THE MASSIVE STAR NEWSLETTER

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Contents of this Newsletter

From the Editor

Submission of abstracts and news via our web interface

From now on you will be able to submit your contributions to the Massive Star Newsletter using our new web interface:
http://www.astroscu.unam.mx/massive_stars/

The web interface is very similar to that used by astro-ph. You can submit your abstracts anytime. When a new issue is completed, you will be alerted by email, so you can read the full newsletter on-line (in pdf format).

If you wish to be alerted every time an abstract is submitted, please subscribe to that service at the above internet link.

If for any reason the new submission method is not convenient for you, please let me know:
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Best regards,

Philippe

Accepted Papers

Bubbles Surrounding Southern Optical Ring Nebulae: Anon(WR 23) and RCW 52

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We analyze the interstellar medium in the environs of two hot and massive stars, HD 92809 (= WR 23, WC6) and LSS 1887 (O8V), which ionize the optical ring nebulae Anon(WR 23) and RCW 52, respectively. Our analysis is based on neutral hydrogen (HI) 21cm line data, which reveal interstellar bubbles surrounding the massive stars and their optical ring nebulae. The HI bubble related to WR 23 is 13.3 pc in radius and is expanding at 10 km s^{-1}. The associated atomic neutral mass amounts to 830 $M_\odot$. The HI structure related to LSS 1887 is about 6.3 pc in radius, has an expansion velocity of 7 km s^{-1} and an associated atomic neutral mass of 100 $M_\odot$. These HI features are the neutral counterparts of the optical ring nebulae and were mainly created by the action of the stellar winds of the massive stars on their environs. The dynamical age of the HI bubble around WR 23 (7×10^5 yr) suggests that it was created during the WR phase of stellar evolution. However, the large tangential motions of WR 23 and LSS 1887 suggest that part of the observed optical and HI structures may be due to a bow shock. The analysis of the distribution of emission in the far infrared and in the CO(1-0) molecular line in the environs of WR 23 and LSS 1887, reveals that there are also infrared and molecular counterparts of the detected HI bubbles.

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The Sub-Arcsecond Dusty Environment of Eta Carinae

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The core of the nebula surrounding Eta Carinae has been observed with the VLT Adaptive Optics system NACO and with the interferometer VLTI/MIDI to constrain spatially *and* spectrally the warm dusty environment and the central object. In particular, narrow-band images at 3.74 μm and 4.05 μm reveal the butterfly shaped dusty environment close to the central star with unprecedented spatial resolution. A void whose radius corresponds to the expected sublimation radius has been discovered around the central source. Fringes have been obtained in the Mid-IR which reveal a correlated flux of about 100 Jy situated $0\farcs3$ south-east of the photocenter of the nebula at 8.7 μm, which corresponds

with the location of the star as seen in other wavelengths. This correlated flux is partly attributed to the central object, and these observations provide an upper limit for the SED of the central source from 2.2 μm to 13.5 μm. Moreover, we have been able to spectrally disperse the signal from the nebula itself at PA=318 degree, i.e. in the direction of the bipolar nebula ($\sim$310°) within the MIDI field of view of 3″. A large amount of corundum (Al_2O_3) is discovered, peaking at 0.″6-1.″2 south-east from the star, whereas the dust content of the Weigelt blobs is dominated by silicates. We discuss the mechanisms of dust formation which are closely related to the geometry of this Butterfly nebulae.

Accepted Astronomy and Astrophysics

Weblink: http://fr.arXiv.org/abs/astro-ph/0501159

First VLTI/MIDI Observations of a Be Star: alpha Arae

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We present the first VLTI/MIDI observations of the Be star
alpha Ara, showing a nearly unresolved circumstellar disk in the N band. The interferometric measurements made use of the UT1 and UT3 telescopes. The projected baselines were 102 and 74 meters with position angles of 7° and 55°, respectively. These measurements put an upper limit to the envelope size in the N band under the Uniform disk approximation of $\phi_{\rm max} = 4 \pm 1.5$ mas, corresponding to 14 $R_\star$, assuming $R_\star$=4.8R$_\odot$ and the Hipparcos distance of 74 pc.

On the other hand the disk density must be large enough to produce the observed strong Balmer line emission. In order to estimate the possible circumstellar and stellar parameters we have used the SIMECA code developed by Stee (1995) and Stee & Bittar (2001). Optical spectra taken with the échelle instrument HEROS and the ESO-50cm telescope, as well as infrared ones from the 1.6m Brazilian telescope have been used together with the MIDI spectra and visibilities. These observations put complementary constraints on the density and geometry of alpha Ara circumstellar disk. We discuss on the potential truncation of the disk by a companion and we present spectroscopic indications of a periodic perturbation of some Balmer lines.

