solutions without sub-surface clumping and inflation are also possible but demand for compact stars with comparatively low mass-loss rates. These objects may resemble the small group of WO stars with their exceptionally hot stellar temperatures and highly ionized winds.

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Back to contents

The rotation rates of massive stars: How slow are the slow ones?

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Context: Rotation plays a key role in the life cycles of stars with masses above ~ 8 Msun. Hence, accurate knowledge of the rotation rates of such massive stars is critical for understanding their properties and for constraining models of their evolution. Aims: This paper investigates the reliability of current methods used to derive projected rotation speeds v sin i from line-broadening signatures in the photospheric spectra of massive stars, focusing on stars that are not rapidly rotating. Methods: We use slowly rotating magnetic O-stars with well-determined rotation periods to test the Fourier transform (FT) and goodness-of-fit (GOF) methods typically used to infer projected rotation rates of massive stars. Results: For our two

magnetic test stars with measured rotation periods longer than one year, i.e., with v sin i < 1 km/s, we derive v sin i ~ 40-50 km/s from both the FT and GOF methods. These severe overestimates are most likely caused by an insufficient treatment of the competing broadening mechanisms referred to as microturbulence and macroturbulence. Conclusions: These findings warn us not to rely uncritically on results from current standard techniques to derive projected rotation speeds of massive stars in the presence of significant additional line broadening, at least when v sin i <~ 50 km/s. This may, for example, be crucial for i) determining the statistical distribution of observed rotation rates of massive stars, ii) interpreting the evolutionary status and spin-down histories of rotationally braked B-supergiants, and iii) explaining the deficiency of observed O-stars with spectroscopically inferred v sin i ~ 0 km/s. Further investigations of potential shortcomings of the above techniques are presently under way.

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Back to contents

One of the most massive stars in the Galaxy may have formed in isolation

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Very massive stars, 100 times heavier than the sun, are rare. It is not yet known whether such stars can form in isolation or only in star clusters. The answer to this question is of fundamental importance. The central region of our Galaxy is ideal for investigating very massive stars and clusters located in the same environment. We used archival infrared images to investigate the surroundings of apparently isolated massive stars presently known in the Galactic Centre (GC). We find that two such isolated massive stars display bow shocks and hence may be `runaways' from their birthplace. Thus, some isolated massive stars in the GC region might have been born in star clusters known in this region. However, no bow shock is detected around the isolated star WR 102ka (Peony nebula star), which is one of the most massive and luminous stars in the Galaxy. This star is located at the centre of an associated circumstellar nebula. To study whether a star cluster may be `hidden' in the surroundings of WR 102ka, to obtain new and better spectra of this star, and to measure its radial velocity, we obtained observations with the integral-field spectrograph SINFONI at the ESO's Very Large Telescope. Our observations confirm that WR 102ka is one of the most massive stars in the Galaxy and reveal that this star is not associated with a star cluster. We suggest that WR 102ka has been born in relative isolation, outside of any massive star cluster.

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Status: Manuscript has been accepted

Weblink: arXiv:1309.7651

Comments:

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Back to contents

A comparison of evolutionary tracks for single Galactic massive stars

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In this paper, we compare the currently available evolutionary tracks for Galactic massive stars. Our main goal is to highlight the uncertainties on the predicted evolutionary paths. We compute stellar evolution models with the codes MESA and STAREVOL. We compare our results with those of four published grids of massive stellar evolution models (Geneva, STERN, Padova and FRANEC codes). We first investigate the effects of overshooting, mass loss, metallicity, chemical composition. We subsequently focus on rotation. Finally, we compare the predictions of published evolutionary models with the observed properties of a large sample of Galactic stars. We find that all models agree well for the main sequence evolution. Large differences in luminosity and temperatures appear for the post main sequence evolution, especially in the cool part of the HR diagram. Depending on the physical ingredients, tracks of different initial masses can overlap, rendering any mass estimate doubtful. For masses between 7 and 20 Msun, we find that the main sequence width is slightly too narrow in the Geneva models including rotation. It is (much) too wide for the (STERN) FRANEC models. This conclusion is reached from the investigation of the HR diagram and from the evolution of the surface velocity as a function of surface gravity. An overshooting parameter alpha between 0.1 and 0.2 in models with rotation is preferred to reproduce the main sequence width. Determinations of surface abundances of carbon and nitrogen are partly inconsistent and cannot be used at present to discriminate between the predictions of published tracks. For stars with initial masses larger than about 60 Msun, the FRANEC models with rotation can reproduce the observations of luminous O supergiants and WNh stars, while the Geneva models remain too hot.

