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Abstracts of 20 accepted papers

Non-standard s process in low metallicity massive rotating stars

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Context. Rotation is known to have a strong impact on the nucleosynthesis of light elements in massive stars, mainly by inducing mixing in radiative zones. In particular, rotation boosts the primary nitrogen production, and models of rotating stars are able to reproduce the nitrogen observed in low-metallicity halo stars.

Aims. Here we present the first grid of stellar models for rotating massive stars at low metallicity, where a full s-process network is used to study the impact of rotation-induced mixing on the neutron capture nucleosynthesis of heavy elements.

Methods. We used the Geneva stellar evolution code that includes an enlarged reaction network with nuclear species up to bismuth to calculate 25 solar mass models at three different metallicities (Z = 1e-3, 1e-5, and 1e-7) and with different initial rotation rates.

Results. First, we confirm that rotation-induced mixing (shear) between the convective H-shell and He-core leads to a large production of primary ^{22}Ne (0.1 to 1% in mass fraction), which is the main neutron source for the s process in massive stars. Therefore rotation boosts the s process in massive stars at all metallicities. Second, the neutron-to-seed ratio increases with decreasing Z in models including rotation, which leads to the complete consumption of all iron seeds at metallicities below Z = 1e-3 by the end of core He-burning. Thus at low Z, the iron seeds are the main limitation for this boosted s process. Third, as the metallicity decreases, the production of elements up to the Ba peak increases at the expense of the elements of the Sr peak. We studied the impact of the initial rotation rate and of the highly uncertain ^{17}O$(alpha,gamma)$ rate (which strongly affects the strength of ^{16}O as a neutron poison) on our results. This study shows that rotating models can produce significant amounts of elements up to Ba over a wide range of Z, which has important consequences for our understanding of the formation of these elements in low-metallicity environments like the halo of our galaxy and globular clusters. Fourth, compared to the He-core, the primary ^{22}Ne production induced by rotation in the He-shell is even higher (greater than 1% in mass fraction at all metallicities), which could open the door for an explosive neutron capture nucleosynthesis in the He-shell, with a primary neutron source.

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A Lighthouse Effect in Eta Carinae

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We present a new model for the behavior of scattered time-dependent, asymmetric near-UV emission from the nearby ejecta of Eta Car. Using a 3-D hydrodynamical simulation of Eta Car's binary colliding winds, we show that the 3-D binary orientation derived by Madura et al. (2012) is capable of explaining the asymmetric near-UV variability observed in the Hubble Space Telescope Advanced Camera for Surveys/High Resolution Camera (HST ACS/HRC) F220W images of Smith et al. (2004b). Models assuming a binary orientation with i ~ 130 to 145 degrees, {omega} ~ 230 to 315 degrees, PAz ~ 302 to 327 degrees are consistent with the observed F220W near-UV images. We find that the hot binary companion does not significantly contribute to the near-UV excess observed in the F220W images. Rather, we suggest that a bore-hole effect and the reduction of Fe II optical depths inside the wind-wind collision cavity carved in the extended photosphere of the primary star lead to the time-dependent directional illumination of circum-binary material as the companion moves about in its highly elliptical orbit.

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Strongly star forming galaxies in the local universe with nebular He II 4686 emission

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We present a sample of 2865 emission line galaxies with strong nebular He II 4686 emissions in Sloan Digital Sky Survey Data Release 7 and use this sample to investigate the origin of this line in star-forming galaxies. We show that star-forming galaxies and galaxies dominated by an active galactic nucleus form clearly separated branches in the He II 4686/H{beta} versus [N II] 6584/H{alpha} diagnostic diagram and derive an empirical classification scheme which separates the two classes. We also present an analysis of the physical properties of 189 star forming galaxies with strong He II 4686 emissions. These star-forming galaxies provide constraints on the hard ionizing continuum of massive stars. To make a quantitative comparison with observation we use photoionization models and examine how different stellar population models affect the predicted He II 4686 emission. We confirm previous findings that the models can predict He II 4686 emission only for instantaneous bursts of 20% solar metallicity or higher, and only for ages of ~ 4 - 5 Myr, the period when the extreme-ultraviolet continuum is dominated by emission from Wolf-Rayet stars. We find however that 83 of the star-forming galaxies (40%) in our sample do not have Wolf-Rayet features in their spectra despite showing strong nebular He II 4686 emission. We discuss possible reasons for this and possible mechanisms for the He II 4686 emission in these galaxies.

