THE HOT STAR NEWSLETTER

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An electronic publication dedicated to O, Of, LBV and Wolf-Rayet stars and related phenomena in galaxies

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http://www.inaoep.mx/∼eenens/hot.html

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From the editor

The Working Group on Hot Massive Stars.

Here are the results of the vote for the Organizing Committee of the *ad hoc* Working Group on Hot Massive Stars:

Philippe Eenens 89
Peter Conti 67
Andre Maeder 52
Tony Moffat 51
Henny Lamers 50
Karel van der Hucht 49
Joe Cassinelli 42
Catharine Garmany 36
Stan Owocki 35
Rolf Kudritzki 32

The number of replies (116) has been amazingly high (approximately half of the researchers active in the field). If I am not mistaken, this indicates a real interest in further improving the communication and collaboration within the hot-star community. I hope we can find efficient ways to achieve these goals. As to the numerous votes for myself, I assume that they mean: *"keep working"*.

For those who like numbers: 116 ballots were received, totalling 1054 votes. Two persons received 30 votes, six more received over 20 votes, 12 over ten votes, 41 ten votes or less.

Contents of this newsletter

Accepted

Starbursts in barred spiral galaxies. I. Mrk 712, a new Wolf-Rayet galaxy

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We report the discovery of emission from Wolf-Rayet stars in a giant H II region 4.5 arcsec South of the nucleus of the IRAS barred spiral galaxy Mrk 712 (= UGC 5342). The ratio of WNL to OV stars, estimated from the luminosity of the He IIλ4686 line, is 0.2. By comparison with starburst and stellar evolution models, we find that this high value is only compatible with a very young starburst episode (3 – 4 Myr) and a flat initial mass function (Γ = –1). The presence of the [Ar V] line reveals that the H II region is strongly ionized by the hot Wolf-Rayet stars. The comparison with other barred Wolf-Rayet galaxies suggests that the detection of Wolf-Rayet stars depends on the dust content and orientation of the galaxy.

Accepted by A & A *For preprints, contact* contini@obs-mip.fr

An infrared spectral analysis of two Cygnus WNE stars

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We investigate whether the stellar parameters and chemistries of Wolf-Rayet stars can be adequately determined from IR observations by focusing on two WN6 stars which have been the subject of numerous optical studies. Our analysis is based on new UKIRT–CGS4 observations of the strong, broad-lined stars WR134 (HD 191765) and WR136 (HD 192163) in Cygnus. We find excellent agreement in our derived stellar parameters for both stars (T_*∼55kK, $T_{2/3}$∼29kK, log $L/L_\odot$∼5.3, log $\dot{M}/M_\odot\,\mathrm{yr}^{-1}$∼−3.9, v_∞∼1900 km s^{-1}) with previous optical tailored analyses (e.g. Hamann et al. 1994). The numerous unblended H and He emission lines in the IR allow us to determine very accurate H/He ratios for these two stars. We confirm that WR136 contains substantial hydrogen (∼10% by mass) while less than 1% hydrogen is found for WR134. We provide a spectral comparison of WN3–9 stars in the I, H and K-bands and give theoretical intrinsic WN infrared colours of use for future IR studies. We note that the WN9 star WR105 (NS4) has a similar spectral morphology to the Galactic Centre helium emission stars (Allen et al. 1990; Krabbe et al. 1991). We also present synthetic 2.5–10μm spectra of WR136 for comparison with planned *ISO* spectroscopic observations.

Accepted by A & A
Preprints available via anonymous ftp - please contact pac@star.ucl.ac.uk

X-Rays from Superbubbles in the Large Magellanic Cloud. III. X-ray Dim Superbubbles

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Only X-ray-bright superbubbles have been reported in the past. *ROSAT* provides an excellent opportunity to study X-ray-dim superbubbles. We have analyzed the *ROSAT* Position Sensitive Proportional Counter observations of four superbubbles in the Large Magellanic Cloud – DEM 31, DEM 105, DEM 106, and DEM 137. None of the four is detected at more than the 2 σ level. The observed luminosities and the 3 σ upper limits are consistent with the luminosities expected from energy-conserving bubbles. These results confirm that not all superbubbles are X-ray bright, suggesting that an intermittent process such as hidden supernova remnants is responsible for the X-ray-bright superbubbles.

Accepted by Ap J for September 1995 *For preprints, contact* chu@astro.uiuc.edu

Thermal Radio Emission from Early-type Binary Systems

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We investigate the effect of binarity on the thermal radio emission from early-type binary systems, finding that the presence of a companion with a substantial wind will tend to increase the expected thermal radio emission as compared to a single star with the same wind characteristics as the primary. While this is not surprising, the degree to which the radio emission is altered is a sensitive function of the wind parameters, and in particular the momentum ratio of the two winds. The hot gas created by the wind collision plays a substantial role in the excess radio emission. In the case of comparable winds the thermal radio emission can be increased by 50 percent or more.

In previous determinations of mass-loss rates of the components of binary systems via thermal radio emission, the effects of binarity have not been included in any rigorous way. This means that the mass-loss rates of some early-type stars in binary systems may have been systematically overestimated. In the light of our calculations, we discuss methods of more accurately estimating the mass-loss rates of both components of binary systems.

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Evolution of WR ring nebulae generated by moving central stars - II. The influence of the RSG bow shock.

