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

News

Proceedings of the Boulder-Munich II workshop

Ian Howarth communicates that papers submitted as contributions to the Proceedings of the Boulder-Munich II workshop on 'Properties of Hot, Luminous Stars', held in Windsor Great Park, England, in 1997 July 21–24, are available for inspection at:

`http://www.star.ucl.ac.uk/∼idh/HSG/BMW/ASPC131.html`

The table of contents of the Proceedings is reproduced at the end of this newsletter.

Eta Carinae Campaign

Augusto Damineli communicates that spectroscopic data collected in July/97 (LNA) show a fading by a factor of three in the high excitation line strengths since its maximum in 1995. Zulema Abraham (IAGUSP/Brazil) and Augusto Damineli (Univ. of Colorado and IAGUSP) reported a similar fading at 7 mm in the flux density measured in October 11th at the Itapetinga radiotelescope (to appear in IAUC). The event is approaching on schedule, as predicted by the 5.52 years period. The central phase of the 1998.0 event is expected to last from December 10 through January 20. However, significant variations in the high excitation lines ([NeIII]3868; [FeIII]4701; [NII]5754; [SIII]6312, [ArIII]7135 and HeI 5876, 6678, 7065, 10830) will occur until May 1998, when η Car regains its "normal" spectrum.

In order to provide rapid information, a Homepage at:

`http://casa.colorado.edu/~damineli/EtaCarinae.html`

(mirrored at `http://www.iagusp.usp.br/~damineli/EtaCarinae.html`)

is open to receive notices on recent observations and meetings related to η Carinae.

Accepted Papers

Long-term visual monitoring of southern luminous variables and a comparison with photoelectric photometry

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We present 9700 visual-magnitude estimates of key objects among southern massive stars, viz. the LBVs/hypergiants HD 6884 (R 40), η Car, AG Car, HDE 326823, HDE 269006 (R 71), HD 33579, HDE 269128 and WR stars HD 5980 and WR 40. The visual estimates are complemented with photoelectric light curves obtained over the last two decades in the framework of the Long-Term Photometry of Variables project. Several of our data sets have been searched for periodicities, and this aspect of the data is commented in graphical form (by means of amplitude spectra) and, where necessary, with additional notes. The visual and photoelectric data demonstrate that the sytematic monitoring of luminous massive stars is scientifically very rewarding.

Accepted by The Journal of Astronomical Data (g.kiers@twinpress.nl)
Preprints from `csterken@vub.ac.be`

Photometric variability of the SMC W-R binary HD 5980

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We present the results of a photometric monitoring campaign of the W-R binary HD 5980 conducted in November–December 1995, 16 months after the LBV-like outburst of one of the components of the system. On the basis of almost 800 y-band measurements, an improved orbital ephemeris is derived. We also report the discovery of a coherent 6 h periodic oscillation visible in the Strömgren b and y bands with amplitudes $\sim 0\overset{\mathrm{m}}{.}025$. This short period may be related to pulsations of the primary or secondary component.

Accepted by A&A
Preprints from `csterken@vub.ac.be`

Spectrophotometric data of the central star of the planetary nebula LMC N66. Quantitative analysis of its WN type spectrum

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HST, *IUE* and ground-based observations of the central star of the LMC planetary nebula N66 (CS N66), obtained in different epochs, are presented. Since 1990 CS N66 has shown remarkable short- and long-term spectroscopic and photometric changes amounting to more than 3 magnitudes in the optical. Expanding model atmospheres have been constructed to fit observations from different epochs. Fits provide the chemical composition, the fundamental stellar parameters, L_*, T_*, R_*, the mass-loss rate and the wind velocity. From our best models we found that CS N66 is a very luminous He star ($X/Y \leq 0.1$), with a small amount of N, undergoing a violent and unstable mass loss event. The photospheric chemical abundances correspond to the equilibrium CNO nuclear burning values, while the nebula has a normal chemical composition. Models fitting data from different epochs show that the fundamental stellar parameters remain constant with time, with values $\log L_*/L_\odot = 4.53 \pm 0.10$, $T_* = 93\,300$ K, and $R_* = 0.71\ R_\odot$. The short- and long-term stellar variations are produced by large changes in the mass-loss rate, which varies by large factors, from $\dot{M} \leq 8 \times 10^{-7}\, M_\odot$ yr^{-1} in 1983 (pre-outburst epoch) to $\dot{M} = 2.5 \times 10^{-5} M_\odot$ yr^{-1} in early 1995 (maximum stellar brightness). No evidence to support the suggestion that the outburst was due to a late thermal pulse was found. We propose that the event taking place in CS N66 was produced by an atmospheric instability similar to those triggering the giant eruptions of Population I LBV stars. The possible mechanism causing the atmospheric instability is briefly discussed.

