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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News

Change of Date: IAU Symposium on Stellar Rotation

IAU Symposium on Stellar Rotation will take place from Monday 2002 November 11 to Friday 15, just a few days later than previously announced.

The first announcement and pre-registration form are available on the Web at
`http://www.astro.ugto.mx/∼eenens/iau215/`

P Cygni 2000

Mart de Groot and Christiaan Sterken, Editors

The Proceedings of the International Workshop "P Cygni 2000" will be available within the next couple of weeks. Those who were not able to attend the workshop, but would like to receive a copy of the Proceedings published in the ASP Conference Series as Vol. No. 233, should contact Mart de Groot at mdg@star.arm.ac.uk. Copies of the Proceedings are available at a cost of USD 50.00 which includes postage and packing. A list of abstracts of papers presented at the workshop can be viewed at http://www.arm.ac.uk/∼mdg.

Accepted Papers

Discovery of a double ring in the core of η Carinae

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We report the discovery of a double ring structure in the waist of the nebula surrounding η Carinae. The rings are detected in the mid-IR dust continuum at wavelengths of 7.9, 11.9, 12.9 and 20 μm. The dust in the rings has a temperature of about 300 K. The orientation of the rings is inclined with respect to the axis of the homunculus by either 37 or 58 degrees. The central star is not in the projected centre of the structure defined by the two rings. This geometry is reminiscent of that seen in SN1987A and some planetary nebulae. We discuss several possible origins for this remarkable geometry and its orientation.

Accepted by Astronomy & Astrophysics

For preprints, contact `hony@astro.uva.nl`

Line-Profile Variability in the Wolf-Rayet Stars WR 135 and WR 111

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We have obtained time-resolved observations of line-profile variations of the two Wolf-Rayet stars WR 135 and WR 111. The spectra, taken during two consecutive nights, cover a broad range from 4470 to 6590 Å. The profile variability of the C III emission line at 5696 Å in WR 135 is shown in detail. The principal difficulties to constrain the velocity law from the frequency drift of discrete spectral features is discussed, emphasizing the crucial dependence on the adopted location of the line-emission region, and the possible necessity to distinguish between the motion of structures and the flow of the matter. — Full access to the observational data is provided via anonymous file transfer.

Accepted by Astronomy & Astrophysics

Preprints from `wrh@astro.physik.uni-potsdam.de`
or by anonymous ftp from `ftp.astro.physik.uni-potsdam.de` file: `pub/wrhamann/lpv.ps(.gz)`
or on the web at `www.astro.physik.uni-potsdam.de`

Near Infrared Observations of the Giant HII Region W49A: A Starbirth Cluster

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W49A is one of the most luminous giant H II (GH II) regions in our Galaxy. This star forming complex contains numerous compact and ultra-compact (UC) II regions, extending over an area of ≈ 15 pc. It emits about 10^{51} Lyman continuum photons per second, equivalent to the presence of about 100 O stars, but it is completely obscured in optical wavelengths by intervening interstellar dust. The center holds a "cluster" of about 30 O stars, each within an individual UCHII region emitting free–free emission at cm wavelengths. Our deep $K-$band (2.2 μm) image toward the W49A cluster reveals just two of the individual exciting stars, each associated with a point–like radio source, but the rest are invisible. These O stars are so recently born as to not yet have emerged from their natal dust cocoons, in contrast to other Galactic clusters embedded in GH II regions in which many of the individual massive stars are already revealed. Plausibility arguments are made which suggest that a stellar disc might be common during the entire UCH II phase of massive star birth, as it persists after accretion ceases in some stars. Nebular emission (e.g., from Brγ) is visible around the periphery of the central region of W49A, along with candidate exciting stars. Star formation there may have preceeded that in the center, or its lower density environment may have speeded up the dispersal of the natal dust cocoons. The W49A cluster can serve as a template for the more luminous buried star clusters now being found in normal galaxies and starbursts.

