THE HOT STAR NEWSLETTER

⋆

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

⋆

No. 65 2001 November - December http://www.astro.ugto.mx/∼eenens/hot/
editor: Philippe Eenens http://www.star.ucl.ac.uk/∼hsn/index.html
eenens@astro.ugto.mx ftp://saturn.sron.nl/pub/karelh/UPLOADS/WRBIB/

Contents of this newsletter

Accepted Papers

On the effective temperature scale of O stars

F. Martins[1], D. Schaerer[1] and D. J. Hillier[2]

[1] Observatoire Midi-Pyrénées, Laboratoire d'Astrophysique, 14, Av. E. Belin, F-31400 Toulouse, France

[2] Department of Physics and Astronomy, University of Pittsburgh, Pittsburgh, PA 15260, USA

We rediscuss the temperature of O dwarfs based on new non-LTE line blanketed atmosphere models including stellar winds computed with the *CMFGEN* code of Hillier & Miller (1998). Compared to the latest calibration of Vacca et al. (1996), the inclusion of line blanketing leads to lower effective temperatures, typically by $\sim$ 4000 to 1500 K for O3 to O9.5 dwarf stars. The dependence of the $T_{\rm eff}$-scale on stellar and model parameters – such as mass loss, microturbulence, and metallicity – is explored, and model predictions are compared to optical observations of O stars. Even for an SMC metallicity we find a non-negligible effect of line blanketing on the $T_{\rm eff}$-scale. The temperature reduction implies downward revisions of luminosities by $\sim$ 0.1 dex and Lyman continuum fluxes Q_0 by approximately 40% for dwarfs of a given spectral type.

Accepted by Astronomy & Astrophysics

Preprints from `martins@ast.obs-mip.fr`
or on the web at http://xxx.lpthe.jussieu.fr/abs/astro-ph/0111233

Evidence for a connection between photospheric and wind structure in HD 64760

A. Kaufer[1], R. Prinja[2], O.Stahl[3]

[1] European Southern Observatory, Alonso de Cordova 3107, Casilla 19001, Santiago 19, Chile

[2] Department of Physics & Astronomy, University College London, Gower Street, London, WC1E 6BT, UK

[3] Landessternwarte Heidelberg, Königstuhl 12, 69117 Heidelberg, Germany

We report on the results of an extended optical spectroscopic monitoring campaign on the early-type B supergiant HD 64760 (B0.5 Ib). The study is based on high-resolution echelle spectra obtained with the Landessternwarte Heidelberg's HEROS instrument at ESO La Silla. Ninety-nine spectra were collected over 103 nights between January 19 and May 1, 1996. The Hα line shows a characteristic profile with a central photospheric absorption superimposed by symmetrically blue- and red-shifted wind-emission humps. The time-averaged line profile is well described by a differentially rotating and expanding radiation-driven wind: the redistribution of the wind emission flux into a double peak profile is interpreted in terms of the resonance zone effect in rotating winds as first described by Petrenz & Puls (1996). Detailed time-series analyses of the line profile variations across the Hα profile reveal for the first time in an optical data set of HD 64760 a periodic 2.4-day modulation of the inner and outer flanks of the Hα emission humps. The stronger modulations of the inner flanks of the emission humps at photospheric velocities are due to complex width variations of the underlying photospheric Hα profile. The weaker variations of the outer flanks are in phase and reflect variations at the base of the stellar wind. The detected 2.4-day modulation period together with a second period of 1.2 days (in the red emission hump only) is in excellent agreement with the outer-wind modulation periods as reported by Fullerton et al. (1997) from intensive IUE UV time-series observations in 1993 and 1995. The 2.4-day period is further detected in the photospheric HeIλ4026 line as prograde traveling (pseudo-)absorption and emission features. The observed variability pattern is indicative for low-order non-radial pulsations in the photosphere of HD 64760. The non-radial pulsations are identified as the source of persistent, regularly spaced stellar surface structure which is maintained throughout the photosphere – wind transition zone (this work) out into the UV regime of the terminal velocity outflow.