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Asteroseismology of the Nearby SN-II Progenitor: Rigel Part I. The MOST High Precision Photometry and Radial Velocity Monitoring

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Rigel (beta Ori, B8 Ia) is a nearby blue supergiant displaying alpha Cyg type variability, and is one of the nearest type-II supernova progenitors. As such it is an excellent test bed to study the internal structure of pre core-collapse stars. In this study, for the first time, we present 28 days of high precision MOST photometry and over 6 years of spectroscopic monitoring. We report nineteen significant pulsation modes of SNR>4.6 from radial velocities, with variability time scales ranging from 1.21 to 74.7 days, which are associated with high order low degree gravity modes. While the radial velocity variations show a degree of correlation with the flux changes, there is no clear interplay between the equivalent widths of different metallic and Halpha lines.

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Photometric and Spectroscopic Studies of Massive Binaries in the Large Magellanic Cloud. I. Introduction and Orbits for Two Detached Systems: Evidence for a Mass Discrepancy?

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The stellar mass-luminosity relation is poorly constrained by observations for high mass stars. We describe our program to find eclipsing massive binaries in the Magellanic Clouds using photometry of regions rich in massive stars, and our spectroscopic follow-up to obtain radial velocities and orbits. Our photometric campaign identified 48 early-type periodic variables, of which only 15 (31%) were found as part of the microlensing surveys. Spectroscopy is now complete for 17 of these systems, and in this paper we present analysis of the first two, LMC 172231 and ST2-28, simple detached systems of late-type O dwarfs of relatively modest masses. Our orbit analysis yields very precise masses (about 2%), and we use tomography to separate the components and determine effective temperatures by model fitting, necessary for determining accurate (0.05 0.07 dex) bolometric luminosities in combination with the light-curve analysis. Our approach allows more precise comparisons with evolutionary theory than previously possible. To our considerable surprise, we find a small, but significant, systematic discrepancy: all of the stars are slightly under-massive, by typically 11% (or over luminous by 0.2 dex) compared to that predicted by the evolutionary models. We examine our approach for systematic problems, but find no satisfactory explanation. The discrepancy is in the same sense as the long-discussed and elusive discrepancy between the masses measured from stellar atmosphere analysis with the stellar evolutionary models, and might suggest that either increased rotation or convective overshooting is needed in the models. Additional systems will be discussed in future papers of this series, and will hopefully confirm or refute this trend.

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Global modelling of X-ray spectra produced in O-type star winds

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High-resolution X-ray spectra of O-type stars revealed less wind absorption than expected from smooth winds with conventional mass-loss rates. Various solutions have been proposed, including porous winds, optically thick clumps or an overall reduction of the mass-loss rates. The latter has a strong impact on the evolution of the star. Our final goal is to analyse high resolution X-ray spectra of O-type stars with a multi temperature plasma model in order to determine crucial stellar and wind parameters such as the mass loss rate, the CNO abundances and the X-ray temperature plasma distribution in the wind. In this context we are developing a modelling tool to calculate synthetic X-ray spectra. We present, here, the main ingredients and physics necessary for a such work. Our code uses the most recent version of the AtomDB emissivities to compute the intrinsic emissivity of the hot plasma as well as the CMFGEN model atmosphere code to evaluate the opacity of the cool wind. Following the comparison between two formalisms of stellar wind fragmentation, we introduce, for the first time in X-rays, the effects of a tenuous inter-clump medium. We then explore the quantitative impact of different model parameters on the X-ray spectra such as the position in the wind of the X-ray emitting plasma. For the first time, we also show that the two formalisms of stellar wind fragmentation yield different results, although the differences for individual lines are small and can probably not be tested with the current generation of X-ray telescopes.
As an illustration of our method, we compare various synthetic line profiles to the observed O VIII λ 18.97 Å line in the spectrum of ζ Puppis. We illustrate how different combinations of parameters can actually lead to the same morphology of a single line, underlining the need to analyse the whole spectrum in a consistent way when attempting to constrain the parameters of the wind.

