THE $\mathrm{H}\,\mathrm{O}^{\mathrm{T}}$ STAR NEWSLETTER

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Contents of this Newsletter

Accepted Papers

The Mass-Loss History of the Symbiotic Nova RR Tel

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Mass loss in symbiotic novae is of interest to the theory of nova-like events as well as to the question whether symbiotic novae could be precursors of type Ia supernovae. RR Tel began its outburst in 1944. It spent five years in an extended state with no mass-loss before slowly shrinking and increasing its effective temperature. This transition was accompanied by strong mass-loss which decreased after 1960. IUE and HST high resolution spectra from 1978 to 1995 show no trace of mass-loss. Since 1978 the total luminosity has been decreasing at approximately constant effective temperature. During the present outburst the white dwarf in RR Tel will have lost much less matter than it accumulated before outburst. - The 1995 continuum at $\lambda \lesssim 1400$ is compatible with a hot star of $T = 140\,000\,\mathrm{K}$, $R = 0.105\,\mathrm{R}_\odot$, and $L = 3700\,\mathrm{L}_\odot$.

Accepted by Astronomy & Astrophysics

Preprints from `nussbaumer@astro.phys.ethz.ch`

New perceptions on the S Dor phenomenon and the micro variations of five Luminous Blue Variables (LBVs)

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We investigated the photometric histories of the LBVs HR Car in the Galaxy, R 127, R 110 and R 71 in the LMC, and R 40 in the SMC by collecting all available photometry. All these objects have been reasonably well observed the last few decades and a number of "S Dor (SD) phases" (episodes of enhanced light) is well documented. Time-scales lie between 1.4 and 25 y. During the SD cycles two different types of micro-variations (amplitudes $\sim 0\overset{\mathrm{m}}{.}2$) are present: one near the minima (time-scale from 2 to 6 weeks; colours generally blue in the maxima and red in the minima) and the other one near the maxima (time-scale ∼100 d; colours generally red in the maxima and blue in the minima). Halfway the ascending and descending branches of the SD cycles the stars switch rather abruptly from one type to the other. We argue that the two types of SD phases are probably caused by different instability mechanisms.

Accepted by A & AS

Preprints from csterken@vub.ac.be

Near infrared low-resolution spectra of 7 Be stars and AG Car

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We present and discuss λ 6470-8780 spectra of 7 poorly-studied Be stars (HD 90966 – HD 91188 – HD 94366 – HD 124834 – HD 128293 – HD 203699 – HD 179419) and of one Luminous Blue Variable (AG Car), and give equivalent widths and radial velocities of selected spectral lines.

Preprints from: rmennick@gauss.cfm.udec.cl

Periodic X-ray Emission from the O7 V Star θ^1 Orionis C

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We report the discovery of large-amplitude, periodic X-ray emission from the O7 V star θ^1 Orionis C, the central star of the Orion Nebula. Ten *ROSAT* HRI snapshots of the Trapezium cluster taken over the course of 21 days show that the count rate of θ^1 Ori C varies from 0.26 to 0.41 counts s^{-1} with a clear 15-day period. The soft X-ray variations have the same phase and period as Hα and He II λ4686 variations reported by Stahl et al., and are in anti-phase with the C IV and Si IV ultraviolet absorption features. We consider five mechanisms which might explain the amplitude, phase, and periodicity of the

X-ray variations: (1) colliding-wind emission with an unseen binary companion, (2) coronal emission from an unseen late-type pre-main–sequence star, (3) periodic density fluctuations, (4) absorption of magnetospheric X-rays in a corotating wind, and (5) magnetosphere eclipses. The *ROSAT* data rule out the first three scenarios, but cannot rule out either of the latter two which require the presence of an extended magnetosphere, consistent with the suggestion of Stahl et al. that θ^1 Ori C is an oblique magnetic rotator. As such, θ^1 Ori C may be the best example of a high-mass analog to the chemically peculiar, magnetic Bp stars.