Accepted by Astronomy & Astrophysics

Preprints from `akaufer@eso.org`

or on the web at `http://www.eso.org/~akaufer/docs/hd64final.ps.gz`

Radio Properties of Pinwheel Nebulae

J. D. Monnier[1], L. J. Greenhill[1], P. G. Tuthill[2], and W. C. Danchi[3]

[1] Harvard-Smithsonian Center for Astrophysics

[2] University of Sydney

[3] NASA-Goddard

A small number of dusty Wolf-Rayet stars have been resolved into pinwheel nebulae, defined by their "rotating" spiral dust shells observed in the infrared. This morphology is naturally explained by dust formation associated with colliding winds in a binary system. In order to confirm and further explore this hypothesis, we have observed the known pinwheel nebulae (WR 104 and WR 98a) as well as the suspected binary WR 112 at multiple radio wavelengths with the Very Large Array to search for non-thermal radio emission from colliding winds. The spectrum of each target is nearly flat between 5

and 22 GHz, consistent with the presence of non-thermal emission that is reduced at low frequencies by free-free absorption. This emission must lie outside the radio "photosphere," leading us to estimate a lower limit to the physical size of the non-thermal emitting region that is larger than expected from current theory. Based on a radio and infrared comparison to WR 104 & 98a, we conclude that WR 112 is a likely candidate pinwheel nebula, but its temporal variability indicates an eccentric binary orbit or a pinwheel viewed nearly edge-on. A sensitive radio survey of IR-bright WRs would stringently test the hypothesis that colliding winds lie at the heart of *all* dusty WR systems. We also discuss the effects of dust obscuration in the ultra-violet and how radio-determined mass-loss rates of pinwheel nebulae (and dusty WR stars in general) may be underestimated due to shadowing effects.

Accepted by Astrophysical Journal 566, 399 (2002 Feb 10)
Preprints from jmonnier@cfa.harvard.edu
or on the web at http://cfa-www.harvard.edu/∼jmonnier/Publications/Radio_Pinwheel.ps

Multicomponent radiatively driven stellar winds II. Gayley-Owocki heating in multitemperature winds of OB stars

J. Krtička[1,2] and J. Kubát[2]

[1] Ústav teoretické fyziky a astrofyziky PřF MU, Kotlářská 2, CZ-611 37 Brno, Czech Republic
[2] Astronomický ústav, Akademie věd České republiky, CZ-251 65 Ondřejov, Czech Republic

We show that the so-called Gayley-Owocki (Doppler, GO) heating is important for the temperature structure of the wind of main sequence stars cooler than the spectral type O6. The formula for GO heating is derived directly from the Boltzmann equation as a direct consequence of the dependence of the driving force on the velocity gradient. Since GO heating deposits heat directly to the absorbing ions, we also investigated the possibility that individual components of the radiatively driven stellar wind have different temperatures. This effect is negligible in the wind of O stars, whereas a significant temperature difference takes place in the winds of main sequence B stars for stars cooler than B2. Typical temperature difference between absorbing ions and other flow components for such stars is of the order 10^3 K. However, in the case when passive component falls back onto the star the absorbing component reaches temperatures of order 10^6 K, which allows for emission of X-rays. Moreover, we compare our computed terminal velocities with the observed ones. We found quite good agreement between predicted and observed terminal velocities. The systematic difference coming from the using of the so called "cooking formula" has been removed.

Astronomy & Astrophysics 377, 175
Preprints from krticka@physics.muni.cz

IRAS18576+0341: a new addition to the class of Galactic Luminous Blue Variables

A. Pasquali[1] and F. Comerón[2]

[1] ESO/ST-ECF, Karl-Schwarzschild-Strasse 2, 85748 Garching bei Muenchen,Germany
[2] ESO, Karl-Schwarzschild-Strasse 2, 85748 Garching bei Muenchen,Germany

We present JHK photometry and low-resolution HK spectroscopy of IRAS18576+0341, a galactic Luminous Blue Variable (LBV) candidate. The star is heavily reddened with observed magnitudes J = 13.21, H = 9.88 and K = 8.06. These values and previously published photometry define a lightcurve

with an amplitude of $\simeq 1.4$ mag between 1999 June and 2001 August, quite compatible with what is observed for well-studied LBVs, i.e. AG Carinae and HR Carinae. The spectrum of IRAS18576+0341 is characterised by prominent H, He and Fe emissions, which are recurrent features in the spectra of well known LBVs such as He 3-519. These findings together with the recent detection of an associated circumstellar nebula (Ueta et al. 2001) confirm the LBV nature of IRAS18576+0341.

