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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From the editor

WR 140 is again nearing periastron. Infrared observers are invited to join the campaign organized by Peredur Williams (see page 2.) Observers at shorter wavelengths will find use in the recent release of the IUE-INES archive. More information on pages 2 and 3.

Several meetings were announced in the past issue. Registrations and contributed papers are now invited for the P CYG 2000 Workshop to be held at Armagh, Northern Ireland, 20-23 August, 2000. For all relevant information, see the web page at http://www.arm.ac.uk/~mdg or e-mail Mart de Groot at mdg@star.arm.ac.uk The last pages of this issue provide the program for the Magnetic Fields Workshop to be held in Santiago, Chile, January 15-19, 2001.

Finally, we are pleased to reproduce two job offers.

Contents of this newsletter

Observing Campaigns

The Next Infrared Outburst of WR 140 (HD 193793): Call for Observations

The next episode of dust formation by the archetypal colliding-wind Wolf-Rayet binary WR 140 (HD 193793) is expected next year (2001). Infrared photometry of this event will be valuable for the following studies:

- Confirmation of the period. The most valuable observations would be of the rise to maximum, expected to occur between about February 1 and around March 29 (maximum in K) or April 16 (maximum in L'). Of course, these dates are most difficult given the position of WR 140 but it should be accessible in the morning twilight at least from early March.
- Even without the rise, observation of the early decline in mid-2001 would be valuable in strengthening the form of the light curve and period.
- Imaging the dust cloud in the infrared is certain to be rewarding; witness the spectacular images of WR 104 and WR 98a from the Keck (Tuthill et al. Nature 398, 478, 1999 and Monnier et al. ApJ 525, L97, 1999) and WR 137 around dust-emission maximum with Nicmos (Marchenko et al. ApJ 522, 433, 1999). WR 140 has the advantage over all these systems in that the stellar and dust emission are more nearly comparable in intensity during 2001. And we know its orbit.
- Observation of the 'shoulder' on the infrared light curve seen especially at 3 μm and longer wavelengths about one year after maximum. Infrared photometry and imaging in late 2001 and from March 2002 will enable us to see whether this is caused by sudden expansion of the dust cloud, condensation of more dust, or ...

Peredur Williams

News

Release of the INES Archive

The International Ultraviolet Explorer (IUE) Archives have been delivered to the world scientific community on 21st March. ESA, in collaboration with the Spanish Laboratory of Space Astrophysics and Theoretical Physics (LAEFF) belonging to INTA (National Institute of Air and Space Technology), has developed and set up the INES system to access IUE Data.

INES (IUE Newly Extracted Spectra) is a complete astronomical archive and data-distribution system. Its release to the community represents the final activity by ESA in the context of the IUE project. From now LAEFF, on behalf of the international astronomical community, will be responsible of maintaining INES, making it available and providing world-wide support to scientists using IUE data.

The IUE Archive contains more than 110,000 spectra of more that 11,000 astronomical objects. All data are fully reduced and calibrated. The INES archive consists of:

- an access catalog containing the parameters required to query the archive and evaluate the observations,
- a publications catalog which links each spectrum to the publications in which it has been used via the ADS,
- and the data themselves (low dispersion spectra, high dispersion spectra rebinned to the low resolution wavelength step, full high dispersion concatenated spectra, and bi-dimensional low dispersion images).

The INES Archive can be accessed at http://ines.vilspa.esa.es. Users can consult the catalogue, preview the spectra and download the data with a standard browser from the Principal Centre at LAEFF, its Mirror Centre located at the Canadian Astronomical Data Centre or any of the National Centres spread in all continents. This distributed system guarantees the availability and efficient access to the data.

Questions about the INES archive can be directed to the INES Help Desk at

`ineshelp@iuearc.vilspa.esa.es`

or at

`http://iuearc.vilspa.esa.es/ines_jb/HelpDesk/`

Accepted Papers

Millennium Essay
Wolf-Rayet Stars and Galaxies[1]

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Wolf-Rayet (W-R) stars have strong broad emission lines of highly excited ions present in their optical spectra. These features have been found in massive, young but highly evolved, hot luminous stars and in the integrated spectra of some starburst galaxies. The stellar emission lines have their origin in robust winds with sufficient density that unit optical depth is formed in the outflowing material. The W-R galaxy spectra arise from the superposition of the emission line spectra of many W-R stars, seen in contrast to the starburst continuum. This occurs when sufficient numbers of W-R stars are present, at a relatively early time in the history of the starburst. I will provide a brief overview of the history of W-R stars, a glance at our current understanding of their nature and evolution, and a glimpse of their promise for providing information about starbursts near and far.