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The Neon Abundance of Galactic Wolf–Rayet Stars

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The fast, dense winds which characterize Wolf-Rayet (WR) stars obscure their underlying cores, and complicate the verification of evolving core and nucleosynthesis models. Core evolution can be probed by measuring abundances of wind-borne nuclear processed elements, partially overcoming this limitation. Using ground-based mid-infrared spectroscopy and the 12.81μm [Ne II] emission line

measured in four Galactic WR stars, we estimate neon abundances and compare to long-standing predictions from evolved-core models. For the WC star WR 121, this abundance is found to be $\gtrsim 11\times$ the cosmic value, in good agreement with predictions. For the three less-evolved WN stars, little neon enhancement above cosmic values is measured, as expected. We discuss the impact of clumping in WR winds on this measurement, and the promise of using metal abundance ratios to eliminate sensitivity to wind density and ionization structure.

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Weblink: astro-ph/0412490

Influence of the Coriolis Force on the Instability of Slowly Pulsating B Stars

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This paper explores the effect of rotation on the κ-mechanism instability of slowly pulsating B stars. A new nonadiabatic code, that adopts the so-called 'traditional approximation' to treat the Coriolis force, is used to investigate the influence exerted by rotation over the stability of stellar models covering the mass range $2.5\,\mathrm{M}_\odot \leq M \leq 13.0\,\mathrm{M}_\odot$. The principal finding is that, for all modes considered apart from the prograde sectoral class, rotation shifts the κ-mechanism instability toward higher luminosities and effective temperatures; these shifts are accompanied by broadenings in the extent of instability strips. Such behaviour is traced to the shortening of mode periods under the action of the Coriolis force. Instability strips associated with prograde sectoral modes behave rather differently, being shifted to marginally lower luminosities and effective temperatures under the influence of rotation.

The implications of these results are discussed in the context of the observational scarcity of pulsation in B-type stars having significant rotation; various scenarios are explored to explain the apparent dichotomy between theory and observations. Furthermore, the possible significance of the findings to Be stars is briefly examined.

Accepted by MNRAS

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A New Calibration of Stellar Parameters of Galactic O Stars

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We present new calibrations of stellar parameters of O stars at solar metallicity taking non-LTE, wind, and line-blanketing effects into account. Gravities and absolute visual magnitudes are derived from

results of recent spectroscopic analyses. Two types of effective temperature scales are derived: one from a compilation based on recent spectroscopic studies of a sample of massive stars – the "observational scale" – and the other from direct interpolations on a grid of non-LTE spherically extended line-blanketed models computed with the code CMFGEN (Hillier & Miller 1998) – the "theoretical scale". These T_{eff} scales are then further used together with the grid of models to calibrate other parameters (bolometric correction, luminosity, radius, spectroscopic mass and ionising fluxes) as a function of spectral type and luminosity class. Compared to the earlier calibrations of Vacca et al. 1996) the main results are:

1) The effective temperature scales of dwarfs, giants and supergiants are cooler by 2000 to 8000 K, the theoretical scale being slightly cooler than the observational one. The reduction is the largest for the earliest spectral types and for supergiants.

2) Bolometric corrections as a function of T_{eff} are reduced by 0.1 mag due to line blanketing which redistributes part of the UV flux in the optical range. For a given spectral type the reduction of BC is larger for early types and for supergiants. Typically BCs derived using the theoretical T_{eff} scale are 0.40 to 0.60 mag lower than that of Vacca et al. (1996), whereas the differences using the observational T_{eff} scale are somewhat smaller.

3) Luminosities are reduced by 0.20 to 0.35 dex for dwarfs, by ~ 0.25 for all giants and by 0.25 to 0.35 dex for supergiants. The reduction is essentially the same for both T_{eff} scales. It is independent of spectral type for giants and supergiants and is slightly larger for late type than for early type dwarfs.

4) Lyman continuum fluxes are reduced. Our theoretical values for the hydrogen ionising photon fluxes for dwarfs are 0.20 to 0.80 dex lower than those of Vacca et al. (1996), the difference being larger at late spectral types. For giants the reduction is of 0.25 to 0.55 dex, while for supergiants it is of 0.30 to 0.55 dex. Using the observational T_{eff} scale leads to smaller reductions at late spectral types.

The present results should represent a significant improvement over previous calibrations, given the detailed treatment of non-LTE line-blanketing in the expanding atmospheres of massive stars.

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The VLT-FLAMES Survey of Massive Stars: Observations in the Galactic Clusters NGC 3293, NGC 4755 and NGC 6611

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We introduce a new survey of massive stars in the Galaxy and the Magellanic Clouds using the Fibre Large Array Multi-Element Spectrograph (FLAMES) instrument at the Very Large Telescope (VLT). Here we present observations of 269 Galactic stars with the FLAMES-Giraffe Spectrograph ($R \simeq 25,000$), in fields centered on the open clusters NGC 3293, NGC 4755 and NGC 6611. These

data are supplemented by a further 50 targets observed with the Fibre-Fed Extended Range Optical Spectrograph (FEROS, $R = 48{,}000$). Following a description of our scientific motivations and target selection criteria, the data reduction methods are described; of critical importance the FLAMES reduction pipeline is found to yield spectra that are in excellent agreement with less automated methods. Spectral classifications and radial velocity measurements are presented for each star, with particular attention paid to morphological peculiarities and evidence of binarity. These observations represent a significant increase in the known spectral content of NGC 3293 and NGC 4755, and will serve as standards against which our subsequent FLAMES observations in the Magellanic Clouds will be compared.