Accepted by The Astrophysical Journal Letters
For preprints, contact marc@colorado.edu
Preprints available at URL: http://casa.colorado.edu/~marc/theta_letter.html

Photoionized Plasma in Cygnus X-3

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ASCA observations of Cygnus X-3 in its X-ray high-intensity state have for the first time resolved the Kα lines from He-like and H-like ions of S, Ar, Ca, and Fe. In addition to these emission lines, we detected an emission-line-like feature at 3.5 keV. We identified this feature as being the free-bound continuum emitted in recombination into the 1^2S state of H-like S. This is direct evidence of a photoionized plasma in the Cyg X-3 system, which has a dense stellar wind from a Wolf-Rayet companion star irradiated by strong X-rays from the compact star. The electron temperature of this plasma was estimated to be 16^{+5}_{-6} eV by measuring the shape of the free-bound continuum.

Accepted by PASJ
Preprints from kawasima@ess.sci.osaka-u.ac.jp
or by anonymous ftp to ftpxray.ess.sci.osaka-u.ac.jp
in the directory /work/personal/kawashima/cygx3.

On the UV Bright Phase of Metal-Rich Horizontal-Branch Stars

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We consider the origin of the UV bright phase of metal-rich helium-burning stars, the slow blue phase (SBP), that was predicted by various earlier works. Based on improved physics including OPAL opacities, which is the same physics as was used in the construction of the new Yale Isochrones, we confirm the existence of the SBP. In addition to our grid of evolutionary tracks, we provide an analytical understanding of the main characteristics of the SBP phenomenon.

The SBP is slow because it is a slow evolving helium-shell-burning phase which is analogous to the early asymptotic giant branch phase. The SBP of a more metal-rich star is slower than a metal-poor counterpart if their $T_{\rm eff}$'s are the same because a more metal-rich helium-burning star has a smaller mass than a metal-poor one and because lifetime increases as mass decreases.

Metal-rich helium-burning stars easily become hot because the luminosity from the hydrogen-burning shell is extremely sensitive to the mean molecular weight μ whereas the luminosity from the helium-burning core is not. Under the assumption of a positive $\Delta Y/\Delta Z$, helium abundance plays the most important role in governing μ, and thus Dorman and collaborators found that the SBP occurs only when $Y \gtrsim 0.4$ when $\Delta Y/\Delta Z \gtrsim 0$.

We suggest that the SBP phenomenon is a major cause of the UV upturn phenomenon in giant elliptical galaxies as will be shown in subsequent papers. The new HB tracks can be retrieved from S.Y.'s web site
http://shemesh.gsfc.nasa.gov/~yi/astronomy.html.

Accepted by Astrophysical Journal
Preprints from `yi@shemesh.gsfc.nasa.gov`
or on the web at `http://shemesh.gsfc.nasa.gov`

Submitted Papers

Spectral Classification of the 30 Doradus Stellar Populations

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An optical spectral classification study of 106 OB stars within the 30 Doradus Nebula has sharpened the description of the spatial and temporal structures among the associated clusters. Five distinct stellar groups are recognized: (1) the central early-O (Carina phase) concentration which includes R136; (2) a younger (Orion phase) population to the north and west of R136 containing heavily embedded early-O dwarfs and IR sources, the formation of which was likely triggered by the central concentration; (3) an older population of late-O and early-B supergiants (Scorpius OB1 phase) throughout the central field, whose structural relationship if any to the younger groups is unclear; (4) a previously known, older still compact cluster 3′ northwest of R136 containing A- and M-type supergiants (h and χ Persei phase), which evidently affects the nebular dynamics substantially; and (5) a newly recognized Sco OB1-phase association surrounding the recently discovered Luminous Blue Variable R143 in the southern part of the Nebula. The intricacy of this region and the implications for the interpretation of more distant starbursts are emphasized. The evidence is that the formation of the 30 Dor stellar content was neither instantaneous nor continuous, but rather that it corresponds to discrete events at different epochs.