Accepted by PASP

Preprints from `pconti@jila.colorado.edu`

[1]This Essay is one of a series of invited contributions which will appear in the *PASP* throughout the year 2000 to mark the upcoming Millennium.

Blobs in Wolf-Rayet Winds: Random Photometric and Polarimetric Variability

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Some isolated Wolf-Rayet stars present random variability in their optical flux and polarization. We make the assumption that such variability is caused by the presence of regions of enhanced density, i.e. blobs, in their envelopes. In order to find the physical characteristics of such regions we have modeled the stellar emission using a Monte Carlo code to treat the radiative transfer in an inhomogeneous electron scattering envelope. We are able to treat multiple scattering in the regions of enhanced density as well as in the envelope itself. The finite sizes of the source and structures in the wind are also taken into account. Most of the results presented here are based on a parameter study of models with a single blob. The effects due to multiple blobs in the envelope are considered to a more limited extent. Our simulations indicate that the density enhancements must have a large geometric cross section in order to produce the observed photopolarimetric variability. The sizes must be of the order of one stellar radius and the blobs must be located near the base of the envelope. These sizes are the same inferred from the widths of the sub-peaks in optical emission lines of Wolf-Rayet stars. Other early-type stars show random polarimetric fluctuations with characteristics similar to those observed in Wolf-Rayet stars, which may also be interpreted in terms of a clumpy wind. Although the origin of such structures is still unclear, the same mechanism may be working in different types of hot stars envelopes to produce such inhomogeneities.

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Preprints from `claudia@das.inpe.br`

or on the web at `http://www.das.inpe.br/preprints/blob.tar.gz`

Calibration of Nebular Emission-Line Diagnostics: II. Abundances

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We examine standard methods of measuring nebular chemical abundances, including estimates based on direct T_e measurements, and also emission-line diagnostics. We use observations of the LMC H II regions DEM L199, DEM L243, DEM L301, and DEM L323, whose ionizing stars have classifications ranging from O7 to WN3. Following common practice, we assume a two-zone T_e structure given by $T(O^{++})$ and $T(O^{+})$ to compute ionic abundances. We compare with photoionization models tailored to the observed properties of the individual objects, and emphasize the importance of correctly relating T_e in the two zones, which can otherwise cause errors of $\sim$0.2 dex in abundance estimates. The data show no spatial variations or local metallicity enhancements to within 0.1 – 0.15 dex in any of the objects, notably including DEM L199, which hosts three WR stars.

Our data agree well with both the modeled $R23$ and $S23$ abundance diagnostics for O and S. We present the first theoretical tracks for $S23$, which are in excellent agreement with a larger available dataset. However, contrary to earlier suggestions, $S23$ is much *more* sensitive to the ionization parameter (U) than is $R23$. This occurs because $S23$ does not sample S IV, which is often a significant population. We

therefore introduce $S234 \equiv$([S II]+[S III]+[S IV])/Hβ, and demonstrate that it is virtually independent of U. Predicted and observed spatial variations in $S234$ are thus dramatically decreased in contrast to $S23$. The intensity of [S IV]$\lambda 10.5\mu$ can be easily estimated from the simple correspondence between [S IV]/[S III] and [O III]/[O II]. Using this method to estimate $S234$ for data in the literature yields excellent agreement with our model tracks, hence we give a theoretical calibration for $S234$. Our models show that the double-valued structure of $S23$ and $S234$ remains an important problem as for $R23$, and presently *we consider calibrations of these S diagnostics reliable only at* $Z \lesssim 0.5 Z_\odot$. However, the slightly larger dynamic range and excellent compatibility with theoretical predictions suggest the S parameters to be more effective abundance diagnostics than $R23$.

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Preprints from oey@stsci.edu
or on the web at http://www.stsci.edu/~oey and astro-ph/0003311

Wolf-Rayet Stars and Relativistic Objects: Distinction of Mass Distribution in Close Binary Systems.