Accepted by A&A

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Weblink: http://www.ing.iac.es/~cje/flames_mw.ps.gz

The Origin of Massive O-type Field Stars. Part II: Field O stars as Runaways

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In two papers we try to confirm that all Galactic high-mass stars are formed in a cluster environment, by excluding that O-type stars found in the Galactic field actually formed there. In de Wit et al. (2004) we presented deep K-band imaging of 5 arcmin fields centred on 43 massive O-type field stars that revealed that the large majority of these objects are single objects. In this contribution we explore the possibility that the field O stars are dynamically ejected from young clusters, by investigating their peculiar space velocity distribution, their distance from the Galactic plane, and their spatial vicinity to known young stellar clusters. We (re-)identify 22 field O-type stars as candidate runaway OB-stars. The statistics show that $4 \pm 2\%$ of all O-type stars with $V < 8^m$ can be considered as formed outside a cluster environment. Most are spectroscopically single objects, some are visual binaries. The derived percentage for O-type stars that form isolated in the field based on our statistical analyses is in agreement with what is expected from calculations adopting a universal cluster richness distribution with power index of $\beta = 1.7$, assuming that the cluster richness distribution is continuous down to the smallest clusters containing one single star.

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On the Evidence for Discs around Blue Straggler Stars

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Recent observations of blue stragglers by De Marco et al. (2004) have revealed continuum deficits on the blue side of the Balmer discontinuity, leading these authors to infer the presence of discs around the stars. This intriguing possibility may throw light on aspects of the mechanisms responsible for at least some of these objects; current theories of blue straggler formation invoke stellar collisions or interacting binaries, both of which appear capable of forming a circumstellar disc.

However, by synthesizing photospheric spectra for models of rotating blue stragglers, we demonstrate that the Balmer jump enhancements can be wholly attributed to the influence of oblateness and gravity darkening on the formation of the continuum. Therefore, we are led to conclude that the observations of De Marco et al. can be ascribed a more prosaic explanation, that of rapid stellar rotation arising from the merger/interaction formation process.

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An XMM-Newton Observation of the Multiple System HD167971 (O5-8V + O5-8V + (O8I)) and the Young Open Cluster NGC6604

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We discuss the results of two XMM-Newton observations of the open cluster NGC6604 obtained in April and September 2002. We concentrate mainly on the multiple system HD167971 (O5-8V + O5-8V + (O8I)). The soft part of the EPIC spectrum of this system is thermal with typical temperatures of about 2 10^6 to 9 10^6 K. The nature (thermal vs non-thermal) of the hard part of the spectrum is not unambiguously revealed by our data. If the emission is thermal, the high temperature of the plasma ($\sim$ 2.3 10^7 to 4.6 10^7 K) would be typical of what should be expected from a wind-wind interaction zone within a long period binary system. This emission could arise from an interaction between the combined winds of the O5-8V + O5-8V close binary system and that of the more distant O8I companion. Assuming instead that the hard part of the spectrum is non-thermal, the photon index would be rather steep ($\sim$3). Moreover, a marginal variability between our two XMM-Newton pointings could be attributed to an eclipse of the O5-8V + O5-8V system. The overall X-ray luminosity points to a significant X-ray luminosity excess of about a factor 4 possibly due to colliding winds. Considering HD167971 along with several recent X-ray and radio observations, we propose that the simultaneous observation of non-thermal radiation in the X-ray (below 10.0 keV) and radio domains appears rather unlikely. Our investigation of our XMM-Newton data of NGC6604 reveals a rather sparse distribution of X-ray emitters. Including the two bright non-thermal radio emitters HD168112 and HD167971, we present a list of 31 X-ray sources along with the results of the cross-correlation with optical and infrared catalogues. A more complete spectral analysis is presented for the brightest X-ray sources. Some of the members of NGC6604 present some characteristics suggesting they may be pre-main

sequence star candidates.

Reference: Accepted by A&A (complete reference not yet available).

Weblink: http://vela.astro.ulg.ac.be/Preprints/P101/

Comments: also available at http://arxiv.org/abs/astro-ph/0503471

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Non-Thermal Radio Emission from O-Type Stars. I. HD 168112

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We present a radio lightcurve of the O5.5 III(f^+) star HD 168112, based on archive data from the Very Large Array (VLA) and the Australia Telescope Compact Array (ATCA). The fluxes show considerable variability and a negative spectral index, thereby confirming that HD 168112 is a non-thermal radio emitter. The non-thermal radio emission is believed to be due to synchrotron radiation from relativistic electrons that have been Fermi accelerated in shocks. For HD 168112, it is not known whether these shocks are due to a wind-wind collision in a binary system or to the intrinsic instability of the stellar wind driving mechanism. Assuming HD 168112 to be a single star, our synchrotron model shows that the velocity jump of the shocks should be very high, or there should be a very large number of shocks in the wind. Neither of these is compatible with time-dependent hydrodynamical calculations of O star winds. If, on the other hand, we assume that HD 168112 is a binary, the high velocity jump is easily explained by ascribing it to the wind-wind collision. By further assuming the star to be an eccentric binary, we can explain the observed radio variability by the colliding-wind region moving in and out of the region where free-free absorption is important. The radio data presented here show that the binary has a period of between one and two years. By combining the radio data with X-ray data, we find that the most likely period is ~ 1.4 yr.