Accepted by The Astrophysical Journal

Preprints from pconti@jila.colorado.edu

or by anonymous ftp to w49xxx.ps *located at* http://www.ctio.noao.edu/ftp/pub/blum/

Confidence levels of evolutionary synthesis models II: On sampling and Poissonian fluctuations

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In terms of statistical fluctuations, stellar population synthesis models are only asymptotically correct in the limit of a large number of stars, where sampling errors become asymptotically small. When dealing with stellar clusters, starbursts, dwarf galaxies or stellar populations within pixels, sampling errors introduce a large dispersion in the predicted integrated properties of these populations. We present here an approximate but generic statistical formalism which allows a very good estimation of the uncertainties and confidence levels in any integrated property, bypassing extensive Monte Carlo simulations, and including the effects of partial correlations between different observables. Tests of the formalism are presented and compared with proper estimates. We derive the minimum mass of stellar populations which is required to reach a given confidence limit for a given integrated property.

As an example of this general formalism, which can be included in any synthesis code, we apply it to the case of young ($t \leq 20$ Myr) starburst populations. We show that, in general, the UV continuum is more reliable than other continuum bands for the comparison of models with observed data. We also show that clusters where more than 10^5 $M_\odot$ have been transformed into stars have a relative dispersion of about 10% in Q(He^+) for ages smaller than 3 Myr. During the WR phase the dispersion increases to about 25% for such massive clusters. We further find that the most reliable observable for the determination of the WR population is the ratio of the luminosity of the WR bump over the Hβ luminosity. A fraction of the observed scatter in the integrated properties of clusters and starbursts can be accounted for by sampling fluctuations.

Accepted by: A&A Main Journal
Preprints from `mcs@laeff.esa.es`
or on the web at `http://www.laeff.esa.es/users/mcs` or `astro-ph/0109435`

Orbits of Four Very Massive Binaries in the R136 Cluster

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We present radial velocity and photometry for four early-type, massive double-lined spectroscopic binaries in the R136 cluster. Three of these systems are eclipsing, allowing orbital inclinations to be determined. One of these systems, R136-38 (O3 V + O6 V), has one of the highest masses ever measured, $57\mathcal{M}_\odot$, for the primary. Comparison of our masses with those derived from standard evolutionary tracks shows excellent agreement. We also identify five other light variables in the R136 cluster which are worthy of follow-up study.

Accepted by the Astrophysical Journal
Preprints from `ftp://ftp.lowell.edu/pub/massey/r136bins.ps.gz`

Submitted Papers

Formation and pre–MS evolution of massive stars with growing accretion

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We briefly describe the three existing scenarios for forming massive stars and emphasize that the arguments often used to reject the accretion scenario for massive stars are misleading. It is usually not accounted for the fact that the turbulent pressure associated to large turbulent velocities in clouds necessarily imply relatively high accretion rates for massive stars.

We show the basic difference between the formation of low and high mass stars based on the values of the free fall time and of the Kelvin-Helmoltz timescale, and define the concept of birthline for massive stars.

Due to D-burning, the radius and location of the birthline in the HR diagram, as well as the lifetimes are very sensitive to the accretion rate $\dot{M}_{\rm accr}$. If a form $\dot{M}_{\rm accr} \propto A\,(M/M_{\rm O})^{\varphi}$ is adopted, the observations

in the HR diagram and the lifetimes support a value of $A \approx 10^{-5}\, M_{\rm O} \cdot {\rm yr}^{-1}$ and a value of $\varphi \geq 1$. Remarkably, such a law is consistent with the relation found by Churchwell (1998) and Henning et al. (2000) between the outflow rates and the luminosities of ultra–compact HII regions, if we assume that a fraction 0.15 to 0.3 of the global inflow is accreted. The above relation implies high $\dot{M}_{\rm accr} \approx 10^{-3}\, M_{\rm O} \cdot {\rm yr}^{-1}$ for the most massive stars. The physical possibility of such high $\dot{M}_{\rm accr}$ is supported by current numerical models.

Finally, we give simple analytical arguments in favour of the growth of $\dot{M}_{\rm accr}$ with the already accreted mass. We also suggest that due to Bondi-Hoyle accretion, the formation of binary stars is largely favoured among massive stars in the accretion scenario.