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Observed properties of WR stars as well as relativistic objects in close binary systems are analyzed. Final masses of carbon – oxygen cores of WR stars $M^f_{\rm CO}$ in WR+O binary systems are calculated taking into account the mass-dependent radial mass loss of WR stars by stellar wind. Clumped structure of WR winds is taken into account as well, allowing one to decrease the value of the mass loss rate $\dot{M}_{\rm WR}$ by several times. Masses $M^f_{\rm CO}$ lie in the range $(1-2)M_\odot \div (20-44)M_\odot$ and have continuous distribution. Masses of relativistic objects are in the range $(1-20)M_\odot$ and have bimodal distribution; mean mass of neutron stars is $(1.35 \pm 0.15)M_\odot$, that of black holes is $(8-10)M_\odot$; in the range of masses $(2-4)M_\odot$ there is a gap. In this range neutron stars and black holes in close binary systems are not observed. Mean final mass of the CO core $< M^f_{\rm CO} >= (7.4-10.3)M_\odot$ is close to the mean mass of black holes. It can be suggested that the nature of a relativistic object is determined not only by the mass of its projenitor, but also by some other parameters: rotation, magnetic field and so on.

One WR SB1 binary and eleven suspected WR+C binaries are selected, which may be WR binaries containing low-mass companions – main sequence or subgiant M-A stars. These WR binaries could be considered as projenitors of black hole or neutron star low-mass X-ray binaries.

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A kinematic and morphological investigation of the asymmetric nebula around the LBV candidate WRA 751

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WRA 751 is an evolved massive star in our Galaxy closely resembling Luminous Blue Variable stars

(LBVs). It is surrounded by a nitrogen enriched nebula of about 23″ diameter. A comparative study of the nebula's morphology and kinematics is presented, it supports—together with spectroscopical evidence—the classification of WRA 751 as a LBV. Images show that the nebula consists of a nearly spherical shell as well as a bipolar-like structure north and south of its main body, the Northern and Southern Caps.

In contrast to the almost spherical appearance of the main body of the nebula, the kinematics shows a deviation even of this part from a classical spherical expansion pattern. From the present data it can be concluded that the main body expands asymmetrically (central expansion velocity $\sim 26\,\mathrm{km\,s^{-1}}$), with a thicker shell at the back side. A bump-like structure can be found to the west of the central star. In addition to the main body, bipolar kinematic components can be identified with the morphologically classified Caps. These results put WRA 751 into the class of LBVs which are surrounded by a nebula with bipolar components, albeit considerably less pronounced than, for instance, in the classical bipolar LBVs η Car and HR Car.

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

Orbital dynamics of Cygnus X-3

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Orbital-phased-resolved infrared spectra of Cygnus X-3 in outburst and quiescence, including tomographic analysis, are presented. We confirm the phasing of broad He II and N V lines in quiescence, such that maximum blue shift corresponds to the X-ray minimum at $\Phi = 0.00 \pm 0.04$. In outburst, double-peaked He I structures show a similar phasing with two significant differences: (a) although varying in relative strength, there is continuous line emission in blue and red peaks around the orbit, and (b) an absorption component, $\sim 1/4$ of an orbit out of phase with the emission features, is discerned. Doppler tomograms of the double-peaked profiles are consistent with a disk-wind geometry, rotating at velocities of 1000 km s^{-1}. Regrettably, the tomography algorithm will produce a similar ring structure from alternative line sources if contaminated by overlying P Cygni profiles. This is certainly the case in the strong 2.0587 μm He I line, leading to an ambiguous solution for the nature of double-peaked emission. The absorption feature, detected 1/4 of an orbit out of phase with the emission features, is consistent with an origin in the He star wind and yields for the first time a plausible radial velocity curve for the system. We directly derive the mass function of the system, 0.027 $\mathrm{M}_\odot$. If we assume a neutron star accretor and adopt a high orbital inclination, $i > 60°$, we obtain a mass range for the He star of 5 $\mathrm{M}_\odot \lesssim M_{\mathrm{WR}} \lesssim 11\ M_\odot$. Alternatively if the compact object is a black hole, we estimate $\mathrm{M}_{\mathrm{BH}} \lesssim 10 M_\odot$. We discuss the implications of these masses for the nature and size of the binary system.

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http://www.physics.uc.edu/~hanson/ABSTRACTS/hanson11.html

On the stability of colliding flows: radiative shocks, thin shells, and supersonic turbulence

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High-resolution numerical simulations reveal the turbulent character of the interaction zone of colliding, radiative, hypersonic flows.