Reference: A&A (in press)

Weblink: http://arxiv.org/abs/astro-ph/0502456

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Outflowing Disk Formation in B[e] Supergiants due to Rotation and Bi-Stability in Radiation Driven Winds

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The effects of rapid rotation and bi-stability upon the density contrast between the equatorial and polar directions of a B[e] supergiant are re-investigated. Based on a new slow solution for different high rotational radiation-driven winds and the fact that bi-stability allows a change in the line–force parameters (α, k, and δ), the equatorial densities are about 10^2–10^4 times higher than the polar ones. These values are in qualitative agreement with the observations.

Reference: Cure, M., Rial, D. F. and Cidale, L., Astronomy and Astrophysics, in press

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Chandra HETGS Multi-Phase Spectroscopy of the Young Magnetic O Star theta[1] Orionis C

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West Chester University, University of Delaware, Swarthmore College, Columbia University, North Carolina State University, University of Delaware, University of Delaware, Prism Computational Sciences

We report on four Chandra grating observations of the oblique magnetic rotator theta[1] Ori C (O5.5 V) covering a wide range of viewing angles with respect to the star's 1060 G dipole magnetic field. We employ line-width and centroid analyses to study the dynamics of the X-ray emitting plasma in the circumstellar environment, as well as line-ratio diagnostics to constrain the spatial location, and global spectral modeling to constrain the temperature distribution and abundances of the very hot plasma. We investigate these diagnostics as a function of viewing angle and analyze them in conjunction with new MHD simulations of the magnetically channeled wind shock mechanism on theta[1] Ori C. This model fits all the data surprisingly well, predicting the temperature, luminosity, and occultation of the X-ray emitting plasma with rotation phase .

Reference: ApJ, 628, in press astro-ph/0504296

Weblink: http://shayol.bartol.udel.edu/~rhdt/t1oc/

Comments: 52 pages, 14 figures (2 color), 6 tables

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Lower Mass Loss Rates in O-Type Stars: Spectral Signatures of Dense Clumps in the Wind of two Galactic O4 Stars

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We have analyzed the far-UV spectrum of two Galactic O4 stars, the O4If+ supergiant HD190429A and the O4V((f)) dwarf HD96715, using archival FUSE and IUE data. We have conducted a quantitative analysis based on the two NLTE model atmosphere and wind codes, TLUSTY and CMFGEN. We have derived the stellar and wind parameters and the surface composition of the two stars. The surface of HD190429A has a composition typical of an evolved O supergiant (N-rich, C and O-poor),

while HD96715 exhibits surface N enhancement similar to the enrichment found in SMC O dwarfs and attributed to rotationally-induced mixing. We find that homogeneous wind models could not match the observed profile of O V1371 and require very low phosphorus abundance to fit the PV1118-1128 resonance lines. However, we are able to match the O V and P V lines using clumped wind models. We find that N IV1718 is also sensitive to wind clumping. For both stars, we have calculated clumped wind models that match well all these lines from different species and that remain consistent with Halpha data. These fits therefore provide a coherent and thus much stronger evidence of wind clumping in O stars than earlier claims. We find that the wind of these two stars is highly clumped, as expressed by very small volume filling factors, namely f=0.04 for HD190429A and f=0.02 for HD96715. In agreement with our analysis of SMC stars, clumping starts deep in the wind, just above the sonic point. The most crucial consequence of our analysis is that the mass loss rates of O stars need to be revised downward significantly, by a factor of 3 and more. Accounting for wind clumping is essential when determining the wind properties of O stars. Our study therefore calls for a fundamental revision in our understanding of mass loss and of O-type star winds. (abridged)

Reference: Astron. Astrophys. (in press)

Weblink: http://xxx.lanl.gov/abs/astro-ph/0412346

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The Influence of Rotation in Radiation Driven Winds from Hot Stars II. CAK Topological Analysis

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The topological analysis from Bjorkman (1995) for the standard model that describes the winds from hot stars by Castor, Abbott & Klein (1975) has been extended to include the effect of stellar rotation and changes in the ionization of the wind. The differential equation for the momentum of the wind is non-linear and transcendental for the velocity gradient. Due to this non-linearity the number of solutions that this equation possess is not known. After a change of variables and the introduction of a new physically meaningless independent variable, we manage to replace the non-linear momentum differential equation by a system of differential equations where all the derivatives are explicitely given. We then use this system of equations to study the topology of the rotating-CAK model. For the particular case when the wind is frozen in ionization ($\delta = 0$) only one physical solution is found, the standard CAK solution, with a X-type singular point. For the more general case ($\delta \neq 0$), besides the standard CAK singular point, we find a second singular point which is focal-type (or attractor). We find also, that the wind does not adopt the maximal mass-loss rate but almost the minimal.

