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From the editor

Besides abstracts of 26 papers (18 accepted for publication in by refereed journals, 2 submitted, 6 in proceedings of conferences), this issue of the Hot Star Newsletter brings you a job offer as well as information on the 2001 Boulder meeting and on new databases.

Have a happy New Millenium!

Philippe Eenens

Accepted Papers

Blowing the Winds from Hot Stars (invited Millenium Essay)

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The rise of ultraviolet astronomy in the seventies and eighties of the last century has taught us that all hot luminous stars are blowing fierce winds into space with velocities of several thousand $\mathrm{km\,s^{-1}}$ and mass loss rates of 10^{-6} to 10^{-4} ($M_\odot\,\mathrm{yr}^{-1}$). The mass loss rates of the normal O, B and A stars are well explained by radiation pressure due to spectral lines, including the observed bi-stability jumps near spectral types B1 and A0. However, several important observed wind features are not well understood: the presence of corotating spiral-like structures in the wind; the high densities of flat outflowing equatorial disks; and the high mass loss rates of the Wolf-Rayet stars. I discuss the discovery and early ideas about winds from hot stars and the triumphs and failures of the radiation driven wind theory.

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Resonance Line Scattering Polarization in Optically Thin Planar Equatorial Disks

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This paper is the third in a series on the anisotropic scattering by optically thin resonance lines in extended stellar envelopes. Considered here is the *polarization* arising from resonance line scattering in equatorial disks. The shape of the polarized line profile is analytically derived under simplifying conditions of constant expansion or rotation for thin lines, with stellar occultation and finite star depolarization effects also included. The polarized profiles for the two cases are radically different. Moreover owing to the symmetries, rotation leads to profiles in both Q_ν and U_ν, whereas only a Q_ν profile survives for an expanding disk, with $U_\nu = 0$ at all Doppler shifts in the line. Retaining the assumption of optical thinness, numerical results are presented for more realistic disk velocity fields: truncated linear expansion and Keplerian rotation. The calculations also include disk absorption of stellar continuum emission. When compared with the simplified analytic cases, many of the gross characteristics of the polarized profiles are retained.

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Turbulent outflows from [WC]-type nuclei of planetary nebulae. I. BD +30° 3639 and other [WC 9–10] stars

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Using spectroscopic observations taken at the Observatoire de Haute-Provence (OHP, France) and the European Southern Observatory (ESO, Chile), we describe wind fluctuations in four [WC 9–10]-type central stars of planetary nebulae, especially BD +30° 3639, which was observed intensively during 15 nights. Moving features seen on the top of the CIIIλ5696 emission line are interpreted as outflowing "blobs" which are radially accelerated outwards, as seen in the winds of massive Wolf-Rayet stars. We find line profile variations occurring on a time scale of hours. Kinematic parameters of the blobs are derived and compared to those of massive Wolf-Rayet stars. The wind fragmentation process appears independent of the strong differences between both types of hot stars.

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Cygnus X-3 with ISO: investigating the wind

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We observed the energetic binary Cygnus X-3 in both quiescent and flaring states between 4 and 16 μm using the ISO satellite. We find that the quiescent source shows the thermal free-free spectrum typical of a hot, fast stellar wind, such as from a massive helium star. The quiescent mass-loss rate due to a spherically symmetric, non-accelerating wind is found to be in the range 0.4–2.9 $\times 10^{-4}$ $M_\odot$ yr^{-1}, consistent with other infrared and radio observations, but considerably larger than the 10^{-5} $M_\odot$ yr^{-1} deduced from both the orbital change and the X-ray column density. There is rapid, large amplitude flaring at 4.5 and 11.5 μm at the same time as enhanced radio and X-ray activity, with the infrared spectrum apparently becoming flatter in the flaring state. We believe non-thermal processes are operating, perhaps along with enhanced thermal emission.

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Ultraviolet and Optical Observations of OB Associations and Field Stars in the Southwest Region of the Large Magellanic Cloud

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Using ultraviolet photometry from the *Ultraviolet Imaging Telescope* (*UIT*) combined with photometry and spectroscopy from three ground-based optical datasets we have analyzed the stellar content of OB associations and field areas in and around the regions N 79, N 81, N 83, and N 94 in the Large Magellanic Cloud. In particular, we compare data for the OB association Lucke-Hodge 2 (LH 2) to determine how strongly the initial mass function (IMF) may depend on different photometric reductions and calibrations. Although the datasets exhibit median photometric differences of up to 30%, the resulting *uncorrected* IMFs are reasonably similar, typically $\Gamma \sim -1.6$ in the 5–60 $\mathcal{M}_\odot$ mass range. However, when we correct for the background contribution of field stars, the calculated IMF flattens to $\Gamma = -1.3 \pm 0.2$ (similar to the Salpeter IMF slope). This change underlines the importance of correcting for field star contamination in determinations of the IMF of star formation regions. It is possible that even in the case of an universal IMF, the variability of the density of background stars could be the dominant factor creating the differences between calculated IMFs for OB associations.