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On the Eddington limit and WR Stars

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We examine some properties of stars evolving close to the classical Eddington limit for electron-scattering opacity, when these stars maintain a chemically homogeneous structure as a result of mixing and/or mass loss.

We consider analytical relations and models computed with the Geneva code.

Homologous, chemically homogeneous stars evolving with a constant Eddington factor obey a relation of the form mu^2 M = const. This applies, for example, to Wolf-Rayet (WR) stars in stages without hydrogen. The value of the constant may depend on the metallicity, initial mass, evolutionary stage, and physical processes included in the considered homologous evolutionary sequence. An average value of the constant between 20 and 40 in solar units is consistent with the masses of Galactic WR stars.

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The Galactic WC stars: Stellar parameters from spectral analyses indicate a new evolutionary sequence

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CONTEXT: The life cycles of massive stars from the main sequence to their explosion as supernova or gamma ray burst are not yet fully clear, and the empirical results from spectral analyses are partly in conflict with current evolutionary models. The spectral analysis of Wolf-Rayet stars requires the detailed modeling of expanding stellar atmospheres in non-LTE. The Galactic WN stars have been comprehensively analyzed with such models in their latest stage of sophistication, while a similarly comprehensive study of the Galactic WC sample is still missing.
AIMS: The stellar parameters and mass-loss rates of the GalacticWC stars shall be established. These data shall provide the empirical basis for studies of (i) the role of WC stars in the evolution of massive stars, (ii) the wind-driving mechanisms, and (iii) the feedback of WC stars as input for the chemical and dynamical evolution of galaxies.
METHODS: We analyze the nearly complete sample of un-obscured Galactic WC stars, using optical spectra as well as UV spectra if available. The observations are fitted with theoretical spectra, using the Potsdam Wolf-Rayet (PoWR) model atmosphere code. A large grid of line-blanked models has been established for the range of WC subtypes WC4 - WC8, and smaller grids for the WC9 parameter domain. WO stars and WN/WC transit types are covered as well using special models.
RESULTS: Stellar and atmospheric parameters have been derived for more than 50 Galactic WC and two WO stars, covering almost the whole Galactic WC population as far as the stars are single, and un-obscured in the visual. In the Hertzsprung-Russell diagram, the WC stars reside between the hydrogen and the helium zero-age main sequences, having luminosities L from 10^4.9 to 10^5.6 Lsun The mass-loss rates scale very tightly with L^0.8. The two WO stars in our sample turned out to be outstandingly hot (~200 kK) and do not fit into the WC scheme.
CONCLUSIONS: From comparing the empirical WC positions in the Hertzsprung-Russell diagram with evolutionary models, and from recent supernova statistics, we conclude thatWC stars have evolved from initial masses between 20 and 45 Msun. In contrast to previous assumptions, it seems that WC stars in general do not descend from the most-massive stars. Only the WO stars might stem from progenitors that have been more massive than 45 Msun initially.

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Comments: PoWR grid models are available online at http://www.astro.physik.uni-potsdam.de/PoWR.html

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X-rays from Colliding Stellar Winds: the case of close WR+O binary systems

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We have analysed the X-ray emission from a sample of close WR+O binaries using data from the public Chandra and XMM-Newton archives. Global spectral fits show that two-temperature plasma is needed to match the X-ray emission from these objects as the hot component (kT > 2 keV) is an important ingredient of the spectral models. In close WR+O binaries, X-rays likely originate in colliding stellar wind (CSW) shocks driven by the massive winds of the binary components. CSW shocks in these objects are expected to be radiative due to the high density of the plasma in the interaction region. Opposite to this, our analysis shows that the CSW shocks in the sample of close WR+O binaries are adiabatic. This is possible only if the mass-loss rates of the stellar components in the binary are at least one order of magnitude smaller than the values currently accepted. The most likely explanation for the X-ray properties of close WR+O binaries could be that their winds are two-component flows. The more massive component (dense clumps) play role for the optical/UV emission from these objects, while the smooth rarefied component is a key factor for their X-ray emission.