Accepted by A&A
Preprints from apasqual@eso.org

Accurate Stellar Population Studies from Multiband Photometric Observations

Martino Romaniello[1], Nino Panagia[2], Salvatore Scuderi[3] and Robert P. Kirshner[4]

[1] ESO, Karl-Schwarzschild-Straße 2, D-85748 Garching bei München, Germany

[2] Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 2121

[3] Osservatorio Astrofisico di Catania, Viale A. Doria 6, I-95125, Catania, Italy

[4] Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, Cambridge, MA 02138

We present a new technique based on multi-band near ultraviolet and optical photometry to measure both the stellar intrinsic properties, *i.e.* luminosity and effective temperature, and the interstellar dust extinction along the line of sight to hundreds of stars per square arcminute. The yield is twofold. On the one hand, the resulting reddening map has a very high spatial resolution, of the order of a few arcseconds, and can be quite effectively used in regions where the interstellar material is patchy, thus producing considerable differential extinction on small angular scales. On the other hand, combining the photometric information over a wide baseline in wavelength provides an accurate determination of temperature and luminosity for thousands of stars. As a test case, we present the results for the region around Supernova 1987A in the Large Magellanic Cloud imaged with the *WFPC2* on board the Hubble Space Telescope.

Accepted by Astronomical Journal
Preprints from mromanie@eso.org
or on the web at http://arXiv.org/abs/astro-ph/0111399
http://www.eso.org/~mromanie/accurate.ps.gz

On the absence of wind bow-shocks around OB-runaway stars: probing the physical conditions of the interstellar medium

F. Huthoff[1] & L. Kaper[1]

[1] Astronomical Institute "Anton Pannekoek" and Center for High-Energy Astrophysics, University of Amsterdam, Kruislaan 403, 1098 SJ Amsterdam, The Netherlands

High-resolution IRAS maps are used to search for the presence of stellar-wind bow-shocks around high-mass X-ray binaries (HMXBs). Their high space velocities, recently confirmed with *Hipparcos* observations, combined with their strong stellar winds should result in the formation of wind bow-shocks. Except for the already known bow-shock around Vela X-1 (Kaper et al. 1997), we do not find convincing evidence for a bow-shock around any of the other HMXBs. Also in the case of (supposedly single) OB-runaway stars, only a minority appears to be associated with a bow-shock (Van Buren et

al. 1995).
We investigate why wind bow-shocks are not detected for the majority of these OB-runaway systems: is this due to the IRAS sensitivity, the system's space velocity, the stellar-wind properties, or the height above the galactic plane? It turns out that none of these suggested causes can explain the low detection rate (∼40 %). We propose that the conditions of the interstellar medium mainly determine whether a wind bow-shock is formed or not. In hot, tenuous media (like inside galactic superbubbles) the sound speed is high (∼100 km s^{-1}), such that many runaways move at subsonic velocity through a low-density medium, thus preventing the formation of an observable bow-shock. Superbubbles are expected (and observed) around OB associations, where the OB-runaway stars were once born. Turning the argument around, we use the absence (or presence) of wind bow-shocks around OB runaways to probe the physical conditions of the interstellar medium in the solar neighbourhood.