We have also combined the *UIT* data with the most extensive of these ground-based optical datasets — the Magellanic Cloud Photometric Survey — to study the distribution of the candidate O-type stars in the field. We find a significant fraction, roughly half, of the candidate O-type stars are found in field regions, far from any obvious OB associations [in accord with the suggestions of Garmany, Conti,

& Chiosi (1982) for O-type stars in the solar neighborhood]. These stars are greater than 2 arcmin (30 pc) from the boundaries of existing OB associations in the region, which is a distance greater than most O-type stars with typical dispersion velocities will travel in their lifetimes. The origin of these massive field stars (either as runaways, members of low-density star-forming regions, or examples of isolated massive star formation) will have to be determined by further observations and analysis.

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Preprints from joel@boulder.swri.edu
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Tailored Analyses of the WN8 Stars WR40 and WR16

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We present the results of tailored spectral analyses of two WN8 Wolf-Rayet stars: WR40 (HD 96548) and WR16 (HD 86161). These analyses were carried out utilizing line blanketed non-LTE model atmospheres with provisions for a clumped wind. For the first time in WN analyses, stellar parameters are derived by attempting to match the entire observed spectrum from 900 to 35,000 Å, including the complex iron pseudo-continuum between 1200–2100 Å. The inclusion of iron and other metals (O, Ne, Mg, Al, Si, S, Ar, & Ca) in the model atmosphere results in a decrease in derived stellar radii by ∼20% from previous, nitrogen-line analyses, while mass-loss rates are decreased by a factor of ∼3 due to clumping.

The abundance of iron and other metals are constrained with uncertainties of about 50%, demonstrating that Wolf-Rayet stars can be used to determine metallicities and metallicity gradients in other galaxies. We find the presence of metals significantly increases the radiative line force the wind experiences, allowing the outer wind to be driven to its theoretical velocity structure, and coming within a factor of five of the needed line force in the inner region (an improvement over earlier radiative transfer models). Coupled with the substantial reduction in the derived performance numbers (factor of ∼3), this indicates that radiation pressure alone may be sufficient to drive the winds of WN8 stars.

Our model parameters achieve good fits simultaneously to the H, He, and N III–IV features of the spectra, a feat that has eluded previous efforts. Comprehensive identification of lines and line complexes are provided, and the effects of the inclusion of metals on the strengths of diagnostic lines are discussed.

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ROSAT HRI observations of P Cyg and surrounding area

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We present a detailed analysis of deep ROSAT HRI observations of the luminous blue variable P Cyg and its surrounding radio nebula. The HRI image provides a point source at the position of P

Cyg. However, we show that this emission can be attributed to the ultraviolet leak of the ROSAT HRI. The X-ray flux upper limit derived from the HRI data of this star is discussed in the context of X-ray emission from hot stars. Furthermore, we present a search for diffuse X-ray emission possibly associated with the radio nebula surrounding P Cyg. We compare our results to model predictions and X-ray fluxes observed for shells around other hot stars. Additionally, we detect 10 X-ray soruces in the field of view. All but one of these X-ray emitters have stellar counter parts in the Palomar Sky Survey. We suggest that they are active late-type stars possibly belonging to Cyg OB1.

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Can the gamma-ray source 3EG J2033+4118 be produced by the stellar system Cyg OB2 No. 5?

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We discuss the possibility that the stellar system Cyg OB2 No. 5 can be a gamma-ray source in the light of recent EGRET and radio data. This system is formed by an O7 Ia + Ofpe/WN9 contact binary. A third star, probably a B0 V star also associated with the system, is located at $\sim$ 1700 AU from the primary. We estimate the expected gamma-ray luminosity from the colliding winds region, the terminal shock of the wind, and the unstable zone at the base of the wind, and conclude that, under very reasonable assumptions, Cyg OB2 No. 5 can generate about a half of the gamma-ray flux detected from the positionally coincident source 3EG J2033+4118. We suggest, then, that other O stars belonging to the association, also placed within the 95 % probability EGRET location contour, could contribute to the observed gamma-ray flux.