To appear in The Astrophysical Journal, 1997 Dec. 10

Preprints from `miriam@astroscu.unam.mx`

A Search for X-ray Evidence of a Compact Companion to the Unusual Wolf-Rayet Star HD50896 (= EZ CMa)

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We analyze results of a ≈25 ksec *ASCA* X-ray observation of the unusual Wolf-Rayet star HD50896 (= EZ CMa). This WN5 star shows optical and ultraviolet variability at a 3.766 day period, which has been interpreted as a possible signature of a compact companion. Our objective was to search for evidence of hard X-rays (≥5 keV) which could be present if the WN5 wind is accreting onto a compact object.

The *ASCA* spectra are dominated by emission below 5 keV and show no significant emission in the harder 5 - 10 keV range. Weak emission lines are present, and the X-rays arise in an optically thin

plasma which spans a range of temperatures from $\leq$0.4 keV up to at least $\approx$2 keV. Excess X-ray absorption above the interstellar value is present, but the column density is no larger than $N_H \sim 10^{22}$ cm^{-2}. The absorption-corrected X-ray luminosity L_x (0.5 - 10 keV) = $10^{32.85}$ ergs s^{-1} gives $L_x/L_{bol} \approx 10^{-6}$, a value that is typical of WN stars. No X-ray variability was detected down to a sensitivity-limited time resolution of 512 seconds.

Our main conclusion is that the X-ray properties of HD50896 are inconsistent with the behavior expected for wind accretion onto a neutron star or black hole companion. Alternative models based on wind shocks can explain most aspects of the X-ray behavior, and we argue that the hotter plasma near $\sim$2 keV could be due to the WR wind shocking onto a normal (nondegenerate) companion.

Accepted by New Astronomy
Preprints from `skinner@jila.colorado.edu`

Knots, filaments, and turbulence in radiative shocks

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We study the structure and stability of asymmetric colliding flows for the case where one shock is oscillating due to the radiative cooling overstability and the interaction zone undergoes no global acceleration. 2D high-resolution numerical simulations reveal a new structure formation mechanism in the wake of such shocks which has been suppressed in previous simulations due to a too coarse numerical mesh. Small scale structures – filaments and knots – are inevitably formed in such shocks. Downstream of the knots a turbulent zone establishes where cold and hot gas are mixed, probably leading to efficient X-ray emission. The bulk of the cooled gas forms a layer of irregular shape and temporally and spatially variable size. The gas in its interior is in mildly supersonic turbulent motion, having a large density and velocity dispersion. Some observed peculiarities in the optical and UV-spectra may be partly due to these characteristics. This mechanism may also contribute to the appearance of knots and filaments in PNe (e.g. in the Helix nebula), in WR ring nebulae, in other circumstellar nebulae like symbiotics, and in SNR. It has consequences for the dynamics of the ISM.

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Preprints from `walder@astro.phys.ethz.ch`
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or on the web at `http://www.astro.phys.ethz.ch/papers/walder`
Video animations are available at http://www.astro.phys.ethz.ch/staff/walder

On the mass-loss of PG 1159 stars

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The winds of the four PG 1159 stars NGC 7094, NGC 246, K 1-16 and RX J2117.1+3412 are investigated by means of non-LTE models for spherically expanding atmospheres. Based on the results of recent plane-parallel non-LTE analyses, several individual models with various mass-loss rates are

calculated. Synthetic profiles of the C IV resonance line are compared to high resolution, high quality HST and IUE UV spectra in order to determine mass-loss rates of the stars and terminal velocities of their winds. Complex model atoms of hydrogen, helium, carbon and oxygen are taken into account.