Submitted to PASP
Preprints from `http://arXiv.org/abs/astro-ph/0109503`

In Proceedings

Singles, Binaries and X-rays from Hot Stars

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We put forward the hypothesis that the recently reported high-resolution X-ray observations of the nearby O type stars ζ Ori A and θ^1 Ori C can be explained by wind interactions in binary systems. The spectra show features, such as symmetrical emission lines and high temperatures, typical of well-known massive binary systems and companions have recently been discovered to both objects. Given the high binary fraction among O stars, it is probable that such large-scale extrinsic macro-shocks account for the bulk of the X-ray produced in many hot stars instead of the instability-driven intrinsic micro-shocks formed in the wind acceleration region seen, for example, in weaker single runaway stars.

Submitted to Proceedings of Coronae2001, PASP Conference Series
Preprints from `andy@westwood.demon.co.uk`

Recent Progress in Understanding the X-ray Sources in Hot Star Winds

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High-resolution X-ray observations of hot stars are rapidly contributing to our understanding of the hot plasma component of their winds. The new generation of X-ray satellites has sufficient resolution to study the velocity structure of isolated X-ray lines and to distinguish the forbidden, intercombination, and resonance (fir) emission lines of He-like ions. For hot stars the f/i ratio is controlled by the UV radiation mean intensity, rather than the electron density as is the case for cool stars. This f/i ratio thus provides information about how far the X-ray sources are from the photosphere. The X-rays are found to escape from the radius where the continuum optical depth is about unity. The fir lines show that the X-rays originate at a wide range of radii, presumably in shock fragments embedded in the

winds. There are some interesting anomalies, however. The He-like ions with the hardest lines, Si XIII (for ζ Ori) and S XV (for ζ Pup), form so close to the star's surface that the wind should not have a speed sufficient to produce the shocks needed for those high ion stages. Magnetic confinement of hot gas at the base of the wind is a possible solution to this problem because it is now realized from work by MacGregor and Cassinelli that magnetic fields can rise to the surface from the dynamo region at the convective core/radiative envelope interface in hot stars.

To Appear in: Stellar Coronae in the Chandra and XMM-Newton Era, ASP Conference Series, F. Favata & J. Drake, eds.
Preprints from nmiller@astro.wisc.edu *or on the web at* www.astro.wisc.edu/∼nmiller

Are All Young Stars Disc Accretors?

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We now understand how low mass stars evolve through cloud collapse and disc accretion, but whether higher mass stars are also disc accretors is as yet unknown. Spectropolarimetry observations can help in answering this basic question, as they probe the first few stellar radii around young stars.

Submitted to "The Earliest Phases of Massive Star Birth"
Preprints from jvink@ic.ac.uk *or on the web at* astro-ph/0110138

The Link between Radiation-Driven Winds and Pulsation in Massive Stars

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Hot, luminous, massive stars have strong stellar winds driven by line-scattering of the star's continuum radiation. They are also often observed to exhibit radial or non-radial pulsations. Such pulsations are possible candidates for providing the base perturbations that induce large-scale structure in the overlying wind, and as such they could help explain various observational manifestions of wind variability, e.g. absorption enhancemens or modulations in UV P-Cygni lines of OB stars, and perhaps even moving bumps in optical emission lines of Wolf-Rayet (WR) stars. Here we review the physics of line driving with emphasis on how perturbations induce variations in a wind outflow. In particular, we present results of a time-dependent dynamical simulation of wind variations induced by the radial pulsation of the beta Cehpeid variable BW Vulpeculae, and show that obervation variability in UV wind lines can be quite well reproduced by synthetic line profiles for this model. We conclude with a discussion of recent evidence that resonances among multiple modes of non-radial pulsation on Be stars play a role in inducing mass ejections that contribute to formation of a circumstellar disk.

Submitted to "Radial and Nonradial Pulsations as Probes of Stellar Physics", proceedings of IAU Colloquium #185
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