Accepted by Astronomy & Astrophysics
Preprints from lexk@science.uva.nl

Spectropolarimetric Clues to the Structure and Evolutionary Status of MWC 349A

Jill M. Meyer[1,2], Kenneth H. Nordsieck[1], and Jennifer L. Hoffman[1]

[1] Department of Astronomy, University of Wisconsin-Madison, 475 N. Charter St., Madison, WI 53706
[2] Maria Mitchell Observatory, 3 Vestal St., Nantucket, MA 02554

We present visible-wavelength spectropolarimetric measurements of the emission-line star MWC 349A and its close optical companion MWC349B, conducted with the HPOL spectropolarimeter on both the 0.9 m telescope at the University of Wisconsin's Pine Bluff Observatory and the 3.5 m WIYN telescope on Kitt Peak. Our measurements allow us to estimate the interstellar polarization contribution and thus constrain the intrinsic polarization of MWC 349A, which we find to be consistent in position angle with the dusty disk seen perpendicular to the bipolar outflow. Our analysis reopens the possibility that MWC 349A may be part of the Cyg OB2 association, suggests that it is not a physical companion to MWC 349B, and supports the classification of MWC 349A as a pre-main seque nce B[e] star.

Accepted by the Astronomical Journal
Preprints from jhoffman@sal.wisc.edu
or on the web at http://xxx.lanl.gov/abs/astro-ph/0112285

Submitted Papers

Massive Binary WR112 and Properties of Wolf-Rayet Dust

S.V. Marchenko[1], A.F.J. Moffat[1], W.D. Vacca[2], S. Côté[3] and R. Doyon[1]

[1]Département de physique, Université de Montréal, C.P. 6128, Succ. Centre-Ville, Montréal, QC, H3C 3J7, Canada, and Observatoire du mont Mégantic
[2]Max-Plank-Institut für extraterrestrische Physik, Postfach 1312, D-85741 Garching, Germany
[3]Canadian Gemini Office, Herzberg Institute of Astrophysics, National Research Council of Canada, 5071 West Sannich Road, Victoria, B.C., V9E 2E7, Canada

Some hot, massive, population-I Wolf-Rayet (WR) stars of the carbon subclass are known to be prolific dust-producers. How dust can form in such a hostile environment remains a mystery. Here we

report the discovery of a relatively cool, extended, multi-arc dust envelope around the star WR112, most likely formed by wind-wind collision in a long-period binary system. We derive the binary orbital parameters, the dust temperature and the dust mass distributions in the envelope. We find that amorphous carbon is a main constituent of the dust, in agreement with earlier estimates and theoretical predictions. However, the characteristic size of the dust grains is estimated to be $\sim 1\mu m$, significantly larger than theoretical limits. The dust production rate is about $5.2 \times 10^{-8} M_{\odot} \mathrm{yr}^{-1}$ and the total detectable dust mass is found to be about $2.8 \times 10^{-5} M_{\odot}$. We also show that, despite the hostile environment, at least ∼20% of the initially-formed dust may reach the interstellar medium.

Submitted to ApJL
Preprints from `sergey@astro.umontreal.ca`
or by anonymous ftp to `ftp.astro.umontrea.ca cd outgoing/sergey/wr112`

In Proceedings

HI bubbles surrounding O-type stars

C. Cappa[1,2], E.M. Arnal[1,2], S. Cichowolski[1], S. Pineault[3] and N. St-Louis[4]

[1] Instituto Argentino de Radioastronomía, C.C. 5, 1894 Villa Elisa, Argentina

[2] Facultad de Ciencias Astronómicas y Geofísicas, UNLP, 1900 La Plata, Argentina

[3] Département de Physique et Observatoire du Mont Mégantic, Université Laval, Ste-Foy, Québec, Canada G1K 7P4

[4] Université de Montréal, Montréal, Canada

We analyzed the interstellar medium in the vicinity of the O-type stars BD+24◦ 3866 (O8.5II(f)) and HD 192281 (O5.5n((f))p) based on radio data obtained with the Synthesis Telescope of the Dominion Radio Astrophysical Observatory (DRAO). We have found HI cavities and shells probably associated with both massive stars. These structures are interpreted as the neutral gas signatures of the interaction of the stellar wind of the massive stars with their surroundings.