As the shocked gas cools radiatively, the cooled matter is squeezed into thin, high density shells. The remaining kinetic energy causes supersonic turbulence within these shells, before it is finally dissipated by internal shocks and vortex cascades. The density is far from homogeneous. High density filaments and large voids coexist. Its mean value is significantly below the stationary value. Similarly, areas with supersonic velocities are found next to subsonic regions. The mean velocity is slightly below or above the sound speed. While quasi uniform flow motions are observed on smaller scales the large scale velocity distribution is isotropic. Part of the turbulent shell is occupied by relatively uniform flow-patches, resembling coherent structures.

Astronomical implications of the turbulent interaction zone are multifarious. It probably drives the X-ray variability in colliding wind binaries as well as the surprising dust formation on orbital scales in some WR-binaries. It lets us understand the knotty appearance of wind-driven structures as planetary and WR-ring nebulae, symbiotics, supernova remnants, galactic supperbubbles. Also, WR and other radiatively driven, clumpy winds, advection dominated accretion, cooling flows and molecular cloud dynamics in star-forming regions may carry its stamp

Colored pictures and mpeg-videos can be taken from http://www.astro.phys.ethz.ch/staff/walder/ and .../folini/ .

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Preprints from `walder@astro.phys.etzh.ch`

or by anonymous ftp to `helene.ethz.ch; cd pub/walder; get tartu_symbiotics.ps.gz`

or on the web at `http://www.astro.phys.ethz.ch/staff/walder/walder.html`

Presupernova Evolution of Rotating Massive Stars II: Evolution of the Surface Properties

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We investigate the evolution of the surface properties of models for rotating massive stars, i.e., their luminosities, effective temperatures, surface rotational velocities, and surface abundances of all isotopes, from the zero age main sequence to the supernova stage. Our results are based on the grid of stellar models by Heger, Langer, & Woosley (2000), which covers solar metallicity stars in the initial mass range $8 - 25\,\mathrm{M}_{\odot}$. Results are parameterized by initial mass, initial rotational velocity and major uncertainties in the treatment of the rotational mixing inside massive stars.

Rotation-induced mixing processes widen the main sequence and increase the core hydrogen burning lifetime, similar to the effects of convective overshooting. It can also significantly increase the luminosity during and after core hydrogen burning, and strongly affects the evolution of the effective temperature. Our models predict surface rotational velocities for various evolutionary stages, in particular for blue supergiants, red supergiants, and for the immediate presupernova stage.

We discuss the changes of the surface abundances due to rotationally induced mixing for main sequence and post main sequence stars. We single out two characteristics by which the effect of rotational mixing can be distinguished from that of massive close binary mass transfer, the only alternative process leading to non-standard chemical surface abundances in massive stars. A comparison with observed abundance anomalies in various types of massive stars supports the concept of rotational mixing in massive stars and indicates that it is responsible for most of the observed abundance anomalies.

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A Multiwavelength Campaign on γ Cas. IV. The Case for Illuminated Disk-Enhanced Wind Streams

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On 1996 March 14–15 we conducted a campaign with the *Hubble Space Telescope* GHRS to observe the Si 4 $\lambda\lambda$1394, 1403 lines of the B0.5e star γ Cas at high temporal and spectral resolution. As a part of this ~22 hour campaign, the *Rossi X-ray Timing Explorer* (*RXTE*) was also used to monitor this star's copious and variable X-ray emission. In this fourth paper of a series we present an analysis of the rapid variations of the Discrete Absorption Components (DACs) of the Si 4 doublet. The DACs attain a maximum absorption at −1280 km s^{-1}, taper at higher velocities, and extend to −1800 km s^{-1}. The DACs in this star's resonance lines have been shown to be correlated with a $\gtrsim$ 6 year cycle in the Balmer line emission V/R ratio, and in 1996 this DAC strength was near its maximum. We derive hydrogen densities of 10^9–10^{10} cm^{-3} in the DAC material using a curve of growth method and find that the plasma becomes marginally optically thick near −1280 km s^{-1}. The "mean DAC" probably represents a broad "plateau" with a volume density intermediate between the star's mid-latitude wind and equatorial disk. We also follow the blueward evolution of subfeatures in the DACs. These features appear to emanate primarily from one or two discrete azimuths on the star and accelerate much slower than expected for the background wind, thereby exhibiting an enhanced opacity spiral stream pattern embedded within the structure forming the DAC. In Papers I and II we suggested that active X-ray centers are associated with at least two major cool clouds forced into corotation. Several correlations of flickering in the Si 4 DACs are found in our data which support the idea that changes in X-ray ionizing flux cause changes in the ionization of material at various sectors along the spiral pattern. We demonstrate that similar flickering is visible in archival *IUE* data from 1982 and may also be responsible for earlier reports from *Copernicus* of rapid changes in this star's UV and optical lines. Finally, we discovered that flickering of the DAC fluxes in the 1982 data is correlated with rotation phase and shows a modulation with a 7.5 hour cyclical cessation of X-ray flares that was observed recently by *RXTE*. This confirms our basic picture that lulls in X-ray activity close to the star's surface cause both a lower Si 5 ionization fraction and an increase in Si 4 variability within the DAC structures.