In contrast to previous studies we find from the C IV line at 1550 Å exceedingly high mass-loss rates of $-7.6 \leq \log(\dot{M}/[M_{\odot}\,\mathrm{yr}^{-1}]) \leq -6.9$ which are, in case of K 1-16, only two times smaller than the mass-loss rates of [WC]-PG 1159 stars. From the comparison with theoretical predictions of line strength and terminal wind velocity it is most likely that the theory of radiation driven winds is appropriate for the PG 1159 stars.

The results are discussed in the light of the evolutionary sequence

$$[\mathrm{WCL}] \rightarrow [\mathrm{WCE}] \rightarrow [\mathrm{WC}] - \mathrm{PG\,1159} \rightarrow \mathrm{PG\,1159} \rightarrow \mathrm{WD}$$

which is suggested for hydrogen deficient post-AGB stars. Similarities between the winds of PG 1159 stars and the exceptional strong winds of [WC]-type stars lead to the assumption that the theory of radiation driven winds might also apply for [WCE] stars. Changes of ionization degrees, which might enhance the mass-loss by multi-scattering processes, are found in the atmospheres of [WCE] stars but not in the atmospheres of PG 1159 stars.

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Preprints from `lars@astro.physik.uni-potsdam.de`
or by anonymous ftp to `ftp.astro.physik.uni-potsdam.de`
or on the web at `www.astro.physik.uni-potsdam.de/astro_literatur.html`

On the wind momentum problem of O-type stars in the Galaxy

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We have examined the wind momentum problem of O-type stars in the Galaxy. It is shown that the discrepancy between theoretical and empirical mass loss rates and terminal velocities can be reversed by using recently updated values of force multiplier parameters. With these new values, the momentum problem found by former investigators is reversed so that there now appears to be more than enough radiation force in order to accelerate the stellar winds of a sample of Galactic O-type stars.

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Preprints from `gil@iac.es`

Quantitative spectroscopy of Wolf-Rayet stars in HD 97950 and R136a - the cores of giant H II regions

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We present quantitative analyses of Wolf-Rayet stars in the cores of two giant H II regions - HD 97950 in NGC 3603 and R136a in 30 Doradus - based on archive HST spectroscopy. We confirm previous WN6h+abs classifications for components A1, B and C in HD 97950, while classifications for R136a1-3 are revised from O3 If/WN6 to WN5h. From detailed non-LTE analyses, we find all stars exhibit

products of CNO-processed material at their surface since they are rich in both helium (H/He∼3-6) and nitrogen (N/He∼0.002-0.006). Their luminosities, $\log(L/L_{\odot})$=6.0-6.3, are amongst the highest known for Wolf-Rayet stars. Consequently they are very massive stars ($M_{\rm init} \geq 100 M_{\odot}$) at a relatively young age (∼2 Myr), reminiscent of the WNL stars in the Carina Nebula.

We obtain a revised distance modulus of 15.03 mag (=10.1 kpc) to NGC 3603 based on available photometry, an updated $M_{\rm V}$-calibration for early O stars and a reddening of $E_{\rm B-V} \approx 1.23$ mag. ¿From a census of the massive stellar content of the two central clusters, we evaluate the contribution made by Wolf-Rayet stars to the total Lyman continuum ionizing flux and kinetic energy released into the ISM. We discuss how simple calibrations can be used to estimate stellar luminosities, ionizing fluxes and mass-loss rates of luminous OB stars. Wolf-Rayet stars provide ∼20 per cent of the total ionizing flux (∼1.3×10^{51} Ly photon s^{-1}) of their cores ($r \leq 0.5$ pc) and ∼60 per cent of the total kinetic energy injected into the ISM (5-6$\times10^{38}$ erg s^{-1}), despite representing only 10 per cent of the massive stellar population. For the larger R136 cluster in 30 Doradus ($r \leq 10$ pc), 119 massive stars provide a total ionizing flux of 4×10^{51} Ly photon s^{-1} and release a total kinetic energy of 1.6×10^{39} erg s^{-1} into the ISM, the latter being dominated by nine WR (42 per cent) and six O3 If/WN (28 per cent) stars.

