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# THE MASSIVE STAR NEWSLETTER

formely known as *the hot star newsletter*

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editor: Philippe Eenens
University of Guanajuato
eenens@astro.ugto.mx
http://www.astroscu.unam.mx/massive_stars
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## Contents of this newsletter



## Accepted Papers

### The WR population predicted by massive single star and by massive binary evolution

**D. Vanbeveren, J. Van Bever, H. Belkus**

Astrophysical Institute, Vrije Universiteit Brussel

We discuss differences between massive single star and massive close binary population number synthesis predictions of WR stars. We show that the WC/WN number ratio as function of metallicity depends significantly on whether or not binaries are included. Furthermore, the observed WC(+OB)/WN(+OB) number ratio in the Solar neighborhood seems to indicate that the WR mass loss rates are lower by another factor two compared to recently proposed clumping corrected formalisms. We then demonstrate that the observed lower luminosity distribution of single WN stars can be explained in a satisfactory way by massive single star evolutionary computations where the red supergiant phase is calculated using a stellar wind mass loss rate formalism that is based on recent observations.

**Reference: ApJ Letters**

*On the web at:* astro-ph/0703796

*Preprints from:* dvbevere@vub.ac.be

## Wind-wind collision in the eta Carinae binary system - III. The He II 4686 line profile

**Z. Abraham (1) & D. Falceta-Goncalves (1,2)**

(1) IAG-USP (2) NAT-UNICSUL

We modeled the HeII 4686 line profiles observed in the eta Carinae binary system close to the 2003.5 spectroscopic event, assuming that they were formed in the shocked gas that flows at both sides of the contact surface formed by wind-wind collision. We used a constant flow velocity and added turbulence in the form of a gaussian velocity distribution. We allowed emission from both the primary and secondary shocks but introduced infinite opacity at the contact surface, implying that only the side of the contact cone visible to the observer contributed to the line profile. Using the orbital parameters of the binary system derived from the 7 mm light curve during the last spectroscopic event (Paper II) we were able to reproduce the line profiles obtained with the HST at different epochs, as well as the line mean velocities obtained with ground based telescopes. A very important feature of our model is that the line profile depends on the inclination of the orbital plane; we found that to explain the latitude dependent mean velocity of the line, scattered into the line of sight by the Homunculus, the orbit inclination should be close to 90 degrees, meaning that it does not lie in the Homunculus equatorial plane, as usually assumed. This inclination, together with the relative position of the stars during the spectroscopic events, allowed us to explain most of the observational features, like the variation of the Purple Haze with the orbital phase, and to conciliate the X-ray absorption with the postulated shell effect used to explain the optical and UV light curves.

**Reference: MNRAS**

*On the web at:* `http://xxx.lanl.gov/abs/astro-ph/0703695`

*Preprints from:* `diego@astro.iag.usp.br`

## On the optical counterpart of NGC300 X-1 and the global Wolf-Rayet content of NGC300

**Paul A Crowther (1), S. Carpano (2), L.J. Hadfield (1), A.M.T. Pollock (2)**

1: Sheffield, UK, 2: ESAC Madrid, Spain

(Conext:) Surveys of Wolf-Rayet (WR) populations in nearby galaxies provide tests of evolutionary models plus Type Ib/c supernova progenitors. This spectroscopic study complements the recent imaging survey of the spiral galaxy NGC 300 by Schild et al.
(Aims): Revisions to the known WR content of NGC 300 are presented. We investigate the WR nature of candidate #41 from Schild et al. which is spatially coincident with the bright X-ray point source NGC 300 X-1;
(Methods:) VLT/FORS2 multi-object spectroscopy of WR candidates in NGC 300 is obtained;
(Results:) We establish an early-type WN nature of #41, i.e. similar to the optical counterpart of IC 10 X-1, which closely resembles NGC 300 X-1. We confirm 9 new WR stars, bringing the current WR census of the inner disk to 31, with N(WC)/N(WN) $\sim$0.9.
(Conclusions:) If #41 is the optical counterpart for NGC 300 X-1, we estimate a WR mass of 38 $M_\odot$ based upon ground-based photometry, from which a black hole mass of $> 10$ $M_\odot$ results from

the 32.8 hr period of the system and WR wind velocity of 1250 km/s. We estimate an 95% completeness among WC stars and 70% among WN stars, such that the total WR content is ∼40, with N(WC)/N(WN) ∼0.7. From the Hα-derived star formation rate of the inner galaxy, we infer N(WR)/N(O) ∼0.04.