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Search for Rotational Modulation of X-ray Centers on the Classical Be Star γ Cas

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In this paper we discuss X-ray observations of γ Cas obtained in 1998 November with the Rossi X-Ray Explorer (RXTE). The data were obtained nearly continuously over 54 hour (about twice the rotational period) An earlier RXTE light curve obtained in 1996 March over 27 hours consisted of variations arising from short-duration shots (flares) superimposed on an undulating "basal" component which varied in anticorrelation to a simultaneously observed UV light curve over a time scale of several hours. The object of the present study was to compare the X-ray characteristics from one epoch to another and also to see whether variations of the basal flux repeat during a second rotation period. Our analysis of the shots in both epochal light curves shows that they follow a frequency distribution which is exponential in form, in contrast to the power-law form followed by events from most other groups of cool flare stars and therefore suggesting an alternative excitation process. In other respects, we have found a number of differences in the X-ray behaviors: (i) the mean X-ray level in 1998 was only 50–60% of the 1996 level, (ii) the basal fluxes vary over shorter timescales (less than 2 hours), (iii) a color (hardness) ratio formed from our data is uncorrelated with the integrated fluxes, and (iv) fluctuations in the colors of shot and basal fluxes, while generally tracking one another, show differences which can change sign over less than a few hours, and (v) the shot rate was relatively low in the 1998 light curve, but extended groups of shots are particularly noticable. The first and second light curve segments, corresponding each to a rotation cycle, do not replicate well, probably because of interference by the extended shot groups.

We also present in this paper archival data confirming the presence of a pair of "dips" separated by 10 hours in the UV continuum light curve at various epochs in both 1982 and 1996. This provides a basis for a refined but still tentative rotational period of 1.12277 days, although the amplitudes of these dips vary markedly from one rotation to the next.

With simulations of flare evolution, we explore attributes of an imposed particle beam of particles into the Be star's atmosphere which would explain the various observed characterstics of the X-ray shots of γ Cas.

In three appendices we discuss arguments against the idea that the X-ray emission from γ Cas arises from, first, mass accretion onto a hypothetical white dwarf companion or, second, from flaring from a cool active companion and, finally, *for* its origin from near the surface of γ Cas.

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FUSE Observations of the Stellar Winds of Two O7 Supergiants in the Magellanic Clouds

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We compare the stellar wind features in far-UV spectra of Sk $-67°111$, an O7 Ib(f) star in the LMC, with Sk 80, an O7 Iaf+ star in the SMC. The most striking differences are that Sk 80 has a substantially lower terminal velocity, much weaker O VI absorption, and stronger S IV emission. We have used line-blanketed, hydrodynamic, non-LTE atmospheric models to explore the origin of these differences. The far-UV spectra require systematically lower stellar temperatures than previous determinations for O7 supergiants derived from plane-parallel, hydrostatic models of photospheric line profiles. At these temperatures, the O VI in Sk $-67°111$ must be due primarily to shocks in the wind.

Accepted by Astrophysical Journal Letters; will appear in a special issue devoted to the first scientific results from the FUSE mission.

For preprints, contact: `awf@pha.jhu.edu`

Preprints available from: `http://xxx.lanl.gov/abs/astro-ph/0005039`

The Ultraviolet and Optical Spectra of Metal-Deficient O Stars in the Small Magellanic Cloud

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An ultraviolet and optical spectral atlas of 15 O stars in the SMC is presented and described. The echelle data have resolving powers of order 10^4; they were obtained with HST/STIS in the UV, and at the AAT or the ESO 3.6 m in the optical. The ultimate objective is to develop metal-deficient templates for the interpretation of distant starbursts, but here we discuss interesting new properties of the SMC stars themselves, revealed by the high quality of these data. The SMC metal deficiency

produces anomalously weak stellar-wind profiles along the entire O main sequence, as well as at intermediate luminosities; the first intermediate Si IV $\lambda1400$ wind profile in the SMC is shown. The second known Of star in the SMC displays wind peculiarities that are identical to those of its spectral classmate, again likely due to the low systemic metallicity. Several objects display marked CNO anomalies, including the first cases of C III $\lambda4650$ emission without N III $\lambda4640$ in O-type spectra. The N/C ratio appears to increase with mass, extent of evolution away from the ZAMS, and/or rotational velocity in the young cluster NGC 346. In addition, the first examples of Onfp (Oef) and Of?p spectra in the SMC have been found (the latter being only the fourth member of its peculiar shell category known anywhere). The UV wind characteristics of these objects correlate with their optical peculiarities. All of these spectroscopic phenomena provide diagnostics of the evolutionary status of metal-deficient massive stars.