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Preprints from `pac@star.ucl.ac.uk`
or by anonymous ftp to `ftp.star.ucl.ac.uk, in pub/pac/ngc3603/ngc3603.ps.Z`
or on the web at `http://www.star.ucl.ac.uk/~pac/publications.html`

Quantitative classification of WC and WO stars

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We present a quantitative classification scheme for carbon and oxygen sequence Wolf-Rayet stars. Our scheme uses new high quality optical AAT and INT observations of 20 stars for which we provide narrow-band photometry and estimates of interstellar reddenings. In increasing order of excitation, our spectral classes range from WC11 to WC4 for Wolf-Rayet stars with a dominant carbon line visual spectrum, and subsequently from WO4 to WO1 for those with predominantly oxygen lines. We refine existing WC and WO schemes (Smith et al. 1990; Kingsburgh et al. 1995) to incorporate stars with higher and lower excitation spectral features. Both massive stars and central stars of Planetary Nebulae (CSPNe) can be classified with the unified system. We have found no criterion that cleanly separates spectra of the two types of star, including elemental abundances (C/O or C/He). However, CSPNe show a wider range of line strength and width than massive stars in the same ionization subclass. Systematically lower FWHM(C IV λ5808) are observed in WO-type CSPNe than the massive WO stars.

For WC4-11 stars, our primary diagnostic is the equivalent width or line flux ratio C IV λ5801-12/C III λ5696. We extend the use of this as the principal criterion throughout the WC sequence, with few re-classifications necessary relative to Smith et al. For WO stars, C III is absent and our new criteria, using primarily oxygen lines, take over smoothly. We define subclasses WO4-1, using O VI λ3811-34/O V λ5590 as our primary diagnostic. The continuation in spectral sequence from WC to WO is used to indicate that the sequence is due primarily to excitation effects, rather than significant abundance differences.

Our scheme allows us to confirm that massive stars and CSPNe are differently distributed over the subclasses. Around 3/5 of massive WC stars lie within the range WC5-8, while ≤1/5 of CSPNe

are found within these spectral types. Stars within both the highest (WO1) and lowest excitation (WC10-11) spectral classes are unique to CSPNe. A WC classification for the hot R CrB star V348 Sgr is excluded (previously [WC12]) since both C III λ5696 and C IV λ5808 are absent in its optical spectrum. Additional criteria allow us to distinguish between WC-type, 'weak emission line' CSPNe, and O stars, allowing us to reclassify the central star of IRAS 21282+5050 (previously [WC11]) as an O star.

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or on the web at `http://www.star.ucl.ac.uk/~pac/publications.html`

The IUE: Riding Herd on Fresh B Star Physics

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It is already clear that the IUE mission marked a "golden era" for hot star research. The IUE's broad spectral coverage and ease of scheduling for monitoring of activities over many timescales has made it the single-most important instrument for B/Be/Bp research in our time. Herein we take stock of several kinds of information that the IUE has provided us about the physics of B stars near the main sequence. Our examples include:

(1) the construction of a UV 2D spectral classification system from lines of pairs of ionization stages, (2) the definition of thermal signatures from pulsations and starspots on UV spectrophometry, (3) the enhanced effect of surface activity on the immediate CS environment, including pulsational non-linearities, and of the creation of transitory and/or co-orbiting structures above the surface, (4) the response of SiIV and CIV wind lines to the "Be episode cycle," as defined by Hα emission, (5) the response of the B star atmosphere to X-ray flares and to heating by a neutron star companion, and (6) the discovery of interacting binaries and the evolution of these systems.

The IUE has pointed the way to go for future UV research on active B stars. Such plans will not be easy to implement unless the need for monitoring of stellar activity in the UV is somehow addressed in satellite mission planning.