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A Search for Wolf-Rayet Stars in the Small Magellanic Cloud

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We report on a comprehensive search for Wolf-Rayet (W-R) stars in the SMC using interference-filter imaging. Photometry of over 1.6 million stellar images on multiple, overlapping fields covering 9.6 square-degrees found the previously known W-Rs at very high significance levels, two known Of-type stars, plus additional candidates which we examined with slit spectroscopy. We discovered two new Wolf-Rayet stars, both of type "WN3+abs", bringing the total number in the SMC to 11. We discuss their spectra, as well as reclassifying the previously known ones with our new data. Our survey also revealed 4 newly found Of-type stars, including one of O5f?p type, which is one of the earliest-type stars known in the SMC. Another newly identified Of star is AV 398 (O8.5 If), a star often used in extinction studies under the assumption that it is of early B type . We recover S18 (AV154), a B[e]

star whose spectrum currently lacks He II λ4686 emission, but which must have had strong emission a year earlier; we compare this star to S Dor, suggesting it is indeed a luminous blue variable (LBV). We also find a previously unknown symbiotic star. whose spectrum is nearly identical to the Galactic symbiotic AG Dra. More important, perhaps, than any of these discoveries is the demonstration that there is not a significant number of W-Rs waiting to be discovered in the SMC. The number of W-Rs is a factor of 3 times lower in the SMC (per unit luminosity) than in the LMC. This strongly suggests that at the low metallicity which characterizes the SMC only the most massive stars can evolve to W-R type.

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The Progenitor Masses of Wolf-Rayet Stars and Luminous Blue Variables Determined from Cluster Turn-offs. II. Results from 12 Galactic Clusters and OB Associations

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In a previous paper on the Magellanic Clouds we demonstrated that coeval clusters provide a powerful tool for probing the progenitor masses of Wolf-Rayet stars (W-Rs) and Luminous Blue Variables (LBVs). Here we extend this work to the higher metallicity regions of the Milky Way, studying 12 Galactic clusters. We present new spectral types for the unevolved stars, and use these, plus data from the literature, to construct H-R diagrams. We find that all but two of the clusters are highly coeval, with the highest mass stars having formed over a period of less than 1 Myr. The turn-off masses show that at Milky Way metallicities some W-Rs (of early WN type) come from stars with masses as low as 20–25$\mathcal{M}_\odot$. Other early-type WNs appears to come from high masses, suggesting a large range of masses evolve through an early-WN stage. On the other hand, WN7 stars are found only in clusters with very high turn-off masses, $> 120\mathcal{M}_\odot$. Similarly the LBVs are only found in clusters with the highest turn-off masses, as we found in the Magellanic Clouds, providing very strong evidence that LBVs are a normal stage in the evolution of the most massive stars. The ages of clusters containing WN7s and LBVs can be as young as 1 Myr, and we argue that even so these objects are evolved, and that the young age simply reflects the very high masses that characterize the progenitors of such stars. In particular we show that the archetype LBV η C ar appears to be coeval with the rest of the Trumpler 14/16 complex. The three WCs in our sample are all found in clusters with turn-off masses $> 70\mathcal{M}_\odot$, whereas in the Magellanic Clouds, the WCs were found in clusters with masses as low as $45\mathcal{M}_\odot$. Whether this difference is significant or due to small-number statistics remains to be seen. The BCs of Galactic W-Rs are hard to establish using the cluster turn-off method, but are consistent with the "standard model" of Hillier.

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Database of Geneva stellar evolution tracks and isochrones for $(UBV)_J(RI)_C$ JHKLL′M, HST-WFPC2, Geneva and Washington photometric systems

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We have used an updated version of the empirically and semi-empirically calibrated *BaSeL* library of synthetic stellar spectra of Lejeune et al. (1997, 1998) and Westera et al. (1999) to calculate synthetic photometry in the $(UBV)_J(RI)_C$ JHKLL′M, HST-WFPC2, Geneva, and Washington systems for the entire set of non-rotating Geneva stellar evolution models covering masses from 0.4–0.8 to 120–150 $M_\odot$ and metallicities Z=0.0004 (1/50 $Z_\odot$) to 0.1 (5 $Z_\odot$). The results are provided in a database which includes all individual stellar tracks and the corresponding isochrones covering ages from 10^3 yr to 16–20 Gyr in time steps of $\Delta \log t = 0.05$ dex. The database also includes a new grid of stellar tracks of very metal-poor stars (Z=0.0004) from 0.8 – 150 $M_\odot$ calculated with the Geneva stellar evolution code.

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Also on the web at `http://webast.ast.obs-mip.fr/stellar`

The full database will be available in electronic form at the CDS `http://cdsweb.u-strasbg.fr/cgi-bin/qcat?J/A+A/(vol)/(page)` and at `http://webast.ast.obs-mip.fr/stellar/`.

Interpretation of the Light curve of the Eclipsing Binary System V444 Cyg on the Set of Convex-Concave Functions

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Interpretation of the narrow-band continuum λ4244Å light curve of the eclipsing Wolf-Rayet binary V444 Cyg has been carried out. Functions describing the brightness and opacity distributions over the WN5 star disk were suggested to be convex-concave, monotonic and non-negative. The convex part of the function corresponds to the "core" of the WN5 star, while the concave part to its extended photosphere and atmosphere.