Submitted to the Proceedings of the meeting *Seeing Through the Dust, the Detection of HI and the Exploration of the ISM of Galaxies*, **Penticton, Canada, 20 – 26 October, 2001**
Preprints from `ccappa@fcaglp.fcaglp.unlp.edu.ar`

A short observational history of X-ray studies of Wolf-Rayet stars

K.A. van der Hucht,

SRON National Institute for Space Research, Sorbonnelaan 2, NL-3584 CA Utrecht, the Netherlands

We discuss available X-ray observations of Wolf-Rayet stars, notably of WR+OB binaries, where variable X-ray excess is an important diagnostic of the physics of colliding winds and for abundance determinations of nucleosynthesis products.

To appear in: F. Giovanelli & L. Sabau-Graziati (eds.), Multifrequency Behaviour of High Energy Cosmic Sources, Proc. Frascati Workshop 2001, Vulacano (Italia) 21-26 May 2001, *Mem. Soc. Astro. Italia*, **in press.**

Preprint on the web at `ftp://saturn.sron.nl/pub/karelh/UPLOADS/papers.dir/vulcano.ps`

Meetings

Winds, Bubbles and Explosions: a conference to honour John Dyson

Pátzcuaro, Michoacán, México, 9-13 September, 2002

This meeting aims to discuss the dynamical effects that mass loss and radiation from astrophysical objects have on their environment in the light of recent observational results and theoretical models.

The topics of the meeting include:

- Low Mass Stars - Formation, Outflows, Jets
- High Mass Stars - Formation, Ionization Fronts, Stellar Winds, Shocks
- Post Main Sequence Winds (PNe, WR stars, LBV)
- Supernovae and their Remnants
- Line Forming Regions of AGN
- Starburst Superwinds

The conference also has the aim of honouring John Dyson, who has made important contributions to our understanding of the dynamics of the interstellar medium.

Format
The scientific programme of the meeting will consist of invited talks, contributed talks selected by the Scientific Organizing Committee, and poster contributions.

Organization
The conference is organized by the Instituto de Astronomia, UNAM, Mexico, where John Dyson has many friends.

Scientific Organizing Committee
Jane Arthur (Mexico, co-chair), Jorge Canto (Mexico), Paola Caselli (Italy), Pepe Franco (Mexico), Tom Hartquist (UK, co-chair), Will Henney (Mexico), Bob O'Dell (USA), Alex Raga (Mexico), Tom Ray (Ireland), John Raymond (USA)

Local Organizing Committee
Jane Arthur (chair), Javier Ballesteros, Paola D'Alessio, Pepe Franco, Will Henney, Simon Kemp, Stan Kurtz, Wolfgang Steffen

Registration
We would like all interested participants to register for the conference using our web page:
http://www.astrosmo.unam.mx/∼bubbles

Contact Details
Web page: http://www.astrosmo.unam.mx/∼bubbles Email: bubbles@astrosmo.unam.mx
Fax: + 52 443 3222726 (Attention Jane Arthur) Phone: + 52 443 3222750

Massive Star Birth: A Crossroads of Astrophysics

Proposal for an IAU Symposium

A meeting on Massive Star Birth is being planned, to take place possibly in the fall of 2002 and to be hosted by IfA (Hawaii).

Co-Chairs:
Peter S. Conti (USA) and Edward B. Churchwell (USA)
PConti@jila.colorado.edu
Churchwell@madraf.astro.wisc.edu

Student Positions

Astronomy Group, Vrije Universiteit, Brussels

One PhD student position is available at the Astronomy Group, Vrije Universiteit Brussels, for working on an observational project related to ground support of the MONS space asteroseismology mission (see http://www.vub.ac.be/STER/MONS/groundsupport.html). The duration of the grant is 4 years, the position is available immediately.

For more details, contact Dr. Chris Sterken at csterken@vub.ac.be.

Astronomical Institute in Utrecht

A student PhD position at the Astronomical Institute in Utrecht is open for the project : "Modeling triggered star formation in interacting galaxies" The student will work in the stellar populations group under the guidance of Prof. Henny Lamers (Utrecht) and Prof Vincent Icke (Leiden). The project involves the calculation of hydrodynamical models to explain the star and cluster formation histories that we have derived from HST-WFPC2 observations for several interacting galaxies.

Start of PhD: as soon as possible (but flexible) Duration of the contract: 4 years.

For more details or applications, contact Henny Lamers (lamers@astro.uu.nl)