Review paper to appear in the Proceedings of the Sevilla conference "Ultraviolet Astrophysics - Beyond the IUE Final Archive", ESA SP-413.
Preprints from `MSMITH@stsci.edu`

Critical IUE Coverage of a Rotational Cycle of Gamma Cas

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Simultaneous UV/X-ray observations were obtained with the *HST/GHRS* and *RXTE/PCA* on the prototypical B0.5 star γ Cas over most of a rotation cycle on 1996 March 14–15. Key Project *IUE* observations were carried out over an 34 hr. interval two months earlier and were processed through NEWSIPS. A high-quality UV continuum light curve was extracted from the *HST* data, showing the

presence of two ∼1% light dips separated by about 10 hrs. The X-ray flux curve showed emission maxima at these same times, suggesting that the X-rays are produced in surface structures modulated with P_{rot} ≈1.125 days. Our *IUE* light curve shows similar light-dip features as in the HST curve if the period is adjusted to 1.123 days, thus strengthening the case an origin of the X-rays on the surface instead of from an oft-hypothesized degenerate binary companion. Additionally, the *IUE* light curve contains information not observable in the *HST* data, namely: (1) the flux dips have a strong color dependence toward short wavelengths (suggesting a thermal origin), and (2) the presence of a third dip (implying for a magnetic scenario that a more complex geometry is needed than a simple dipole field). The brief duration of the dips in the *HST* and *IUE* light curves requires that they are not caused by surface spots. In contrast, models with optically-thin, anchored, co-orbiting clouds can fit the light curve well.

Poster paper to appear in the Proceedings of the Sevilla conference "Ultraviolet Astrophysics - Beyond the IUE Final Archive", ESA SP-413.
Preprints from MSMITH@stsci.edu

The Treatment of Non-LTE Line Blanketing in Spherically Expanding Outflows

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Extensive modifications to the non-LTE radiative transfer code of Hillier (1990) have been made in order to improve the spectroscopic analysis of stars with stellar winds. The main improvement to the code is the inclusion of blanketing due to thousands of overlapping lines. To implement this effect we have used the idea of super levels first pioneered by Anderson (1989). In our approach, levels with similar excitation energies and levels are grouped together. Within this group we assume that the departure coefficients are identical. Only the population (or equivalently, departure coefficient) of the super level need be solved in order to fully specify the populations of the levels within a super-level. Our approach is a natural extension of the single level LTE assumption and thus, LTE is recovered *exactly* at depth.

In addition to line blanketing, the code has been improved significantly in other regards. In particular the new code incorporates the effect of level dissolution, the influence of resonances in the photoionization cross-sections and the effect of Auger ionization. Electron scattering with a thermal redistribution can be considered, although it is normally treated coherently in the comoving frame (which still leads to redistribution in the observers frame).

Several example calculations are described to demonstrate the importance of line blanketing on spectroscopic analysis. We find the inclusion of blanketing modifies the strengths of some optical CNO lines in Wolf-Rayet (W-R) stars by factors of two to five. In particular, the strengths of the WC classification lines C III λ5696 and C IV λ5805 are both increased due to iron blanketing. This should help alleviate problems found with non-blanketed models, which were incapable of matching the strengths of these lines. We also find that in the UV (1100 to 1800 Å) the influence of Fe is readily seen in both emission and absorption. The emission is sensitive to the iron abundance and should allow, for the first time, Fe abundances to be deduced in W-R stars.

The improvements made to our code should greatly facilitate the spectroscopic analysis of stars with stellar winds. We will be able to determine the importance and influence of line blanketing, as well

as several other effects that have been included in the new code. It will also allow us to better determine several basic physical parameters of W-R stars such as luminosities, elemental abundances, wind velocities and mass loss rates. With future application to related objects, such as novae and supernovae, our new code should also improve our understanding of these objects with extended outflowing atmospheres.