Radius of the opaque "core" of the WN5 star is $r_{\rm WN5}^{core} \simeq 4R_\odot$, the brightness temperature of the "core" $T_{br}^{core} > 52000$K. Radial outflow in the WN5 star wind is accelareted. The material in the WN5 star wind remains being accelerated on the considerable distances from the center of the WN5 star. If one roughly approximates the restored velocity law of the WN5 star wind by the Lamers velocity law the large value of the acceleration parameter is obtained $\beta = 1.58 \div 1.82$.

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Velocity Law in the Wolf-Rayet Wind in the Eclipsing Binary System V444 Cyg: Parametric Models

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The continuum light curve λ4244Å of the eclipsing Wolf-Rayet binary system V444 Cyg is analysed in two models for the velocity law $v(r)$ in the WN5 star wind: Lamers' law and power law. It is shown that both parametric models are not adequate to the observed light curve and may be rejected at the significance level $< 2\%$. The conclusion is drawn that the deviations of the empirical law $v(r)$ obtained from the analysis of the same light curve on the set of convex-concave functions (Antokhin and Cherepashchuk, Astronomy Reports, 2001, in press) from the parametric Lamers' law are significant. The material of the WN5 star wind remains to be accelerated on considerably large distances from the center of the WN5 star. In the model of rough approximation of the empirical velocity law $v(r)$ by the Lamers' law it corresponds to the large value of the acceleration parameter $\beta > 1$.

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An analysis of HST UV spectra of Cyg OB2 stars

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As a first step of a vigorous program to investigate the Wind Momentum – Luminosity Relationship (WLR) of Galactic O-stars by analyzing stars belonging to the same cluster we present UV HST observations of six supergiants and one giant in the Cyg OB2 association. Terminal and turbulent wind velocities, velocity laws and metal ion column densities are derived and mean ionization fractions are estimated. Turbulent velocities are mostly in the range 10 – 14 % of v_∞. The terminal velocities agree well with the average v_∞ vs. spectral class relationship compiled by Kudritzki & Puls ([**?**]). We compare the observed v_∞ vs. escape velocity (depending on the diagnostics of the stellar mass) correlation with the predictions of the radiatively driven wind theory and find better agreement with the spectroscopic masses rather than with the evolutionary ones. The β velocity field exponents are in the range 0.7 – 0.8, without any trend towards larger values. We show that for a single luminosity class there is a tight relationship between $T_{\rm eff}$ and $< \rho >$ (the mean density at the point in the stellar wind, where half the wind terminal velocity is reached). In consequence, the ionization fractions show the same trend with both, $T_{\rm eff}$ and $< \rho >$: we find that N v increases with $T_{\rm eff}$, Si iv decreases and C iv does not clearly correlate. As a byproduct, we also derive interestellar H i column densities towards Cyg OB2, which turn out to be quite large. For one object (Cyg OB2#2) we find inconsistencies making the association membership questionable.

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Simultaneous Hα and Photometric Observations of P Cygni

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For the first time an extensive set of (quasi-) simultaneous photometric (UBV) and spectroscopic (Hα line profiles) observations of P Cygni, covering a period from May, 1990 to June, 1994 was analyzed in terms of time variability. It is found that the Hα equivalent width (EW) exhibits two different patterns of variability: a slower one, called Long-Term (LT) variability, with an amplitude of about 30Å and a characteristic duration of about 600 days and a faster one, called Short-Term (ST) variability, with an amplitude up to 10Å and duration of 40 to 60 days. Suggestive evidence for EW variation on a longer time scale (about few years) also exists. The variations in the Hα luminousity are not solely due to changes in the underlying continuum but also reflect variations in the physical properties of the wind. We find, in terms of a simplified spherically-symmetric wind model, that the LT variation of the line can be successfully explained in terms of a 26% alteration of the mass-loss rate, possibly accompanied by variations in the velocity field.

From the analysis of the photometric behaviour of the star we find evidence for a very slow variation in the stellar brightness with an amplitude of about 0.13 mag and a duration of about 2600 days, i.e. about 7 years. During this variation, i.e. when the star brightens, the effective temperature decreases (by about 10%) and the radius increases (by about 7 %). The properties of this Very Long Term (VLT) variation suggest that P Cygni has probably experienced a normal S Dor-type variation with a minimum phase around 1988 and a maximum phase in 1992. Some hints for a positive correlation between mass loss variations and changes in the stellar radius, due to the normal SD variability, do exist implying that the behaviour of P Cygni is more likely similar to that of R71 and S Dor but different from e.g. AG Car, R127 and HD160529.