Reference: Cure, M. and Rial, D. F., Astronomy and Astrophysics, v.428, p.545-554 (2004)

Weblink: astro-ph/0408511

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Statistical Confirmation of a Stellar Upper Mass Limit

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We derive the expectation value for the maximum stellar mass ($m_{\rm max}$) in an ensemble of N stars, as a function of the IMF upper-mass cutoff ($m_{\rm up}$) and N. We statistically demonstrate that the upper IMF of the local massive star census observed thus far in the Milky Way and Magellanic Clouds clearly exhibits a universal upper mass cutoff around $120 - 200\ m_\odot$ for a Salpeter IMF, although the result is more ambiguous for a steeper IMF.

Reference: Astrophysical Journal Letters

Weblink: http://arxiv.org/abs/astro-ph/0501135

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Chandra X-ray Observations of the Young Stellar Cluster NGC 6193 in the Ara OB1 Association

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A 90 ksec Chandra HETG observation of the young stellar cluster NGC 6193 in the southern Ara OB1 association detected 43 X-ray sources in a $2' \times 2'$ core region centered on the massive O stars HD 150135 (O6.5V) and HD 150136 (O3 + O6V). The cluster is dominated by exceptionally bright X-ray emission from the two O stars, which are separated by only $10''$. The X-ray luminosity of HD 150136 is log L_X = 33.39 (ergs s^{-1}), making it one of the most luminous O-star X-ray sources known. All of the fainter X-ray sources in the core region have near-IR counterparts, but existing JHK photometry provides little evidence for near-IR excesses. These core sources have typical mean photon energies $\langle E \rangle \approx 2$ keV and about one-third are variable. It is likely that some are young low-mass stars in the cluster, but cluster membership remains to be determined. Grating spectra show that the X-ray properties of HD 150135 and HD 150136 are similar, but not identical. Both have moderately broadened unshifted emission lines and their emission is dominated by cool plasma at kT $\approx$ 0.3 keV, pointing to a wind-shock origin. However, the emission of HD 150136 is slightly hotter and four times more luminous than its optical twin HD 150135. We discuss the possibility that a radiative colliding wind shock contributes to the prodigious X-ray output of the short-period (2.66 d) spectroscopic binary HD 150136. A suprising result is that the X-ray emission of HD 150136 is slowly variable on a timescale of <1 day. The origin of the variability is not yet known but the observed behavior suggests that it is an occultation effect.

Reference: MNRAS, in press

Weblink: http://arxiv.org/abs/astro-ph/0504559

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The Physical Properties and Effective Temperature Scale of O-type Stars as a Function of Metallicity. II. Analysis of 20 More Magellanic Cloud Stars, and Results from the Complete Sample

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In order to determine the physical properties of the hottest and most luminous stars, and understand how these properties change as a function of metallicity, we have analyzed *HST*/UV and high S/N optical spectra of an additional 20 Magellanic Cloud stars, doubling the sample presented in the first paper in this series. Our analysis uses NLTE line-blanketed models that include spherical extension and the hydrodynamics of the stellar wind. In addition, our dataset includes *FUSE* observations of OVI and *HST* near-UV He I and He II lines to test for consistency of our derived stellar properties for a few stars. The results from the complete sample are as follows: (1) We present an effective temperature scale for O stars as a function of metallicity. We find that the SMC O3-7 dwarfs are 4000 K hotter than Galactic stars of the same spectral type. The difference is in the sense expected due to the decreased significance of line-blanketing and wind-blanketing at the lower metallicities that characterize the SMC. The temperature difference between the SMC and Milky Way O dwarfs decreases with decreasing temperature, becoming negligible by spectral type B0, in accord with the decreased effects of stellar winds at lower temperatures and luminosities. The temperatures of the LMC stars appear to be intermediate between that of the Milky Way and SMC, as expected based on their metallicities. Supergiants show a similar effect, but are roughly 3000-4000 K cooler than dwarfs for early O stars, also with a negligible difference by B0. The giants appear to have the same effective temperature scale as dwarfs, consistent with there being little difference in the surface gravities. When we compare our scale to other recent modeling efforts, we find good agreement with some CMFGEN results, while other CMFGEN studies are discordant, although there are few individual stars in common. WM-Basic modeling by others have resulted in significantly cooler effective temperatures than what we find, as does the recent TLUSTY/CMFGEN study of stars in the NGC 346 cluster, but our results lead to a far more coeval placement of stars in the H-R diagram for this cluster. (2) We find that the wind momentum of these stars scale with luminosity *and* metallicity in the ways predicted by radiatively-driven wind theory, supporting the use of photospheric analyses of hot luminous stars as a distance indicator for galaxies with resolved massive star populations. (3) A comparison of the spectroscopic masses with those derived from stellar evolutionary theory shows relatively good agreement for stars with effective temperatures below 45000 K; however, stars with higher temperatures all show a significant mass discrepancy, with the spectroscopic masses a factor of 2 or more smaller than the evolutionary masses. This problem may in part be due to unrecognized binaries in our sample, but the result suggests a possible systematic problem with the surface gravities or stellar radii derived from our models. (4) Our sample contains a large number of stars of the earliest O-types, including those of the newly proposed O2 subtype. We provide the first quantitative descriptions of their defining spectral characteristics and investigate whether the new types are a legitimate extension of the effective temperature sequence. We find that the NIII/NIV emission line ratio used to define the new classes does not, by itself, serve as an effective temperature indicator within a given luminosity class: there are O3.5 V stars which are as hot or hotter than O2 V stars. However, the He I/He II ratio does not fare much better for stars this hot, as we find that He I λ4471/ He II λ4542, usually taken primarily as a temperature indicator, becomes sensitive to both the mass-loss rate and surface gravities for the hottest stars. This emphasizes the need to rely upon

