THE HOT STAR NEWSLETTER

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

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Contents of this newsletter

Accepted Papers

HST and Groundbased Observations of the 'Hubble-Sandage' Variables in M31 and M33

Th. Szeifert[1], R.M. Humphreys[2], K. Davidson[2], T.J. Jones[2], O. Stahl[1], B. Wolf[1] and F.-J. Zickgraf[1]

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The small group of peculiar stars known as the Hubble-Sandage variables in M31 and M33 belong to the class of stars we now call the Luminous Blue Variables - highly unstable, evolved massive stars found in many spiral and irregular galaxies. We have used the Hubble Space Telescope to obtain UV imaging and spectroscopy of several of the LBVs in M31 and M33. The UV observations are combined with groundbased spectra and optical and infrared photometry to estimate their apparent temperatures, luminosities, and mass loss rates.

We were fortunate to catch Var B in M33 during an LBV eruption while Var C in M33 was observed during its decline from its recent maximum. Var B is especially interesting because one of the optical

spectra showed emission lines of He I, indicating a temperature of 20 000 K or more while the rest of the lines were typical of an LBV in eruption, at a temperature near 9000 K. With no other indication of a temperature or radial change, we suggest the He I lines were excited by a shock or produced by hot radiation escaping from the polar regions. The UV spectrum of AE And shows an unusually strong emission line of Fe II at 2507 Å similar to η Carinae. The spectra of AE And, AF And, and Var 83 in M33, all observed at visual minimum, show a veritable forest of Fe II and [Fe II] emission lines. This is in contrast to the quiescent spectra of some LBVs which resemble Of/WN9 stars, such as R127 and AG Car.

Accepted by A & A
For preprints, contact Thomas Szeifert: `T.Szeifert@lsw.uni-heidelberg.de`
Preprints available from anonymous ftp-server `ftp.lsw.uni-heidelberg.de` –
directory `incoming/tszeifer` – file `t6704.ps.gz` – size `487KByte`.

The galactic distribution and luminosity function of ultracompact HII regions

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The distribution of ultracompact HII regions in the IRAS Point Source Catalog in both galactic longitude and flux are studied in this paper, to derive the radial surface density profile in the galactic disk and the luminosity function under the assumptions of cylindrical symmetry and a position-independent luminosity function. An advantage of this approach is that the surface density profile is derived independently of kinematical information, allowing us to probe the inner regions of the galactic disk where kinematical distances become unreliable.

An interesting result of our analysis is the discovery of a star forming ring about 2 kpc from the galactic center, possibly associated with the Inner Lindblad Resonance as observed in external galaxies with strong bars. On the other hand, comparison with the mass function in the solar neighbourhood allows us to estimate the average lifetime of ultracompact HII regions, which appears to be less than 10^5 years, contrary to previous estimates. The luminosity function also suggests that this lifetime is not sensitive to the mass of the exciting star. The supernova rate in the galactic disk as derived from our results is found to be compatible with other current estimates.

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A Spectral Atlas of Hot, Luminous Stars at 2 microns

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We present 2-μm (K-band) spectra of 180 well studied, optically-visible, luminous stars. Most of the stars are of OB spectral type, but we have also included a number of Oe and Be stars, OBN and OBC stars, cool hypergiant stars, and high-mass X-ray binary stars. Our aim in studying normal OB stars is to develop an empirical relationship between 2-μm spectral features of these massive stars

and their stellar temperature and luminosity. We find the system of lines between 2.0 and 2.2 μm is particularly good for differentiating the early- and mid-O type stars. In the late-O and early-B stars, differentiation becomes more difficult, as the features show only moderate changes. We have developed a spectral classification system for the K band to be used to estimate effective temperatures of O and early-B stars. We demonstrate that K-band spectroscopy is superior in estimating the temperature of hot, luminous stars than the traditional methods of using infrared or *even optical* photometric colors alone. The only requirements are that adequate resolution (R>1000) and signal-to-noise (S/N$\sim$70) be achieved. With our classification system, stars behind large amounts of visible extinction, such as young, heavily reddened H II regions through-out our Galaxy, may be identified and studied for the first time through 2-μm spectroscopy.