The average difference between the derived and calibration absolute visual magnitudes of the stars is 0.05, indicating that the classification, calibration, and adopted distance modulus ($V_0 - M_V = 18.6$) are accurate. For 70 of the stars, either that difference is ≤ 0.6 mag, or they are subluminous dwarfs or superluminous supergiants. A number of astrophysically interesting objects have been isolated for further investigation. Surprisingly in view of the presence of several O3 supergiants, the mid-Of star R139 is identified as the most massive object in this sample; it is located well along the 120 $M_\odot$ track, very near the Humphreys-Davidson limit, and it is likely an immediate LBV precursor. This work can and should be extended in three ways: (1) higher-resolution and –S/N observations of many of the

stars with larger ground-based telescopes for quantitative analysis; (2) ground-based spectral classification of the numerous additional accessible stars in the field; and (3) spatially resolved spectral classification of compact multiple systems with the *Hubble Space Telescope*.

Submitted to ApJ Supplements
Preprints from walborn@stsci.edu

Radio and infrared structure of the colliding-wind Wolf-Rayet system WR 147

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New, high-resolution infrared and radio images of the X-ray luminous Wolf-Rayet system WR 147 (AS 431) are presented. The 5-GHz radio image resolves both components of this double source. The emission from one component, that to the South and associated with the wind of the WN8 star is $\sim 170 \times 253$ mas, indicating that the stellar wind is not spherically symmetric. The second, non-thermal component $\sim 0''.6$ north of the WN8 star, is extended East-West to ~ 267 mas. The infrared image reveals the presence of a companion to the WN8 star, close to the non-thermal radio source but slightly (~ 60 mas) more distant from the WN8 star. The companion is $\Delta K \sim 3$ mag. fainter than the WN8 star and has a luminosity of a B0.5V star, just sufficiently luminous to possess a stellar wind capable of colliding with that of the WN8 star. The presence of the non-thermal emission between the two stars and much closer to that with the weaker wind is direct evidence for a colliding-wind origin for the emission. A significant portion of the X-ray emission can also be accounted for by the release of energy in the wind collision. Comparison of the non-thermal flux with those of the three systems incorporating WC type stars (WR 125, WR 140 and WR 146) shows a correlation with velocity of the WR wind.

Submitted to MNRAS
Preprints from P.M.Williams@roe.ac.uk

In Proceedings

Is the maximum phase of LBVs caused by increased mass loss?

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We review the concept of 'pseudo' photospheres and show – using a heuristic model – that mass loss changes can not explain the observed stellar radius changes in LBV stars during typical variations. We also discuss the reverse problem, namely the likely effect of a change in radius on the stellar mass loss.

To appear in: *Luminous Blue Variables: Massive Stars in Transition,* **eds. A. Nota, H.J.G.L.M. Lamers, ASP Conf. Ser.**
Preprints from `alex@homie.gsfc.nasa.gov`
or by anonymous ftp to `homie.gsfc.nasa.gov` *in* `pub` *file* `Kona-LBV.ps`

Near-Infrared Variability of η Carinae

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The photospheric temperature of η Carinae is lower than currently believed and cannot excite the observed lines of HeI 10830, [ArIII], [NeIII], and [FeIII]. In order to account for the observed variability from x-ray to radio wavelengths, a compact source of energy is needed, with hard spectrum, located not too far from the stellar photosphere. Shocked wind is invoked. Data supporting the prediction of a new low excitation event to occur in late 1997 are presented.

To appear in: *Luminous Blue Variables: Massive Stars in Transition,* **eds. A. Nota, H.J.G.L.M. Lamers, ASP Conf. Ser.**
Preprints from `damineli@jila02.colorado.edu`

Disks around B[e] and LBV Stars

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In this paper we discuss several models that can lead to the formation of "disks", or equatorially enhanced winds. Then we consider a combination of two of the effects in these models that can lead to disks around luminous stars that are rotating slower than 40% critical. The two effects are the bistability mechanism of Pauldrach and Puls (1990) and the 2-D wind compressed zone effects of Ignace, Cassinelli, and Bjorkman (1996).