all of the spectroscopic diagnostic lines, and not simply N III/N IV or even He I/He II, for these extreme objects. (5) The two stars with the most discordant radial velocities in our sample happen to be O3 "field stars", i.e., found from the nearest OB associations. This provides the first compelling observational evidence as to the origin of the field O stars in the Magellanic Clouds; i.e., that these are classic runaway OB stars, ejected from their birth places.

Reference: ApJ 627, in press

Weblink: ftp://ftp.lowell.edu/pub/massey/haw2final.pdf

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A Change in the Physical State of Eta Carinae?

Davidson, K.; Martin, J.; Humphreys, R. M.; Ishibashi, K.; Gull, T. R.; Stahl, O.; Weis, K.; Hillier, D. J.; Damineli, A.; Corcoran, M.; Hamann, F.

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During eta Car's spectroscopic event in mid-2003, the stellar wind's bright H? and H? emission lines temporarily had a distinctive shape unlike that reported on any previous occasion and particularly unlike the 1997-1998 event. Evidently the structure of the wind changed between 1997 and 2003. Combining this with other evidence, we suspect that the star may now be passing through a rapid stage in its recovery from the Great Eruption seen 160 years ago. In any case, the data indicate that successive spectroscopic events differ, and the hydrogen line profiles are quantitative clues to the abnormal structure of the wind during a spectroscopic event.

Reference: Davidson et al. 2005, AJ, 129, 900

Weblink: http://adsabs.harvard.edu/cgi-bin/nph-bib_query?bibcode=2005AJ....129..900D&db_key=AST

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First Ever Polarimetric Detection of a Wind-Wind Interaction Region and a Misaligned Flattening of the Wind in the Wolf-Rayet Binary CQ Cep

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In this paper, we present unfiltered and multi-band (i.e. UBVRI) polarimetric observations of the short-period Wolf-Rayet binary CQ Cep. Using the basic assumptions of an optically-thin corotating envelope and point-like sources (i.e. BME78 assumptions), we determined the orbital parameters of the system [i.e. $i = (99\pm1)^o$ and $\Omega = (76\pm2)^o$ at the 2σ level] with an accuracy many times better than any previous work. Residual non-BME78 variability around phase 0.0 was present in our data, which

we associate with the polarimetric eclipse of the dense central parts of the WR wind by the orbiting O-star. We attribute the observed phase-lag of -0.15 between our residuals and those expected for a standard polarimetric eclipse to a wind-wind interaction (WWI) region distorted by Coriolis forces based on the model presented by Marchenko et al. (1995). This model was also able to explain the strong wavelength-dependence of the polarimetric amplitudes in our multi-band observations. Our analysis also reveals important epoch-dependent departures of the matter distribution from spherical symmetry, which were not related to the orbital plane and therefore cannot be the result of tidal interaction. We conclude that binarity is not playing an important role in driving the wind of the WR star in CQ Cep and contributing to the observed non-spherical matter distribution. On the other hand, this asymmetry could be explained by a rotationally-induced disk misaligned with the orbital plane.

Reference: ApJ, 624 (in press)

Comments: Preprints available by email.

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The Effective Temperature Scale of Galactic Red Supergiants: Cool, but not as Cool as we Thought

Emily M. Levesque, Philip Massey, K. A. G. Olsen, Bertrand Plez, Eric Josselin, Andre Maeder, Georges Meynet

Lowell Observatory; MIT; Cerro Tololo Inter-American Observatory; GRAAL, Universite du Montpellier; Geneva Observatory

We use moderate-resolution optical spectroscopy and the new MARCS stellar atmosphere models to determine the effective temperaturesof 74 Galactic red supergiants (RSGs). The stars are mostly members of OB assocations or clusters with known distances, allowing a critical comparison with modern stellar evolutionary tracks. We find we can achieve excellent matches between the observations and the reddened model fluxes and molecular transitions, although the atomic lines Ca I 4226 and CA II H and K are found to be unrealistically strong in the models. Our new effective temperat! ure scale is significantly warmer than those in the literature, with the differences amounting to 400 K for the latest-type M supergiants (i.e., M5 I). We show that the newly derived temperatures and bolometric corrections give much better agreement with stellar evolutionary tracks. This agreement provides a completely independent verification of our new temperature scale. The combination of effective temperature and bolometric luminosities allows us to calculate stellar radii; the coolest and most luminous stars (KW Sgr, Case 75, KY Cyg, HD 206936=mu Cep) have radii of roughly 1500 solar radii (7 AU) in excellent accordance with the largest stellar radii predicted from current evolutionary theory, although smaller than that found by others for the binary VV Cep and for the peculiar star VY CMa. We find that similar results are obtained for the effective temperatures and bolometric luminosities using only the de-reddened $V - K$ colors, providing a powerful demonstration of the self-consistency of the MARCS models.