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or on the web at `http://www.boulder.swri.edu/`*sim*`joel/papers.html`

Submitted Papers

Non-thermal emission in WR stars: are massive companions required?

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We examine the radio spectral indices of 23 Wolf-Rayet stars to identify the nature of their radio emission. We identify nine systems as non-thermal emitters. In seven of these systems the non-thermal emission dominates the radio spectrum, while in the remaining two it is of comparable strength to the thermal, stellar wind emission, giving a "composite" spectra. Among these nine systems, seven have known spectroscopic or visual binary companions. The companions are all massive O or early B-type stars, strongly supporting a connection between the appearance of non-thermal emission in WR stars and the presence of a massive companion. In three of these binaries, the origin of non-thermal emission in a wind-collision region between the stars has been well-established in earlier work. The binary systems that exhibit only thermal emission are all short period systems where a wind-collision zone is deep within the opaque region of the stellar wind of the WR star. To detect non-thermal emission in these systems requires optically thin lines of sight to the wind-collision region.

Submitted to Monthly Notices or the RAS
Preprints from `sean.dougherty@hia.nrc.ca`
or by anonymous ftp to `ftp://ftp.drao.nrc.ca/pub/smd/wr_nt/wr_nt_submitted.ps`
or on the web at `http://www.drao.nrc.ca/~smd/preprint/wr_nt_submitted.ps`

The He II Emitting Nebula N44C in the LMC: Optical/UV Spectroscopy of the Nebula and its Ionizing Star

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We present *HST* spectroscopy and imaging, along with new ground-based spectroscopy and *ROSAT* HRI imaging, of the He II emitting nebula N44C and its ionizing star. A GHRS spectrum of the ionizing star yields a spectral type of about O7 for the star. The lack of P Cygni profiles for Si IV and C IV indicates that the star is not a supergiant. The nebular abundances in the ionized gas are consistent with average abundances for LMC H II regions, with the possible exception that nitrogen may be enhanced. Enrichment by a former evolved companion star is not evident. A long-slit echelle spectrogram in Hα + [N II] shows no evidence for high-velocity gas in N44C. This rules out high-velocity shocks as the source of the nebular He II emission. A 108 ks ROSAT HRI image of N44C shows no X-ray point source to a 3σ upper limit $L_X < 10^{34}$ erg s^{-1} in the 0.1-2.0 keV band. Based on new measurements of the electron density in the He II emitting region, we derive recombination timescales of $\approx$ 20 yrs for He^{+2} and $\approx$ 4 yrs for Ne^{+4}. If N44C is a fossil X-ray ionized nebula, this places severe constraints on when the putative X-ray source could have turned off. The presence of strong [Ne IV] emission in the nebula is puzzling if the ionizing source has turned off. It is possible the system is related to the Be X-ray binaries, although the O star in N44C does not show Be characteristics at the present time. Monitoring of X-rays and He II emission from the nebula, as well as a radial velocity study of the ionizing star, are needed to fully understand the emission line spectrum of N44C.

Submitted to The Astrophysical Journal

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In Proceedings

Far-UV FUSE spectroscopy of the O VI resonance doublet in Sand 2 (WO)

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We present *Far-Ultraviolet Spectroscopic Explorer (FUSE)* spectroscopy of Sand 2, a LMC WO-type Wolf-Rayet star, revealing the O VI resonance P Cygni doublet at 1032–38Å. These data are combined with *HST*/FOS ultraviolet and Mt Stromlo 2.3m optical spectroscopy, and analysed using a spherical, non-LTE, line-blanketed code. Our study reveals exceptional stellar parameters: $T_* \sim$150,000K, v_∞=4100 km s^{-1}, $\log(L/L_\odot)$=5.3, and $\dot{M} = 1 \times 10^{-5} M_\odot \mathrm{yr}^{-1}$, if we adopt a volume filling factor of 10%. Elemental abundances of C/He$\sim 0.7\pm0.2$ and O/He$\sim 0.15^{+0.10}_{-0.05}$ by number qualitatively support previous recombination line studies. We confirm that Sand 2 is more chemically enriched in carbon than LMC WC stars, and is expected to undergo a supernova explosion within the next 5×10^4yr.