Accepted by ApJ *For preprints contact* jdh@galah.phyast.pitt.edu
Also available from http://www.pitt.edu/~hillier

ICCD Speckle Observations of Binary Stars. XIX. An Astrometric/Spectroscopic Survey of O Stars

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We present the results of a speckle interferometric survey made with the CHARA speckle camera and 4-m class telescopes of Galactic O-type stars with $V < 8$. We can detect with the speckle camera binaries in the angular separation range $0\farcs035 < \rho < 1\farcs5$ with $\Delta m < 3$, and we have discovered 15 binaries among 227 O-type systems. We combined our results on visual binaries with measurements of wider pairs from the *Washington Double Star Catalog* and fainter pairs from the *Hipparcos Catalogue*, and we made a literature survey of the spectroscopic binaries among the sample. We then investigated the overall binary frequency of the sample and the orbital characteristics of the known binaries. Binaries are common among O stars in clusters and associations ($> 59\%$ have a visual or spectroscopic companion) but less so among field and especially runaway stars. There are many triple systems among the speckle binaries, and we discuss their possible role in the ejection of stars from clusters. The period distribution of the binaries is bimodal in $\log P$ but we suggest that binaries with periods of years and decades may eventually be found to fill the gap. The mass ratio distribution of the visual binaries increases toward lower mass ratios, but low mass ratio companions are rare among close, spectroscopic binaries (probably due to the difficulty of spectroscopic detection rather than a real deficit). We present distributions of the eccentricity and longitude of periastron for spectroscopic binaries with elliptical orbits, and we find strong evidence of a bias in the longitude of periastron distribution (the "Barr effect") which is probably caused by line distortions introduced by circumstellar gas.

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New Models for Wolf-Rayet and O Star Populations in Young Starbursts

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Using the latest stellar evolution models, theoretical stellar spectra, and a compilation of observed emission line strengths from Wolf-Rayet (WR) stars, we construct evolutionary synthesis models for

young starbursts. We explicitly distinguish between the various WR subtypes (WN, WC, WO), whose relative frequency is a strong function of metallicity, and we treat O and Of stars separately.

We calculate the numbers of O and WR stars produced during a starburst and provide detailed predictions of UV and optical emission line strengths for both the WR stellar lines and the major nebular hydrogen and helium emission lines, as a function of several input parameters related to the starburst episode. We also derive the theoretical frequency of WR-rich starbursts.

Our models predict that nebular HeII λ4686 emission from a low-metallicity starburst should be associated with the presence of WC/WO stars and/or hot WN stars evolving to become WC/WO stars. In addition, WR stars contribute to broad components beneath the nebular Balmer lines; the broad WR component may constitute several percent of the total flux in the line.

We review the various techniques used to derive the WR and O star content from integrated spectra, assess their accuracy, and propose two new formulae to estimate the WR/O number ratio from UV or optical spectra.

We also explore the implications of the formation of WR stars through mass transfer in close binary systems in instantaneous bursts. While the formation of WR stars through Roche lobe overflow prolongs the WR dominated phase, there are clear observational signatures which allow the phases in which WR stars are formed predominantly through the single or the binary star channels to be distinguished. In particular at low metallicities, when massive close binaries contribute significantly to the formation of WR stars, the binary-dominated phase is expected to occur at ages corresponding to relatively low Hβ equivalent widths.

The observational features predicted by our models allow a detailed quantitative determination of the massive star population in a starburst region (particularly in so-called "WR galaxies") from its integrated spectrum and provide a means of deriving the burst properties (e.g., duration, age) and the parameters of the initial mass function of young starbursts. The model predictions should provide the most reliable determinations to date. They can also be used to test the current theories of massive star evolution and atmospheres and investigate the variation in stellar properties with metallicity.

Accepted by ApJS
Preprints from `schaerer@stsci.edu`
Paper and model results available on the web at `http://www.stsci.edu/ftp/science/starburst`

In Proceedings

Non-LTE Model Atmospheres with Line Blanketing and Photon Loss

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Photon loss from the He II λ303 transition was found to be an important process for Wolf-Rayet atmospheres. Here, I investigate whether photon loss is also important for O-star atmospheres. By studying the photon-loss effects on a model of an O5.5 supergiant, I find that there is a region around $\tau_{\rm R} \approx 0.1$ where the level populations are sensitive to the photon loss. However, the line profiles of the diagnostic lines do not show any changes, because they are formed in deeper layers than those affected by photon loss.