Reference: Levesque et al. 2005, ApJ 628, in press

Weblink: ftp://ftp.lowell.edu/pub/massey/RSGMW.pdf

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The Stellar Content of Nearby Star-Forming Galaxies. III. Unravelling the Nature of the Diffuse Ultraviolet Light

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[4] - Johns Hopkins University
[5] - Goddard Space Flight Center
[6] - Catholic University of America

We investigate the nature of the diffuse intra-cluster ultraviolet light seen in twelve local starburst galaxies, using long-slit ultraviolet spectroscopy obtained with the Space Telescope Imaging Spectrograph (STIS) aboard the Hubble Space Telescope (HST). We take this faint intra-cluster light to be the field in each galaxy, and compare its spectroscopic signature with STARBURST99 evolutionary synthesis models and with neighboring star clusters. Our main result is that the diffuse ultraviolet light in eleven of the twelve starbursts lacks the strong O-star wind features that are clearly visible in spectra of luminous clusters in the same galaxies. The difference in stellar features dominating cluster and field spectra indicate that the field light originates primarily from a different stellar population, and not from scattering of UV photons leaking out of the massive clusters. A cut along the spatial direction of the UV spectra establishes that the field light is not smooth, but rather shows numerous "bumps and wiggles". Roughly 30-60peaks seen in field regions of the closest (¡4 Mpc) starbursts appear to be resolved, suggesting a contribution from superpositions of stars and/or faint star clusters. Complementary WFPC2 U,V,I imaging for the three nearest target galaxies, NGC 4214, NGC 4449, and NGC 5253 are used to obtain a broader picture, and establish that all three galaxies have a dispersed population of unresolved, luminous blue sources. Because the field spectra are dominated by B-stars, we suggest that the individual sources observed in the WFPC2 images are individual B stars (rather than O stars), or small star clusters. We consider several scenarios to understand the lack of observed massive stars in the field, and their implications for the origin of the field stellar population. If the field stellar populations formed in situ, the field must either have an IMF slope which is steeper than Salpeter (3.0-3.5), or a Salpeter slope with an upper mass cutoff of 30-50 solar masses. If star formation occurs primarily in star clusters, the field could be composed of older, faded clusters, and/or a population which is coeval with the luminous clusters but lower in mass. We use these benchmark populations to place constraints on the field stellar population origin. Although the field probably includes stars of different ages, the UV light is dominated by the youngest stellar populations in the field. If the field is composed of older, dissolving clusters, we estimate that star clusters (regardless of mass) need to dissolve on timescales 7-10 Myr to create the field. If the field is composed of young clusters which fall below the detection limit of individual sources in our spectroscopy, they would have to be several hundred solar masses or less, in order to be deficient in O stars, despite their extreme youth.

Reference: 2005, ApJ, 628 (in press)

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Submitted Papers

On the He II Emission In Eta Carinae and the Origin of Its Spectroscopic Events

J. C. Martin, K. Davidson, R. M. Humphreys, D. J. Hillier, K. Ishibashi, et al

AA(University Of Minnesota), AB(University Of Minnesota), AC(University Of Minnesota), AD(University Of Pittsburg), AE(MIT)

We report Hubble Space Telescope (HST) observations of emission in Eta Carinae near 4680 Å, presumably He II 4687, which are not spatially resolved from the central star. The emission was not detected in the spectrum from 1998.0 to 2003.0, or after the spectroscopic event in 2003.5. It appeared in early 2003, rapidly grew to a larger brightness than the previous authors reported, and then disappeared suddenly near 2003.5. For several weeks the He II 4687 luminosity was too high to explain easily in most proposed models for Eta Car's spectroscopic events. According to our analyses, this feature appears most cons! istent with a wind-disturbance or mass-ejection type of model with relatively high gas densities. An unusual form of radiative excitation, making use of trapped He II 304 resonance photons, may have played a major role.

Reference: submitted to the ApJ

Weblink: http://arxiv.org/abs/astro-ph/0504151

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Book

Evolution of Massive Stars, Mass Loss and Winds

Summer Schools on Stellar Physics XII-XIII,
EAS Publications Series, Volume 13,
EDP Sciences, France,
2004

Editors: M. Heydari-Malayeri, Ph. Stee, J.-P. Zahn

This volume presents a selection of lectures which have been given during two consecutive Summer Schools in Stellar Physics (XII and XIII). The first of these schools took place in Aussois, a ski resort in the Alps, on 13-18 October, and it dealt with the formation and the evolution of massive stars. The second was held at Oléron, an island off the Atlantic shore, on 6-10 October, and it focussed on mass loss from stars and on stellar winds. The subjects of these two schools are closely linked, since massive stars lose an important fraction of their mass in the course of their evolution, and that is why we merged the lecture notes in a single volume.