Superimposed on the VLT component in the photometric variability of P Cygni, we observe ST brightness variations with an amplitude between 0.1 and 0.2 mag which appears to recur on a time scale of three to four months. The colour behaviour of these microvariations, at least of those which appear near the maximum phase of the VLT variation, is redder in $B-V$ and bluer in $U-B$ when the star brightens in V. The properties of this ST photometric variability are similar to the properties of the so-called "100 d-type micro-variations", recognised in other LBVs by van Genderen et al. (1997a,b). Based on time-scale evidences we suggest that the microvariability observed are rather due to "relaxation oscillations" (Stothers & Chin 1995) than to strange-mode oscillations in the stellar interior.

Evidence for a close relationship between ST variations in Hα and changes in the stellar brightness and temperature is found. From other results about P Cygni's spectral variations (Markova, 2000a), we conclude that the ST variability of the wind is most likely connected with processes in the stellar photosphere.

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Chandra Discovers a Very High Density X-ray Plasma on the O-Star ζ Orionis

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We report on a Chandra line spectrum observation of the O supergiant, ζ Orionis (O9.7 Ib). A 73.4 ks HETGS observation shows a wide range of ionization stages and line strengths over the wavelength range of 5 to 26 Å. The observed emission lines indicate a range in temperature of 2 to 10 MK which is consistent with earlier X-ray observations of ζ Ori. Many lines are spectrally resolved showing Doppler broadening of 900 ± 200 km s^{-1}. The observed He-like ions (O VII, Ne IX, Mg XI, and Si XIII) provide information about the spatial distribution of the X-ray emission. Although the observations support a wind distribution of X-ray sources, we find three conflicting results. First, line diagnostics for Si XIII indicate that this line emission forms very close to the stellar surface, where the density is of order 10^{12} cm^{-3}, but the velocity there is too small to produce the shock jump required for the observed ionization level. Second, the strong X-ray line profiles are symmetric and do not show any evidence of Doppler blue-shifted line centroids which are expected to accompany an outwardly moving source in a high density wind. Third, the observed velocity dispersions do not appear to correlate with the associated X-ray source radii velocities, contrary to expectations of wind distributed source models. A composite source model involving wind shocks and some magnetic confinement of turbulent hot plasma in a highly non-symmetric wind, appears to be needed to explain the line diagnostic anomalies.

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BCD spectrophotometry of stars with the B[e] phenomenon

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Low resolution spectra in the $\lambda\lambda 3500-4600$ Å wavelength range of 23 stars with the B[e] phenomenon are presented. Spectral classification of 15 program stars was performed using the BCD spectrophotometric system, based on the study of the Balmer discontinuity, which is independent of interstellar and circumstellar dust extinctions and of circumstellar gas emissions and/or absorptions. From calibrations of the (λ_1, D) BCD parameters we determined the $(T_{\rm eff}, \log g, M_{\rm bol})$ of the studied stars. For stars where this method could not be applied, we tried to estimate the temperature of the central star by using the Balmer and He I emission lines and/or their visible energy distribution. The colour temperature and the temperatures obtained from the study of Balmer and He I lines are consistent with each other. The new results are compared with those obtained previously by other authors and discussed for each star individually. For some stars, differences between the effective temperatures derived using the BCD classification system and those obtained elsewhere, based on photometric or spectroscopic analysis, imply spectral-type classification disagreements ranging from 2-3 up to 6 B sub-spectral types. The fundamental parameters of AS 119, CD-24°5721, Hen2-91, HD 316375 and

BD-11°4747 were determined for the first time. A simple method was introduced to calculate total (interstellar+circumstellar) dust extinction towards the studied stars. For HD 53179, which is a double stellar system, and for HD 45677 and HD 50138, which are suspected to be binaries, we predicted the characteristics of the components that are consistent with the observed (λ_1, D) parameters. However, the possible binarity of HD 45677 and HD 50138 still needs to be confirmed spectroscopically.

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Properties and nature of Be stars XX. Binary nature and orbital elements of γ Cas

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An analysis of accurate radial velocities (RVs) of the Be star γ Cas from 295 Reticon spectrograms secured between October 1993 and May 2000 allowed us to prewhiten the RVs for the long-term changes and to obtain the first orbital RV curve of this star. The orbital period is 203.59 days and the orbit has an eccentricity of 0.26. The orbital motion is detectable even in the published velocities, based on photographic spectra. This implies that γ Cas is a primary component of a spectroscopic binary. The secondary has a mass of about 1 solar mass, appropriate for a white dwarf or a neutron star, but it could also be a normal late-type dwarf. The ultimate solution of the dispute whether the observed X-ray emission is associated with the secondary or with the primary will need further dedicated studies.