Emission lines are commonly seen in the K-band spectra of supergiant stars, however, the OBN supergiants, which have a higher ratio of some processed materials at their surface, may be more likely to show line emission, especially the He I singlet transition at 2.058 μm. This has lead us to propose an evolutionary scenario for some of the galactic center He I emission-line stars which evokes rotational mixing (Maeder 1987; Langer 1992) to explain both the strong line emission and high luminosity of these mysterious sources.

We have compared our spectroscopic database with the most recent stellar atmosphere models. We are encouraged by the good match between the model line profiles at 2 μm of Schaerer et al. (1996b) and those observed in OB stars. Finally, we include a thorough discussion of the observational and reduction methods employed to obtain the spectra shown in this atlas for the benefit of those wishing to obtain similar, classification-quality, near-infrared spectra.

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Variable central stars of young Planetary Nebulae. I. Photometric multisite observations of IC 418

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We report the results of a photometric multisite campaign devoted to HD 35914, the variable central star[1] of the Planetary Nebula IC 418. From the analysis of 120 hours of data acquired with a variety of

[1] editor note: spectral type Of(H)

techniques, we find that HD 35914 exhibits two distinct kinds of variability: irregular light modulation with a time scale of days, as well as cyclic variations with a time scale of 6.5 hours. The short-term variations are not strictly periodic, and cannot be reasonably explained by multiperiodicity; they appear to be semiregular. The star is generally redder when it is brighter; this behavior appears to be connected with the long-term variability.

A re-analysis of most of the older data obtained for HD 35914 by various researchers suggests that the basic behavior of the star did not change during the last 15 years.

We carefully discuss all the possible causes for the light variations of the star. Rotational modulation of surface features cannot explain the observations, and binarity is unlikely. Pulsations may be excited, but wind variability (or a combination of both) can also not be ruled out.

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Stationary hydrodynamic models of Wolf-Rayet stars with optically thick winds

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We investigate the influence of a grey, optically thick wind on the surface and internal structure of Wolf-Rayet (WR) stars. We calculate hydrodynamic models of chemically homogeneous helium stars with stationary outflows, solving the full set of stellar structure equations from the stellar center up to well beyond the sonic point of the wind, including the line force originating from absorption lines in a parameterized way. For specific assumptions about mass loss rate and wind opacity above our outer boundary, we find that the iron opacity peak may lead to local super-Eddington luminosities at the sonic point.

By varying the stellar wind parameters over the whole physically plausible range, we show that the radius of the sonic point of the wind flow is always very close to the hydrostatic stellar radius obtained in WR star models which ignore the wind. However, our models confirm the possibility of large values for observable WR radii and correspondingly small effective temperatures found in earlier models.

We show further that the energy which is contained in a typical WR wind can not be neglected. The stellar luminosity may be reduced by several 10 %, which has a pronounced effect on the mass-luminosity relation. I. e., the WR masses derived for a given luminosity may be considerably larger. Thereby, also the momentum problem of WR winds is considerably reduced, as well as the scatter in the $\dot{M}$ vs. M diagram for observed hydrogen-free WN stars.

Accepted by A&A *Preprints from* `ahg@mpa-garching.mpg.de`
or by anonymous ftp to `ftp://ftp.mpa-garching.mpg.de/pub/ntl/wrwind.ps.gz`
or on the web at `http://www.MPA-Garching.MPG.DE/~ahg/Publications/Publications.html`

Submitted Papers

On the early evolution of aspherical WR bubbles

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In this paper we have investigated the dynamical evolution of WR ring nebulae during the early phases, when the WR wind expands through the unperturbed RSG wind. In particular, we focused our attention on the effect of an anisotropic RSG mass loss and of a progressive increasing of the WR mechanical luminosity, as expected during the transition RSG → WR.

These two assumptions produce two separate phenomena. The anisotropic RSG wind causes the outer shock to be radiative near the equatorial plane and, at the same time, adiabatic in the polar region. This fact has an important observational consequence: the polar regions are strong X-ray emitters, while the radiative portions of the shock emit in the optical band. The increase of the wind mechanical power causes the acceleration and then the efficient fragmentation, via R-T instabilities, of the shell.

This result, together with the results of other recent numerical simulations indicates that the shell fragmentation is an unavoidable process in WR ring nebulae. The fate of the knots and their feedback on the nebula dynamics are still unclear and more detailed theoretical and observational studies on this subject would be highly desirable.