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Back to contents

Fundamental properties of core-collapse supernova and GRB progenitors: predicting the look of massive stars before death

Jose H. Groh (1), Georges Meynet (1), Cyril Georgy (2), and Sylvia Ekstrom (1)

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We investigate the fundamental properties of core-collapse supernova (SN) progenitors from single stars at solar metallicity. For this purpose, we combine Geneva stellar evolutionary models with initial masses of Mini = 20-120 Msun with atmospheric and wind models using the radiative transfer code CMFGEN.

We provide synthetic photometry and high-resolution spectra of hot stars at the pre-SN stage. For models with Mini = 9-20 Msun, we supplement our analysis using publicly available MARCS model atmospheres of RSGs to estimate their synthetic photometry. We employ well-established observational criteria of spectroscopic classification and find that, depending on their initial mass and rotation, massive stars end their lives as red supergiants (RSG), yellow hypergiants (YHG), luminous blue variables (LBV), and Wolf-Rayet (WR) stars of the WN and WO spectral types. For rotating models, we obtained the following types of SN progenitors: WO1-3 (Mini ≥ 32 Msun), WN10-11 (25 < Mini < 32 Msun), LBV (20 ≤ Mini ≤ 25 Msun), G1 Ia+ (18 < Mini < 20 Msun), and RSGs (9 ≤ Mini ≤ 18 Msun). For non-rotating models, we found spectral types WO1-3 (Mini > 40 Msun), WN7-8 (25 < Mini ≤ 40 Msun), WN11h/LBV (20 < Mini ≤ 25 Msun), and RSGs (9 ≤ Mini ≤ 20 Msun). Our rotating models indicate that SN IIP progenitors are all RSG, SN IIL/b progenitors are 56% LBVs and 44% YHGs, SN Ib progenitors are 96% WN10-11 and 4% WOs, and SN Ic progenitors are all WO stars. We find that the most massive and luminous SN progenitors are not necessarily the brightest ones in a given filter, since this depends on their luminosity, temperature, wind density, and the way the spectral energy distribution compares to a filter bandpass. We find that SN IIP progenitors (RSGs) are bright in the RIJHKS filters and faint in the UB filters. SN IIL/b progenitors (LBVs and YHGs), and SN Ib progenitors (WNs) are relatively bright in optical/infrared filters, while SN Ic progenitors (WOs) are faint in all optical filters. We argue that SN Ib and Ic progenitors from single stars should be undetectable in the available pre-explosion images with the current magnitude limits, in agreement with observational results.

Reference: Groh, Meynet, Georgy and Ekstrom 2013, A&A 558, 131
Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/arXiv:1308.4681

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Back to contents

Abstracts of 1 submitted papers

The VLT-FLAMES Tarantula Survey. XIV: On the nature of O,V z stars in 30 Doradus

C. Sabín-Sanjulián(1,2), S. Simón-Díaz(1,2), A. Herrero(1,2), N. R. Walborn(3), J. Puls(4), J. Maíz Apellániz(5), C. J. Evans(6), I. Brott(7), A. de Koter(8,9), M. Garcia(10), N. Markova(11), F. Najarro(10), O. H. Ramírez-Agudelo(8), H. Sana(3), W. D. Taylor(6) and J. S. Vink(12)

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Context. OV z stars, a subclass of O-type dwarfs characterized by having HeII4686 stronger in absorption than any other helium line in their blue-violet spectra, have been suggested o be on or near the Zero-Age-Main-Sequence (ZAMS). If their youth were confirmed, they would be key objects with which to advance our knowledge of the physical properties of massive stars in the early stages of their lives.

Aims. To test the hypothesis of OV z stars being at a different (younger) evolutionary stage in comparison with normal O-type dwarfs.