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Submitted Papers

Wind circulation in selected rotating magnetic early-B stars

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The rotating magnetic B stars are a class of variables consisting of He-strong and some β Cep stars which have oblique dipolar magnetic fields. Such stars develop co-rotating, torus-shaped clouds by channeling wind particles from their magnetic poles to circumstellar regions centered around the plane of their magnetic equators. The rotation of the cloud-star complex permits the study of absorptions

from the cloud as it occults the star. In this paper we describe a quantitative analysis of archival *IUE* data to map the properties of these clouds over four stars (HD 184927, σ Ori E, β Cep, and HR 6684). By computing spectral synthesis models for these stars, we find that only β Cep has a solar-like metallicity. Our analysis also shows that the heavy element composition across the surfaces of all these stars is at least approximately homogeneous.

Using the Hubeny code *CIRCUS*, we demonstrate that the periodic variations of broad-band UV continuum fluxes can be explained fully by the absorptions of the co-rotating cloud. We show next that among selected lines, those arising from low-excitation states are selectively affected by cloud absorption and turbulence. Our analysis also quantifies the cloud temperatures and column densities required to match the absorptions of a number of weak to moderate strength resonance lines. These temperatures increase with the ionization potential of the parent ions of these various lines, a result which is consistent with radiative equilibrium models in which temperature increases with decreasing distance to the star's surface. Although these attributes appear stable from one epoch to another, dynamic processes are nonetheless at work. Both the strengths and widths of resonance lines at occultation phases indicate the presence of turbulence in the cloud which increases inwards.

The spectroscopic hallmark of this stellar class is the presence of strong C IV and N V resonance line absorptions at occultation phases and of redshifted emissions of these lines at magnetic pole-on phases. The emissions have characteristics which seem most compatible with their generation by high-energy shocks at the wind-cloud interface, as predicted recently by Babel ([**?**]).

Submitted to Astronomy and Astrophysics

Preprints from `msmith@stsci.edu`
or by anonymous ftp to `nobel.stsci.edu/pub/aapaper`

Theoretical Profile Shapes for Optically Thin X-ray Emission Lines from Spherical Stellar Winds

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One of the major outstanding problems in hot star wind theory is an understanding of the observed X-ray emissions from the early type B, O, and Wolf-Rayet (WR) stars. The latest X-ray satellites *Chandra* and *XMM-Newton* are providing key new observations to advance that understanding. In particular, *Chandra*'s high spectral resolution will yield well resolved X-ray emission lines from stellar winds for the first time. This study presents a derivation of the expected emission line profiles, assuming optically thin line emission, and spherical symmetry, with a proper treatment of the attenuation of X-rays by the dense cool wind component. Examples of line profile variability for a narrow outflowing shell is presented. It is also shown that for the special case of constant expansion, the emission profile shapes can be derived analytically, and in the limit of strong wind attenuation, the profile achieves a homologous form.

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In Proceedings

Are peculiar Wolf-Rayet Stars of type WN8 Thorne-Żytkow Objects?

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Most population I Wolf-Rayet (WR) stars are the He-rich descendants of the most massive stars ($M_i = 25 - 100 M_\odot$). Evidence has been accumulating over the years that among all pop I WR stars, those of the relatively cool, N-rich subtype "WN8" are among the most peculiar:
1. They tend to be runaways, with large space velocity and/or avoid clusters. 2. Unlike their equally luminous WN6,7 cousins, only a very small number of WN8 stars are known to belong to a close binary with an OB companion. 3. They are the systematically most highly stochastically variable among all (single) WR stars.
Taken together, these suggest that many WN8 stars may originally have been in close binaries (like half of all stars), in which the original primary exploded as a supernova, leaving behind a very close binary containing a massive star with a neutron star/black hole companion (like Cyg X-3). When the massive remaining star evolved in turn, it engulfed and eventually swallowed the compact companion, leading to the presently puffed-up, variable WN8 star. Such stars could fall in the realm of the exotic Thorne-Żytkow objects.

To appear in: "Stellar Collisions, Mergers, and their Consequences", ed. Michael M. Shara, ASP Conf. Series.
Preprints from `foellmi@astro.umontreal.ca`
or by anonymous ftp to `ftp://ftp.astro.umontreal.ca/outgoing/foellmi/TZOproc.ps.gz`

Theoretical predictions for the cold part of the colliding wind interaction zone

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We present 2D and 3D hydrodynamical simulations of the colliding wind interaction zone in WR+O binaries. It is shown that 3D effects can basically explain certain observed, orbit dependent flux variations. Possible connections between the interior structure of the interaction zone and dust formation are outlined and its stability is re-investigated.