To appear in *FUSE special issue of ApJ Letters*
Preprints from `pac@star.ucl.ac.uk`
or on the web at `http://www.star.ucl.ac.uk/~pac/publications.html`

Theses

X-ray Emission From Colliding Stellar Winds: Theoretical Modelling and Observations

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This thesis presents a detailed theoretical and observational study of the X-ray emission from colliding stellar winds, using a mixture of advanced hydrodynamical simulations and *ROSAT*, *ASCA* and *RXTE* X-ray observations.

Various X-ray properties from the colliding stellar winds in O+O-star binaries are initially investigated. In particular, theoretically generated lightcurves are compared to observational counterparts. This work explores some essential parameter space in a coherent fashion for the first time but for computational reasons the stellar winds are assumed to instantaneously accelerate. This assumption is very poor in close systems and/or where strong interactions between the winds and the radiation fields occur.

Throughout the rest of the thesis the hydrodynamical code is improved and becomes increasingly realistic. Major refinements include the relaxation of the assumption of the instantaneous acceleration of the stellar winds and the inclusion of orbital motion. Simulations with parameters appropriate for the modelling of Iota Orionis and Eta Carinae are performed, and the results are compared to the latest observations of these systems. A detailed analysis of the latest *ASCA* observations of Iota Orionis revealed surprising results, whilst we were able to reproduce the X-ray lightcurve of Eta Carinae remarkably well, adding further support to a binary interpretation of Eta Car.

This work also reveals the limitations and biases of the traditional methods of X-ray analysis and demonstrates the need for direct comparison between complex theoretical models and observational data. Further refinement of the hydrodynamic code is expected to lead to additional understanding of the colliding winds phenomena and the underlying stellar, wind and binary parameters.

PhD thesis directed by Ian Stevens, and defended at the University of Birmingham, on 29th October, 1999
Preprints from `jmp@ast.leeds.ac.uk`
or on the web at `http://ast.leeds.ac.uk/~jmp/thesis.html`

Jobs

Postdoctoral position
Dynamics of Hot Star Winds

The Department of Physics and Astronomy at University College London

Applications are invited for a PPARC-funded postdoctoral position in studies of time-dependent phenomena in the winds of luminous early-type (OB) stars. The successful candidate will work with Dr Raman Prinja on multi-wavelength observational studies which aim to provide fresh perspectives on the origin and nature of large- and small-scale structure in the winds of massive, luminous stars. The programme covers extended optical spectroscopy, data from radio and mm facilities, plus kinematic and hydrodynamical modelling. There will also be opportunities to contribute to studies of accretion-disc winds from cataclysmic variables, based on rapid optical and UV spectroscopy.

Candidates should have recently completed a Ph.D. and should preferably have experience in studies of stellar outflows. The position is available from 1 October 2000 for three years (following successful review after one year). The starting salary will be at the lower end of the University RA1A Scale. Further information is available from Dr Raman Prinja (rkp@star.ucl.ac.uk; Department of Physics and Astronomy, UCL, Gower Street, London WC1E 6BT).

Prospective applicants should submit a full curriculum vitae, including publications list, brief statement of research interests, and names of two referees.

The closing date for applications is 31 May 2000.

Postdoc Position in Astrophysics
Stellar Atmospheres and Spectroscopy

Applications are invited for a postdoctoral position in the group of Prof. W.-R. Hamann (Chair for Astrophysics, University of Potsdam). The group has leading experience in modelling the radiative transfer in stellar winds and the quantitative analysis of Wolf-Rayet spectra. The applicant should have a strong background in theoretical astrophysics and numerical simulations. Knowledges in the field of stellar atmospheres are expected. A PhD in Physics or Astronomy is prerequisite.

The appointment will be given for two years, with possible renewals. The salary (german level BAT IIa Ost) is strongly dependent on age and marital status, but of the order of 5000 DM per month before taxes and social insurance and - very roughly - 3000 ... 3500 DM after reductions. The position can be used for further graduation ("Habilitation") according to the german academic system.