Methods. We perform the first comprehensive quantitative spectroscopic analysis of a statistically-meaningful sample of OV z and OV stars in the same star-forming region, exploiting the large number of OV z stars identified by the VLT-FLAMES Tarantula Survey in the 30 Doradus region of the Large Magellanic Cloud (LMC). We obtain the stellar and wind parameters of 38 OV z stars (and a control sample of 46 OV stars) using the FASTWIND stellar atmosphere code and the IACOB-GBAT, a grid-based tool developed for automated quantitative analysis of optical spectra of O stars. In the frame of a differential study, we compare the physical and evolutionary properties of both samples, locating the stars in the logg vs. logT_eff, logQ vs. logT_eff, and logL/L_sun vs. logT_eff diagrams. We also investigate the predictions of the FASTWIND code regarding the O,V z phenomenon.

Results. We find a differential distribution of objects in terms of effective temperature, with OV z stars dominant at intermediate values. The OV z stars in 30,Doradus tend to be younger (i.e. closer to the ZAMS), less luminous, and have weaker winds than the OV stars, but we also find examples with ages of 2-4 Myr, and with luminosities and winds which are similar to those of normal O dwarfs. Moreover, the OV z stars do not appear to have higher gravities than the OV stars.
In addition to effective temperature and wind strength, our FASTWIND predictions indicate the importance of taking other stellar parameters (gravity and projected rotational velocity) into account for the correct interpretation of the OV z phenomenon.

Conclusions. In general, the OV z stars appear to be on, or very close to, the ZAMS, but there are some examples where the Vz classification does not necessarily imply extreme youth. In particular, the presence of OV z stars in our sample at more evolved phases than expected is likely a consequence of modest O-star winds due to the low-metallicity environment of the LMC.

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Status: Manuscript has been submitted

Weblink:

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Back to contents

Abstracts of 1 conference proceedings

Rotational properties of the O-type star population in the Tarantula region

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The 30 Doradus (30,Dor) region in the Large Magellanic Cloud (also known as the Tarantula Nebula) is the nearest massive starburst region, containing the richest sample of
massive stars in the Local Group. It is the best possible laboratory to investigate aspects of the formation and evolution of massive stars. Here, we focus on rotation which is a key parameter in the evolution of these objects. We establish the projected rotational velocity, $v_{e}sin i$, distribution of an unprecedented sample of 216 radial
velocity constant ($rm{Delta RV, leq, 20 ,km s^{-1}}$) O-type stars in 30,Dor observed in the framework of the VLT-FLAMES Tarantula Survey (VFTS). The distribution of $v_{e}sin i$ shows a two-component structure: a peak around 80 $rm{km s^{-1}}$ and a high-velocity tail extending up to sim600 $rm{km s^{-1}}$. Around 75% of the sample has 0 $leq, v_{e}sin i leq$ 200 $rm{km s^{-1}}$ with the other 25% distributed in the high-velocity tail.
The presence of the low-velocity peak is consistent with that found in other studies of late-O and early-B stars.

The high-velocity tail is compatible with expectations from binary interaction synthesis models and may be predominantly populated by post-binary interaction, spun-up, objects and mergers. This may have important implications for the nature of progenitors of long-duration gamma ray bursts.

Reference: Conference proceedings article: Massive stars: from alpha to Omega, 10-14 June 2013, Rhodes, Greece
Status: Conference proceedings

Weblink: http://adsabs.harvard.edu/abs/2013arXiv1309.2929R

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Back to contents

JOBS

POSTDOCTORAL POSITION IN MASSIVE STARS

Prof. Artemio Herrero

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Spain

The Instituto de Astrofísica de Canarias (IAC, Tenerife, Spain) invites applications for ONE postdoctoral contract in Astrophysics to work within the framework of the project “Formation And Evolution Of Massive Stars Across The Milky Way And The Local Group” (AYA2012-39364-C02-01), financed by the Spanish Ministry of Economy and Competitiveness and and led by Prof. Artemio Herrero Davó.