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Preprints from `walder@astro.phys.ethz.ch`
or by anonymous ftp to `helene.ethz.ch; cd pub/folini; get canada00.ps.gz`
or on the web at `http://www.astro.phys.ethz/staff/folini/`

Selective Emission Lines in O-Type Spectra

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A review of selective emission lines in O-type optical spectra is presented. These lines appear in emission while others from the same ions remain in absorption, and they correlate with the physical parameters of the atmospheres. Several have been known for many years, but only two have been explained in detail, by means of analyses of special processes populating or depopulating the relevant energy levels. A number of new examples have recently been discovered in high-quality digital data. Some possible patterns in the levels involved are pointed out. Explanations of these phenomena will improve understanding of both atomic transitions and hot stellar atmospheres. Moreover, it may well be that other lines remaining in absorption have their intensities altered from standard equilibrium values by similar processes, which could contribute to current uncertainties and discrepancies in quantitative analyses of hot atmospheres, especially those of supergiants.

To appear in the proceedings of *Eta Carinae and Other Mysterious Stars–The Hidden Opportunities of Emission Line Spectroscopy*, ed. T. Gull, S. Johansson, & K. Davidson, ASP Conf. Ser., 2001

Preprints from `walborn@stsci.edu`

Stellar winds of massive stars

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We review the various techniques through which wind properties of massive stars – O stars, AB supergiants, Luminous Blue Variables (LBVs), Wolf-Rayet (WR) stars and cool supergiants – are derived. The wind momentum-luminosity relation (e.g. Kudritzki et al. 1999) provides a method of predicting mass-loss rates of O stars and blue supergiants which is superior to previous parameterizations. Assuming the theoretical $Z^{0.5}$ metallicity dependence, Magellanic Cloud O star mass-loss rates are typically matched to within a factor of two for various calibrations. Stellar winds from LBVs are typically denser and slower than equivalent B supergiants, with exceptional mass-loss rates during giant eruptions $\dot{M} = 10^{-3} \ldots 10^{-1} M_{\odot}$ yr^{-1} (Drissen et al. 2001). Recent mass-loss rates for Galactic WR stars indicate a downward revision of 2–4 relative to previous calibrations due to clumping (e.g. Schmutz 1997), although evidence for a metallicity dependence remains inconclusive (Crowther 2000). Mass-loss properties of luminous ($\geq 10^5 L_{\odot}$) yellow and red supergiants from alternative techniques remain highly contradictory. Recent Galactic and LMC results for RSG reveal a large scatter such that typical mass-loss rates lie in the range $10^{-6} \ldots 10^{-4} M_{\odot}$ yr^{-1}, with a few cases exhibiting $\sim 10^{-3} M_{\odot}$ yr^{-1}.

To appear in: The influence of binaries on stellar population studies', Brussels, Aug 2000 (D. Vanbeveren ed.), Kluwer

Preprints from `pac@star.ucl.ac.uk`

or on the web at `http://xxx.lanl.gov/abs/astro-ph/0010581`

Theoretical considerations on colliding clumped winds

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First attempts are made to derive astrophysical implications of the collision of clumped stellar winds from order of magnitude estimates and preliminary numerical simulations. Compared to colliding smooth winds, we find that the most significant differences occur in widely separated systems like WR 140. Clumped winds de-stabilize the wind-wind interaction zone of such systems. Highly compressed, cold knots of WR-wind material can form. Hydrogen rich material is likely to be mixed into these knots by the excited turbulence. Such knots, therefore, are good candidates to form dust. We briefly discuss to what degree our results can be applied to other systems and look at different possibilities for the origin and nature of the inhomogeneities in hot star winds.

To appear in the proceedings of the workshop on Interacting Winds from Massive Stars
Preprints from `walder@astro.phys.ethz.ch`
or by anonymous ftp to `helene.ethz.ch; cd pub/walder; get coll_clumped_winds.ps.gz`
or on the web at `http://www.astro.phys.ethz.ch/staff/walder/`

Systematic Search for Wolf-Rayet Binaries in the Magellanic Clouds: Preliminary Results

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The Magellanic Clouds represent the best laboratories to study the metallicity effect on the late evolution of massive stars. The low ambient metallicity is expected to lower the mass-loss rate by stellar winds. Therefore, it increases the minimum mass to form Wolf-Rayet (WR) stars. Binarity is then expected to be responsible of the formation of a large fraction of WR stars in the Magellanic Clouds. We present here the rationale behind a systematic search for radial velocity variations in a subsample of WR stars both in the Small Magellanic Cloud (SMC) and the Large Magellanic Cloud (LMC). Some very preliminary results of this study are also presented and discussed. This project is the first to gather repeated spectroscopic data spread over several contiguous weeks (for 3 different epochs spread over 2 years) on a complete sub-population of WR stars (namely WNE stars) in the MC in order to detect short-period binaries (i.e., $P < 200d$, those that should show evidence of an evolutionary interaction between the two stars) as well as medium- to moderately long-period binaries (up to 2 years).