The simple model presented in this paper may explain the X-ray morphology of the WR ring nebula NGC 6888, consisting in two bright lobes present in opposite zones along the major axis.

Submitted to MNRAS *Preprints from* `brighenti@astbo3.bo.astro.it`

In Proceedings

The Erupting Wolf-Rayet Binary HD5980 in the Small Magellanic Cloud: Spectral Transition from a B1.5Ia$^+$ to a WN6 and the Accompanying Light Curve.

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HD 5980 is one of the most fascinating systems one can encounter among massive stars. With a bolometric magnitude of 12.8 (Massey et al. 1989), it is the most luminous object in the SMC cluster NGC346, and it contains at least two massive stars in a highly eccentric, eclipsing 19.3-day orbit. As a Wolf-Rayet star, it has made its way through the spectral types of the WN sequence ranging from WN3 to WN8, or perhaps even later, and, as we shall show in this paper, has even presented an early

B-type spectrum. It has undergone an eruption in which its visual luminosity brightened by more than 3 magnitudes (Barba et al. 1995) with characteristics in its optical spectrum indicative of an LBV-type event. All these changes observed in the spectral regions of the optical as well as the UV (Koenigsberger et al. 1994,1995) have occurred during the past 18 years.

In this paper we analize the high dispersion IUE spectra of HD5980 obtained shortly after the maximum in the optical light curve and one year later. We show that the earliest spectrum has features which are characteristic of B1.5Ia$^+$ spectra. Subsequent spectra indicate a photosphere which is gradually increasing its T_{eff}, containing Fe IV and Fe V absorption features, and becoming finally a WN6. We also present a UV light curve at two wavelength bands (1300 A and 1850 A) covering a year after maximum in the eruption, where both eclipses of the 19.3 day orbit are evident.

To appear in: "Colliding Winds in Binary Stars", Workshop celebrating Jorge Sahade's 80th Birthday, Rev. Mex. Astron. Astroph. Conf. Ser., V. Niemela and N. Morrell (eds) 1996.
Preprints from `gloria@astroscu.unam.mx`

News

New Astronomy: an electronic journal

Elsevier is about to launch a new astronomy journal, New Astronomy, available both on paper and electronically. The first issue of this journal will appear shortly, probably in June. In the case of stellar astrophysics, articles can be submitted directly to Peter Conti: p.conti@elsevier.nl

Some of the incentives are:

o the electronic edition on WWW is available free of charge for anyone during the start-up period (1996, possibly 1997),

o the paper edition will be made available at no extra cost to almost all astronomy, astrophysics or space science libraries, during the start-up period,

o no page charges,

o the possibility to publish color images on the electronic edition at no extra charge,

o complimentary annual subscription to the paper edition for the corresponding author.

Further information from:

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or from Michiel Kolman, Publishing Editor: m.kolman@elsevier.nl

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A&A has decided that from January 1, 1997 onward all the three forms (Letters, Main Journal and Supplement Series) will be published electronically in addition to a paper version.

Demonstrations can already be observed through the Internet servers of Springer Verlag
http://science.springer.de/aa/aa-main.htm

(for the Letters and the Main Journal) and of Editions de Physique

http://www.ed-phys.fr

(for the Supplement Series). The big tables will continue to be available at the Centre de Données de Strasbourg

anonymous ftp 130.79.128.5

http://cdsweb.u-strasbg.fr/Abstract.html

with links to the above servers.

Electronic publication now makes it possible to shorten the paper version of articles to the essential parts and to move the more detailed, technical details to appendices. A publication then consists of a short version, a "core" (appearing in identical paper and electronic forms) and appendices that are available only electronically. We expect that in this way the readibility of articles will improve considerably and that the readership per published article will increase. The "core article" will include text, figures and short tables. The details of observations, calculations, elaborate tabular material and non-crucial, but useful figures will be published in the appendices.

The full electronic publication can be obtained via all workstations and pc's that have the same "ip" number as a library with an institutional subscription to A&A. If your institute subscribes to A&A, you will have directly access to all three forms of A&A publications.

Despite expected reductions in mailing costs, these changes will mean a raise in the subscription price (7 percent in 1997).