The IAC is a leading Center for Astrophysics in Spain, covering theoretical and observational research and instrumentation across most areas of Astrophysics. It has been selected as a “Severo Ochoa Centers of Excellence” in research by the Spanish Government. The successful candidate will have access to all telescopic and supercomputing facilities in the Canary Islands, including the 10.4m GTC. Ample travel funding is available.

The candidate will join the research currently underway in the group: multi-wavelength observations and analysis of massive stars in the Milky Way and nearby galaxies, comparison with evolutionary models, update of atmosphere models, velocity fields.

The candidate should hold a PhD in Astrophysics. High value will be given to experience in any of the following fields: observational astronomy, analysis of stellar spectra and pulsations, use of atmosphere or evolutionary models and knowledge of numerical and statistical techniques.

Remuneration: The gross annual salary is 32.886 €

Duration: Until the end of the 2015.

The application procedure is explained on the web site. All documents, including the recommendation letters, must be received before the application deadline: October 31, 2013.

Details of the selection process, including the list of applicants, will be published on the web; successful candidates will also be informed by e-mail.

Attention/Comments: interested candidates may contact Artemio Herrero at the emailaddress below

Weblink: http://www.iac.es/info.php?op1=26&id=446⟨=en

Email: ahd@iac.es

Deadline: October 31th, 2013

Back to contents

MEETINGS

The Space Photometry Revolution
CoRoT Symposium 3, Kepler KASC-7 joint meeting

6-11 July 2014

Venue: Toulouse, France

This is the first announcement for CoRoT Symposium 3, Kepler KASC-7 joint meeting entitled The Space Photometry Revolution. The conference will be held in Toulouse (France), 6-11 July 2014. Preregistration is now open!

Topics include:
1. Extrasolar planets and planet systems
2. Probing stellar structure and evolution with asteroseismology
3. Binarity and star-planet interactions
4. Stellar activity and rotation
5. Present and future ground-based and space projects. Synergies

Important dates:
* Preregistration opens: 20 Sep 2013
* Registration opens: 15 Dec 2013

* Deadline for early registration: 01 Mar 2014
* Abstract deadline for contributed talks: 31 Mar 2014
* Abstract deadline for posters: 15 May 2014
* Deadline for registration and payment: 15 May 2014

We invite you to express your interest by sending an e-mail to corot3-kasc7@sciencesconf.org

Weblink: http://corot3-kasc7.sciencesconf.org/

Email: jerome.ballot@irap.omp.eu

Back to contents

Eta Carina Coordination Meeting January 9, 10, 2014: University of Maryland, Baltimore County, Maryland, USA

Ted Gull

NASA/GSFC

Eta Carina will undergo its next periastron event in July-August 2014. This coordination meeting will focus on current observations, models of the massive binary system, and observations needed to constrain the models.

We encourage you to contact Ted.Gull@nasa.gov if you plan to attend, along with potential contributions and subjects that you would like to discuss. A head count is desired by October 31.

A similar planning session at Mt. Rainier in the summer of 2002 focused on the Hubble Eta Carinae Treasury Program. The inputs of several dozen astronomers at that meeting strongly impacted the actual observations, brought in additional coordinated observations and inspired new approaches to the modeling of the massive interacting winds. It is our goal to further improve our knowledge of this fascinating astrophysical laboratory with a coordinated approach.

This meeting was initially planned to be splinter sessions within the American Astronomical Society January 2014 meeting. However, due to cost, scheduling conflicts and potential limiting quotas of NASA attendees, we chose to move the coordination meeting to a separate venue. A conference room has been found at University of Maryland, Baltimore County for the two-day meeting. Within the building complex are located other meeting rooms and a cafeteria. The facility is about six miles from Baltimore Washington International Airport and just off Interstates 95 and 195.

The format of the meeting, based upon many local meetings discussing Eta Carinae, will be a series of reviews with structured discussions on these general topics:

Current observations
Current models of massive stars
Observations needed to constrain models that could be obtained across the 2014.6 periastron event.
Models needed to explain current and planned observations.

Small group meetings addressing specific topics will be encouraged both afternoons.

A draft agenda will be circulated in early November.

Additional information will be posted as it comes available on: http://etacar2014.wikidot.com/meetings

Reference: Notice of meeting
Status: Other

Weblink:

Comments:

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Back to contents