In spite of their relatively small number, massive stars play a key role in several aspects. They are the principal sites of nucleosynthesis, and because most of their matter is ejected by their winds and in

the final supernova explosion, they are responsible for the chemical evolution of their host galaxy, and thus of the Universe. They are the main energy providers to the interstellar medium, through their winds and their UV radiation. Finally, since they are very luminous, they can be detected in remote galaxies, and tell us about their star formation.

In recent years, one has become increasingly aware that their evolution strongly depends on their mass loss, and also on the internal mixing which is induced by rotation, as was emphasized by André Maeder in Aussois, and Georges Meynet in Oléron. These effects must be taken into account when modeling these stars, or else one misses completely the late stages of evolution.

In massive stars the mass loss occurs through radiation driven winds, whose description has benefited tremendously from the development of new techniques of high angular resolution, and from obsevation in space. The physical processes involved are now much better understood, and they are being reproduced in the laboratory. In his lectures, Stan Owocki gave us a complete picture of mass ejection by contrasting these winds blowing from hot stars with those, much less powerful, emitted by solar-type stars.

Beside the principal lecturers, several others addressed particular topics, such as the formation of massive stars, the late phases, rotational mixing, the structure of the winds, the role of binarity, colliding winds, wind diagnostics, even laboratory experiments reproducing radiative shocks.

You can read the abstract on the EDP web site:
http://www.edpsciences.org/articles/eas/abs/2004/03/contents/contents.html
See also http://194.2.231.155/articles_books/textes/eas_13.html

Jobs

Postdoctoral Researcher
University of Glasgow, Department of Physics and Astronomy

GBP 21,640 - GBP 25,699 per annum

REF 11241/DPL/A3

The appointment will be in plasma astrophysics theory and data modelling in one or both of:

(a) energetic phenomena in solar atmospheric plasmas, or
(b) mass loss processes from hot stars

Candidates from these, or closely related disciplines (including plasma physics), are welcome to apply. This PPARC funded post will be available for up to three years in the first instance, commencing 1 October 2005.

Applications comprising (hardcopy) c.v., lists of publications and research interests, and two letters of reference to Professor J.C.Brown, Astronomer Royal, for Scotland, Kelvin Building, University of Glasgow, G12 8QQ to whom enquiries may be directed (john@astro.gla.a.c.uk).

Closing Date: 31 May 2005.

(Volunteer) Webmaster of the Massive Star Working Group Website

We are currently seeking a part-time, volunteer webmaster to join the Organizing Committee (OC) of the IAU Working Group on Massive Stars. The webmaster will be responsible for designing, updating, and maintaining our website at http://www.astroscu.unam.mx/massive_stars/. The webmaster will become a member of the OC and will serve as the liaison between the OC and the computer support group at UNAM (Mexico City). In close collaboration with the OC and UNAM computer support, the webmaster will monitor the existing web services and be responsible for making content upgrades, updates, and other changes. The webmaster will be based at her/his home institution. All interaction and communication will occur over the internet at flexible hours.

Ideal candidates will possess (or are working towards) a Ph.D. in astronomy, and have prior experience in web design. Working knowledge of applicable software (HTML, Javascript, Perl, CGI, Dreamweaver or other HTML editor, Photoshop) and familiarity with UNIX are required. Pre- or postdoctoral research experience in fields related to massive stars is highly desirable.

Candidates should express their interest to Claus Leitherer (leitherer@stsci.edu). This is a volunteer position, working approximately 4 hours per week. Junior astronomers seeking high visibility in the community will find this opportunity particularly attractive. The vacancy is available immediately and will be open until filled. Women and minorities are strongly encouraged to apply.

Meetings

Calibrating the Top of the Stellar M-L Relation

A one-day Joint Discussion

to be held during the IAU General Assembly

Prague, August 2006

Scientific Organizing Committee: Claus Leitherer (Baltimore; Chair), Norbert Langer (Utrecht), Anthony Moffat (Montreal), Stanley Owocki (Delaware), and Joachim Puls (Munich).

The goal is to bring together theorists and observers from the stellar and extragalactic communities to discuss the properties of the most massive stars and the implications for cosmological studies. We will focus on a set of themes that follow from fundamental stellar astronomy, such as mass determinations in binary stars, to recent modeling of atmospheres and evolution, to the significance of massive stars for the ecology of the host galaxy, and finally to a critical assessment of the properties of the first generation of stars in the universe.

For more information and to provide feedback to the organizers, Newsletter readers are encouraged to visit the Bulletin Board at the website of the Working Group on Massive Stars:

http://www.astroscu.unam.mx/cgi-bin/discus/discus.pl