To appear in: "The Influence of Binaries on Stellar Population Studies", Brussels, Aug. 2000 (D. Vanbeveren ed.), Kluwer Academic Pub.
Preprints from `foellmi@astro.umontreal.ca`
or by anonymous ftp to `ftp://ftp.astro.umontreal.ca/outgoing/foellmi/WRbinClouds.ps.gz`

Jobs

Johns Hopkins University: Postdoctoral Position Available

A Postdoctoral Research position is available to work with Dr. Luciana Bianchi at the Center for Astrophysical Sciences , The Johns Hopkins University, Baltimore, MD, USA. The position will involve modeling spectra of hot massive stars in Local Group galaxies. Significant experience in modeling of photospheric plus wind spectra is required. Experience in observing/reducing spectroscopic data is a desirable plus. The program includes analysis of HST-STIS (UV to visual) spectra, ground-based and FUSE far-UV spectra of early type stars (and CSPN) in the Local Group. The candidate should have a PhD in Astronomy or closely-related degree.

The position is available immediately (1 year, renewable) and will be filled as soon as a suitable candidate is found. Interested candidates should send CV, publications list (preprints if relevant), and arrange to have three letters of reference sent to:
Dr. Luciana Bianchi
The Johns Hopkins University
239 Bloomberg Center for Physics and Astronomy
3400 N. Charles St.
Baltimore, MD 21218-2695, USA
fax: (1)-410-516-8260, email: bianchi@pha.jhu.edu

JHU encourages applications from women and minority candidates. AAE/EOE

Meetings

The Earliest Phases of Massive Star Birth

Massive star birth is one of the least understood and most exciting new areas of stellar astrophysics. Our workshop will bring together active scientists and students who study the properties of young massive stars from the giant molecular cloud stage, through to the commencement of their main sequence phase, when they are still obscured by their natal cloud at optical wavelengths. The forthcoming workshop provides a follow-up, albeit to the successful 'Massive Star Birth' Joint Discussion that was held at the IAU General Assembly in Manchester, August 2000. It is expected that an IAU Symposium on this topic will be proposed in the near future, to be held in approx 2004.

A tentative outline of the workshop, together with registration details, is available at the following website:

http://jilawww.colorado.edu/StarBirth

Speakers confirmed as of 29 Nov 00, include, Ed Churchwell, Neal Evans, Stan Kurtz, Melvin Hoare, Nolan Walborn, Harold Yorke, Andre Maeder, Ian Bonnell, John Bally, Chris McKee, Bob Blum, Jean Turner & Paul Ho. Since the capacity of the venue for the meeting, NCAR, is strictly limited,

early registration is highly recommended. Given that we are not seeking outside sponsorship, and a registration fee will have to carry the expenses, we will not be able to offer travel or any other expenses. The registration fee is likely to be US $150-200, including lunch, conference dinner and a copy of the proceedings. We can, however, promise an invigorating and interactive meeting and a comfortable environment for this conference.

SOC Ed Churchwell, Peter Conti (co-Chair), Paul Crowther (co-Chair), Bo Reipurth

LOC Kelsey Johnson (Chair), Remy Indebetouw, Joel Parker

For further information or registration, please contact `StarBirth@jila.colorado.edu`

News

New database and Web server for stellar models and synthetic photometry

This is to announce the availability of two new tools/databases for studies of individual stars and resolved stellar populations.

1) The "Stellar" database of Geneva stellar evolution tracks and isochrones for UBVRIJHKLL'M, HST-WFPC2, Geneva and Washington photometric systems.

Complete sets of stellar tracks and isochrones for metallicities from Z=0.0004 (1/50 Zsun) to Z=0.1 (5 Zsun) converted to the above photometric systems using the latest version of the "BaSeL" library of empirically corrected synthetic stellar spectra compiled by Lejeune, Cuisinier & Buser (1997, 1998).

The database is described in Lejeune & Schaerer (2000, A&A, in press; astro-ph/0011497) and is available on-line at http://webast.ast.obs-mip.fr/stellar/ and at the CDS.

The Web page also includes links to related stellar evolution and atmosphere models, evolutionary synthesis models (including a European mirror of Starburst99) etc.

2) An interactive Web-server for the conversion of stellar properties into various photometric systems using the latest update of the BaSeL spectral library.

The server, developed at the Astronomical Observatory of Coimbra, Portugal, is available at http://tangerine.astro.mat.uc.pt/BaSeL/.

In the near future, this server also aims to provide various data related with stellar astrophysics, such as grids of synthetic spectra, color tables, empirical photometric calibrations, stellar evolution models, etc.

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