To appear in Proceedings of the Boulder-Munich Workshop II, ed. I. Howarth, ASP Conference Series
Preprints from schmutz@astro.phys.ethz.ch

Ultraviolet Study of Wolf-Rayet Stars

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Archival IUE spectra of WR stars are used to determine fundamental stellar parameters. Temperatures were derived basing on available contour plots of spectral characteristics for a grid of NLTE models. The revised extinction curve towards WR stars is used for dereddening. We construct the stellar distance scale for the sample of stars attributed to open clusters or associations and adopt it for the other galactic WR stars. The remaining fundamental parameters are then derived and HR diagram for program stars is presented.

To appear in the Proceedings of the Sevilla Conference "Ultraviolet Astrophysics - Beyond the IUE Final Archive", ESA SP-413.
Preprints from kroch@astri.uni.torun.pl

Evolutionary Connections among Massive Stars – an Observer's Perspective

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B[e] supergiants are considered to be the evolutionary descendants of rapidly rotating massive stars. While B[e] supergiants populate a region of the HRD which overlaps with that of other massive stars, such as normal AB supergiants and Luminous Blue Variables (LBVs), it has yet to be established how they fit in with evolutionary scenarios for massive stars. I propose several observational tests.

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Stellar Winds in High-Mass X-Ray Binaries

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High-mass X-ray binaries (HMXBs) provide important observational diagnostics for the study of massive stars, their stellar winds, and the nature of accreting compact X-ray sources. In wind-fed systems, the produced X-ray flux strongly depends on the local wind velocity, making the X-ray source a sensitive probe of the stellar-wind structure. A comparison of the observed and predicted X-ray luminosity suggests that the wind speed at the orbit of the X-ray source is lower than expected

for the usual $\beta = 1$ velocity law. An explanation for this is that the X-ray source is embedded in an extended region of high ionization in which the radiative acceleration of the stellar wind is suppressed. This effect also gives rise to the formation of a strong shock at the trailing border of the ionization zone where the stagnant flow meets the undisturbed stellar wind. Preliminary results based on infrared observations obtained with the ISO satellite are presented.

On a much larger spatial scale, the impact of stellar winds in HMXBs can be observed as well. Scenarios for massive binary evolution predict that HMXBs receive a large kick velocity during the supernova explosion of the compact star's progenitor. One might, therefore, expect to observe wind bow shocks around these systems such as observed around many OB-runaway stars. Such a wind bow shock has recently been discovered around the system Vela X-1.

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EELOs: can we define a galactic B[e] group?

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The class of B[e] stars is a spectroscopically defined group from which members can be identified as LBVs, supergiants, symbiotics, post-AGB, proto-planetary and young stars. Objects that cannot be classified as such are frequently designated to be a special stellar class with an unidentified (evolutionary) status. To investigate if such a new stellar B[e] class holds an homogeneous stellar population we have searched for galactic B[e] stars among several samples of EELOs.

Based on the spectral definition alone, we find 31 B[e] stars and 18 candidates that are unclassified. We argue that most of these objects could be member of the classes mentioned when properly characterized and their astrophysical properties are better determined. We find only a few objects that are well studied and could not be classified. On statistical and evolutionary grounds we argue that these objects will end up in one of the known classes leaving no further arguments to define new classes of B[e] stars. Based on these results, we show and propose a new classification scheme for B[e] stars.

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Search for B[e] stars in young open clusters

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The properties and the stellar content of five young open clusters have been investigated to identify new B[e] stars. After a detailed analysis we conclude that none of the $\sim$ 260 relatively young early

type stars can be identified as such. We propose that either the B[e] characteristic is not present in young stars or that due to the close proximity of other hot stars the circumstellar material can not hold sufficient amounts of material to show this spectroscopic property. After investigating the direct environment of well known galactic B[e] stars we find support for our hypothesis that the B[e] phenomenon is mostly seen in rather isolated sources. As many massive stars are located in clusters it explains the paucity of this spectral characteristic.

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