To appear in: *Luminous Blue Variables: Massive Stars in Transition,* **eds. A. Nota, H.J.G.L.M. Lamers, ASP Conf. Ser.**
Preprints from rico@astro.gla.ac.uk

Theses

The Dynamics of Circumstellar Bubbles: η Carinae, HR Carinae, Sk-69 279 and Sk-69 271

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This Diploma thesis presents a dynamical study of the circumstellar bubbles around the galactic LBVs η Carinae and HR Carinae, as well as the Large Magellanic Cloud (LMC) stars Sk-69 279 and Sk-69 271. Both LMC stars were recently found to be surrounded by ring nebulae (Weis et al. 1995, RevMexAA Series de Conferencias 3, 237).

With long-slit echelle spectra, kinematic informations of the stars were obtained and supported with HST and ground based images of the bubbles. Using high-dispersion and resolution data a detailed velocity analysis was done and the most probable geometries of the structures and nebulae derived.

For the so called *Homunculus* nebula around the LBV η Car the work presented in this Diploma thesis concentrated on the N Condensation. The data are found to be consistent with the newly proposed model (Duschl et al. 1995, RevMexAA Series de conferencias 2, 170) that introduced an expanding disk around η Car.

The LBV nebula around HR Car revealed a structure similar to the bipolar symmetry seen in the Homunculus around η Car. A comparison of both LBV nebulae seems to indicate an evolutionary scenario of bipolar LBV nebulae.

In addition to the LBV nebulae, two bubbles around LMC blue supergiants were analyzed. Sk-69 279 revealed a nitrogen enhanced slowly expanding bubble. The star Sk-69 271 showed a complicated velocity pattern and therefore it is not clear by now, if it is surrounded by an interstellar bubble or not. The CNO processed material in the bubble around Sk-69 279 leads to the conclusion that the bubble was formed during an evolved state of the star as a red supergiant or even in a LBV phase.

Diploma Thesis accepted November 15th 1996, at Universität Heidelberg
Advisor: Wolfgang J. Duschl
Language: German

Preprints from kweis@ita.uni-heidelberg.de
or on the web at http://www.ita.uni-heidelberg.de/publications/thesis/index.html#/Diploma

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Book

Wolf-Rayet Stars in the Framework of Stellar Evolution

The Proceedings of the 33rd Liege International Astrophysical Colloquium on Wolf-Rayet Stars in the Framework of Stellar Evolution (July 1-3, 1996) are now available. The table of contents and an order form can be found at

http://www.astro.ulg.ac.be/colloques/proceed.html

or from ASTROCOL@vm1.ulg.ac.be

Meeting

BMW-II: The Second Boulder-Munich Workshop

The Second Boulder-Munich Workshop will be held in Windsor Great Park, UK, **July 21-24 1997**, under the aegis of the UCL Cumberland Lodge meeting. The broad subject area of the meeting will be the observation and interpretation of the spectra of luminous, early-type (OBA) stars, including:

Spectral characteristics of very young OB stars, particularly in the IR;

Identification of hot stars in star-forming regions;

Quantitative spectroscopic diagnostics, from the IR to the UV;

The effects of line blanketting and outflows on spectroscopic models; ISO results; luminous stars in galaxies; Galactic-Centre objects; slash stars; IR-bright starburst galaxies; and related topics.

The principal focus of the meeting will be away from Wolf-Rayets, LBVs, and variability, all of which have been, or will be, dealt with in separate meetings in 1996-98. We intend to structure the meeting primarily around oral presentations, and to minimize any 'poster' content. Interested parties may care to note that the 1997 Herstmonceux Conference on 'The Initial Mass Function' will be held in Cambridge (UK) in the preceding week.

This residential meeting will be held in the beautiful setting of Windsor Great Park, and will cost 350 pounds sterling (ca. 600 USD), inclusive of accommodation, all meals (and drinks), organized transport from (21th) and to (24th) central London or Heathrow, and the proceedings volume (ASP Conference Series). Discounts will be available for students and room-sharers (including 'partners'), but no financial support is available from the organizers.

Registration forms are available from idh@star.ucl.ac.uk
or via http://www.star.ucl.ac.uk/∼kws/bmwII.