**Reference: A&A Letters in press**

*On the web at:* `http://arxiv.org/abs/0705.1544`

*Preprints from:* `Paul.Crowther@sheffield.ac.uk`

## Erratum: An overview of the photometric events, trends and brightenings of $\eta$ Carinae

**A. M. van Genderen[1], C. Sterken[2] , W. H. Allen[3] and W. S. G. Walker[4]**

(1) Leiden University Observatory, Postbus 9513, NL-2300RA Leiden, The Netherlands (2) Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussels, Belgium (3) Alvine Estate, Vintage Lane, RD 3, Blenheim, New Zealand 272 Heath Road, Awanui RD 1, New Zealand 0451

The paper "An overview of the photometric events, trends and brightenings of *eta* Carinae" was published in sl The Journal of Astronomical Data 12, 3 (2006). The conclusion "If this assumption is correct, it would mean that the mass of the stellar wind envelope is growing linearly, thus, the mass loss rate per orbital cycle was, on the average, constant over at least the last 35,yr" in Sect. 5.7.2 is incorrect and should be ignored.

**Reference: The Journal of Astronomical data 13, 1 2007**

*On the web at:* `ADS`

*Preprints from:* `csterken@vub.ac.be`

## Late-Type Red Supergiants: Too Cool for the Magellanic Clouds?

**Emily M. Levesque, Philip Massey, K. A. G. Olsen, Bertrand Plez**

Institute for Astronomy, University of Hawaii; Lowell Observatory; NOAO; GRAAL, Universite de Montpellier II

We have identified seven red supergiants (RSGs) in the Large Magellanic Cloud (LMC) and four RSGs in the Small Magellanic Cloud (SMC), all of which have spectral types that are considerably later than the average type observed in their parent galaxy. Using moderate-resolution optical spectrophotometry and the MARCS stellar atmosphere models, we determine their physical properties and place them on the H-R diagram for comparison with the predictions of current stellar evolutionary tracks. The radial velocities of these stars suggest that they are likely all members of the Clouds rather than foreground dwarfs or halo giants. Their locations in the H-R diagram also show us that those stars are cooler than the current evolutionary tracks allow, appearing to the right of the Hayashi limit, a region in which stars are no longer in hydrodynamic equilibrium.

These stars exhibit considerable variability in their V magnitudes, and three of these stars also show changes in their effective temperatures (and spectral types) on the time-scales of months. One of these

stars, [M2002] SMC 055188, was caught in an M4.5 I state, as late as that seen in HV 11423 at its recent extreme: considerable later, and cooler, than any other supergiant in the SMC. In addition, we find evidence of variable extinction due to circumstellar dust and changes in the stars' luminosities, also consistent with our recent findings for HV 11423 - when these stars are hotter they are also dustier and more luminous. We suggest that these stars have unusual properties because they are in an unstable (and short-lived) evolutionary phase.

**Reference: ApJ, in press**

*On the web at:* `http://xxx.lanl.gov/abs/0705.3431`

*Preprints from:* `emsque@ifa.hawaii.edu`

## An Extensive Collection of Stellar Wind X-ray Source Region Emission Line Parameters, Temperatures, Velocities, and Their Radial Distributions as Obtained from Chandra Observations of 17 OB Stars