Applicants are encouraged to contact us informally (email to wrh@astro.physik.uni-potsdam.de) before submitting the usual documents (curriculum vitae, list of publications, statement of scientific interests and plans, and the addresses of three possible referees) to the address below. Applications will be reviewed after June 1, 2000.

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Meetings

Magnetic Fields across the Hertzsprung-Russell diagram

Santiago, Chile
January 15-19, 2001
http://www.eso.org/gen-fac/meetings/magfield2001/
E-mail: magfield@eso.org

1. **Introductory talk**
   (a) Magnetic fields across the Hertzsprung-Russel diagram (*L. Mestel*)
2. **The Sun**
   (a) Photospheric field
      i. Large-scale structure and solar cycle
      ii. Small-scale structure: sunspots (*J.C. del Toro Iniesta*)
      iii. Small-scale structure: non-spot fields (*S.K. Solanki*)
   (b) Chromospheric and coronal fields
      i. Chromospheric fields (*C. Keller*)
      ii. Coronal fields (*S.M. White*)
   (c) Magnetic field diagnosis techniques
      i. Zeeman and Hanle effect (*E. Landi Degl'Innocenti*)
   (d) Theory
      i. Magnetic field generation and dynamos (*F. Cattaneo*)
      ii. Models of the solar dynamo (*F. Moreno-Insertis*)
      iii. Theory of chromospheric and coronal fields (*A.A. van Ballegooijen*)
      iv. Magneto-convection (*M. Schüssler*)
3. **Non-degenerate stars**
   (a) Cool stars
      i. Direct measurements of magnetic fields in cool stars (*S.H. Saar*)
      ii. Stellar dynamos (*P. Charbonneau*)
      iii. Magnetic activity (*J.H.M.M. Schmitt*)
      iv. Magnetic fields in binaries (*C.G. Campbell*)

(b) Ap and Bp stars
   i. Magnetic fields of Ap and Bp stars: overview (*G. Mathys*)
   ii. Recent advances in magnetic field diagnosis techniques (*J.D. Landstreet*)
   iii. Geometrical structure of Ap and Bp star magnetic fields (*S. Bagnulo*)
   iv. Zeeman-Doppler Imaging (*V.L. Khokhlova*)
   v. Theory: the origin of Ap and Bp star magnetic fields

(c) Hot stars
   i. Magnetic fields in hot stars: direct detection attempts (*G.A. Wade*)
   ii. Magnetic fields in hot stars: indirect indicators (*H. Henrichs*)
   iii. Determination of stellar magnetic fields through the Hanle effect (*R. Ignace*)

4. **Degenerate stars**
   (a) Magnetic fields in isolated white dwarfs: overview (*G.D. Schmidt*)
   (b) Structure of white dwarf magnetic fields (*D.T. Wickramasinghe*)
   (c) The role of magnetic fields in cataclysmic variables (*L. Ferrario*)
   (d) Magnetic fields of neutron stars: overview (*S.R. Kulkarni*)
   (e) Magnetic fields and stellar spindown: white dwarfs and neutron stars (*H.C. Spruit*)

5. **Pre-main sequence (PMS) stars**
   (a) Magnetic fields in PMS stars: overview (*E.W. Günther*)
   (b) Magnetic activity from protostars and T Tau stars (*E.D. Feigelson*)
   (c) Spindown of young stars: the role of magnetic fields (*K.B. MacGregor*)
   (d) Star formation models with magnetic fields

6. **Instrumentation: present and future**
   (a) Ground-based instrumentation for solar magnetic field studies (*H.P. Povel*)
   (b) Space-based instrumentation for solar magnetic field studies (*B.W. Lites*)
   (c) Ground-based instrumentation for stellar magnetic field studies
      i. Polarimetry and spectropolarimetry on new generation very large telescopes (*J.-F. Donati*)
      ii. Resolved magnetic structures on stellar surfaces: prospects for interfero-spectropolarimetry (*F. Vakili*)
      iii. Pulsar radiopolarimetry (*R.N. Manchester*)
   (d) Space-based instrumentation for stellar magnetic field studies (*S. Fineschi*)
   (e) Relevance of instruments and diagnostic techniques used in stellar magnetic field studies for other areas of astrophysics

7. **Towards a global picture**
   (a) Instrumentation and techniques for magnetic field diagnosis (*J.O. Stenflo*)
   (b) Observable effects induced by or related to magnetic fields
      i. Hot stars (*J.P. Cassinelli*)
      ii. Cool stars (*P.G. Judge*)
   (c) Theoretical aspects: the solar-stellar connection (*R. Rosner*)