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We present detailed simulations of the evolution of Wolf-Rayet ring nebulae expanding around stars

which move through the interstellar medium. Attention is payed to describe how the circumstellar matter is processed by the previous action of the stellar wind during the red supergiant phase. In particular, we found that the radiative bow shock around the RSG star suffer strong dynamical (K-H plus R-T) instabilities, which make the circumstellar medium very disorderly. The evolution of the ring nebula is greatly influenced by these instabilities. The models are compared with some observed ring nebulae.

Accepted by MNRAS *For preprints, contact* brighenti@astbo3.bo.astro.it

Submitted

Stellar winds and the EUV continuum excess of early B-giants

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The strong excess of radiation in the Lyman- and HeI-continuum of the B-giant ϵ CMA, detected very recently with EUVE (Cassinelli et.al. 1994), is partially explained as a consequence of transonic velocity fields of weak stellar winds. Velocity induced density changes or Doppler-shifts reduce the opacity and increase the escape probability in the resonance transitions of hydrogen and neutral helium at the depths of formation of the ground state continua. As a result the ground state occupation numbers and the corresponding absorption edges are reduced significantly, and the emergent Lyman- and HeI- fluxes are enhanced.

A small sequence of simple model atmospheres for B-giants including spherical extension and stellar winds is calculated to demonstrate the importance of this effect and to investigate its dependence on the mass-loss rate. It is shown that the number of hydrogen and helium ionizing photons of early B-giants is a strong function of the mass-loss rate. This might have consequences for the diffuse ionizing radiation field in galaxies.

Submitted to A&A *For preprints, contact* paco@usm.uni-muenchen.de
Available by anonymous ftp: ftp.usm.uni-muenchen.de cd pub/paco/epscma.ps

Long-term time-series spectroscopy of OBA supergiants

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[4] STScI, Homewood Campus, 3700 San Martin Drive, Baltimore MD 21218, USA

We present time-series spectra of a small number of early-type supergiants (ζ Pup (O5 Iaf), P Cygni

(B1 p), HD 169454 (B1 Ia$^+$), ζ^1 Sco (B1.5 Ia$^+$), HD 91619 (B7 Ia), β Ori (B8 Ia), HD 96919 (B9 Ia), HD 92207 (A0 Ia), HD 100262 (A2 Ia), α Cyg (A2 Ia), HD 160529 (A2 Ia$^+$), and η Car (pec)) which have been obtained with a number of telescopes within the last years (between 1990 and 1994). In addition we present spectra of the Trapezium star θ^1 Ori C (O7 V), which was included in our monitoring program. A total of 1719 spectra covering the wavelength range from 4000 to 6800 Å with a spectral resolution ($\lambda/\Delta\lambda$) between 12 000 and 20 000 is presented. The data present a unique data base for the study of the variability of early-type supergiants on time scales from days to years. The data are available on CD-ROM.

Submitted to The Journal of Astronomical Data (published on CD-ROM)
For preprints, contact ostahl@mail.lsw.uni-heidelberg.de
The manuscript is available by anonymous ftp 147.142.111.23, /incoming/ostahl/OBAstars.ps.Z

Dissertation abstracts

Complete Stellar Models: Spectral and Interior Evolution of Massive Stars

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This thesis work presents the first "complete stellar models" for massive stars, which consistently treat the stellar interior, the atmosphere, and the stellar winds. This approach allows to simultaneously predict basic stellar parameters (luminosity, radii, temperatures), nucleosynthesis (abundances), as well as the detailed emergent spectrum through the relevant evolutionary phases (corresponding to OB, LBV and Wolf–Rayet stars). On the other hand, our modelling including the stellar winds also allows to study the influence of the outer layers on the stellar structure and evolution. Conceptually the thesis is divided in two main parts.

In the first part we construct the first non–LTE line blanketed hydrodynamic models of spherically expanding atmospheres of hot stars. The entire domain from the optically thick photosphere out to the terminal velocity of the wind is treated. We discuss in detail the effects of line blanketing and the importance of the hydrodynamic structure for the determination of stellar parameters of OB stars.

In the second part we develop the "complete stellar models" (*CoStar*). As a first application we study the main sequence (MS) interior and spectral evolution of massive stars at solar metallicity. The evolutionary tracks and the interior evolution are found to be basically unchanged by the realistic treatment of the outer layers. The main *CoStar* predictions presented for the MS are the following: *1)* Estimates of mass loss rates due to radiation pressure including multiple scattering and line overlap, *2)* continuous spectral energy distribution (EUV to IR) and ionising fluxes, *3)* UBVRIJHKLMN photometric evolution, *4)* UV colours, *5)* detailed metal line blanketed UV spectra, *6)* non–LTE hydrogen and helium line spectra in the visible and IR, including theoretical K band spectra, and *7)* fit formulæ to derive mass loss rates from Hα, Pα and Bα equivalent width measurements.

As a second application we present Wolf–Rayet (WR) models with spherically outflowing envelopes. We study the possible influence of the strong WR mass loss on their interior structure and evolution, and derive subphotospheric radii ($\tau_{\rm cont} \sim$ 10–20) for WNE and WC/WO stars with strong mass loss

rates. The possible importance of the iron opacity peak for the acceleration of WR winds in the optically thick part is briefly discussed.

Ph.D. degree awarded: January 1995
Thesis advisor: André Maeder
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Meetings

The second announcement for the August 21–25 meeting on [WR] central stars of PNe is available at URL: http://nastol.astro.lu.se/ eva/ven/ven.html
The organizers plan to make the abstracts of contributions also available on the WWW.