**Wayne L. Waldron (1), Joseph P. Cassinelli (2)**

(1) Eureka Scientific, Inc., (2) University of Wisconsin-Madison

Chandra high energy resolution observations have now been obtained from numerous non-peculiar O and early B stars. We present a straightforward analysis of a broad collection of OB stellar line profile data to search for morphological trends. The line emission parameters and the spatial distributions of derived quantities are examined with respect to luminosity class. The X-ray spatial distributions are derived from the He-like ion f/i line ratios and X-ray temperatures are derived from the H-like to He-like line ratios. Our luminosity class study reveals line widths increasing with luminosity, and a small, but finite, blue-ward line-shift asymmetry which also increases with luminosity. However, the majority of emission lines are found to be symmetric with little central line displacement. Our spatial distribution study finds that the highest X-ray temperatures occur near the star and steadily decrease towards lower values in the outer wind regions. We find no evidence of any high temperature X-ray emission in the outer wind regions for any OB star. Since this is counter to basic shock model calculations, we call this the "near-star high-ion problem" for OB stars. When using the traditional mass loss rates, we find a good correlation between the fir-inferred radii and their associated X-ray continuum optical depth unity radii. We discuss the significance of these anomalous X-ray results with regards to our current understanding of X-ray production in OB stellar winds.

**Reference: ApJ, 668, in press**

*Preprints from:* `wwaldron@satx.rr.com`

## Models for Massive Stellar Populations with Rotation

**Gerardo A. Vazquez, Claus Leitherer, Daniel Schaerer, Georges Meynet, Andre Maeder**

Johns Hopkins University, STScI, Observatoire de Geneve

We present and discuss evolutionary synthesis models for massive stellar populations generated with the Starburst99 code in combination with a new set of stellar evolution models accounting for rotation. The new stellar evolution models were compiled from several data releases of the Geneva group and cover heavy-element abundances ranging from twice solar to one fifth solar. The evolution models were computed for rotation velocities on the zero-age main-sequence of 0 and 300 km/s and with the latest revision of stellar mass-loss rates. Since the mass coverage is incomplete, in particular at non-solar chemical composition, our parameter study is still preliminary and must be viewed as exploratory. Stellar population properties computed with Starburst99 and the new evolution models show some marked differences in comparison with models obtained using earlier tracks. Since individual stars now tend to be more luminous and bluer when on the blue side of the Hertzsprung-Russell diagram, the populations mirror this trend. For instance, increases by factors of two or more are found for the light-to-mass ratios at ultraviolet to near-infrared wavelengths, as well as for the output of hydrogen ionizing photons. If these results are confirmed once the evolution models have matured, recalibrations of certain star-formation and initial mass function indicators will be required.

**Reference: Astrophysical Journal, 2007, 663, 995**

*On the web at:* `http://arxiv.org/abs/astro-ph/0703699`

*Preprints from:* `vazquez@pha.jhu.edu`

# Jobs

## Postdoctoral Position On Massive Stars and Circumstellar Environments

Dr. Pat Morris
NASA Herschel Science Center M/S 100-22 Caltech Pasadena, CA, USA 91125

A post-doctoral research fellowship is available at the Infrared Processing and Analysis Center on the California Institute of Technology campus in Pasadena, California. The successful applicant will work with Drs. Patrick Morris and Schuyler Van Dyk on mid-infrared observations (spectroscopy and imaging) obtained with the Spitzer Space Telescope, archival Infrared Space Observatory spectroscopy, and ground-based observations of the circumstellar environments of evolved massive stars. The research emphasizes the formation and destruction of dust over epochs of mass loss through stellar winds progressively enriched with CNO-processed material from the stellar cores. The research also involves extension of a successful program to locate new, "hidden" Population I Wolf-Rayet stars in the Milky Way and characterizing their environments in the thermal infrared regime, also using data obtained with the Spitzer Space Telescope. The fellow would assist with follow-up spectroscopic observations of candidate stars using the Palomar 5-m and other large telescopes. It is desired that the

applicant have an interest in stellar and observational infrared astronomy, massive star evolution, the formation and processing of circustellar dust and feedback with the interstellar medium. The position is initially funded for two years. Applicants should submit a curriculum vitae, list of publications, and names of and contact information for two references to Dr. Pat Morris at the above address, or to pmorris@ipac.caltech.edu, by 2007 Oct 1 to receive full consideration.

Caltech is an Affirmative Action/Equal Opportunity Employer. Women, Minorities, Veterans, and Disabled Persons are encouraged to apply.

*Email contact:* `pmorris@ipac.caltech.edu`

*Closing date:* 1 Oct 2007