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High-resolution X-ray spectroscopy reveals the special nature of Wolf-Rayet star winds

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We present the first high-resolution X-ray spectrum of a putatively single Wolf-Rayet star. 400 ks observations of WR 6 by the XMM-Newton-telescope resulted in a superb quality high-resolution X-ray spectrum. Spectral analysis reveals that the X-rays originate far out in the stellar wind, more than 30 stellar radii from the photosphere, and thus outside the wind acceleration zone where the line-driving instability could create shocks. The X-ray emitting plasma reaches temperatures up to 50 MK, and is embedded within the un-shocked, "cool" stellar wind as revealed by characteristic spectral signatures. We detect a fluorescent Fe line at approx 6.4 keV. The presence of fluorescence is consistent with a two-component medium, where the cool wind is permeated with the hot X-ray emitting plasma. The wind must have a very porous structure to allow the observed amount of X-rays to escape. We find that neither the line-driving instability nor any alternative binary scenario can explain the data. We suggest a scenario where X-rays are produced when the fast wind rams into slow "sticky clumps" that resist acceleration. Our new data show that the X-rays in single WR-star are generated by some special mechanism different from the one operating in the O-star winds.

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The relationship between gamma Cassiopeiae's X-ray emission and its circumstellar environment

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gamma Cas is the prototypical classical Be star and is best known for its variable hard X-ray emission. To elucidate the reasons for this emission, we mounted a multiwavelength campaign in 2010 centered around 4 XMM-Newtonobservations. The observational techniques included Long Baseline Optical Interferometry (LBOI), monitoring by an Automated Photometric Telescope and Halpha observations. Because gamma Cas is also known to be in a binary, we measured Halpha radial velocities and redetermined its period as 203.55+/-0.2 days and an eccentricity near zero. The LBOI observations suggest that the star's decretion disk was axisymmetric in 2010, has an inclination angle near 45^o, and a larger radius than previously reported. The Be star began an "outburst" at the beginning of our campaign, made visible by a disk brightening and reddening during our campaign. Our analyses of the new high resolution spectra disclosed many attributes found from spectra obtained in 2001 (Chandra) and 2004 (XMM). As well as a dominant hot 14 keV thermal component, these familiar ones included: (i) a fluorescent feature of Fe K stronger than observed at previous times, (ii) strong lines of N VII and Ne XI lines indicative of overabundances, and (iii) a subsolar Fe abundance from K-shell lines but a solar abundance from L-shell ions. We also found that 2 absorption columns are required to fit the continuum. While the first column maintained its historical average of 1x10^21 cm^-2, the second was very large and doubled to 7.4x10^23 cm^-2 during our X-ray observations. Although we found no clear relation between this column density and orbital phase, it correlates well with the disk brightening and reddening both in the 2010 and earlier observations. Thus, the inference from this study is that much (perhaps all?) of the X-ray emission from this source originates behind matter ejected by gamma Cas into our line of sight.

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The G305 star-forming complex: the central star clusters Danks 1 and Danks 2

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The G305 H II complex (G305.4+0.1) is one of the most massive star-forming structures yet identified within the Galaxy. It is host to many massive stars at all stages of formation and evolution, from embedded molecular cores to post-main-sequence stars. Here, we present a detailed near-infrared analysis of the two central star clusters Danks 1 and Danks 2, using Hubble Space Telescope+NICMOS imaging and Very Large Telescope+ISAAC spectroscopy. We find that the spectrophotometric distance to the clusters is consistent with the kinematic distance to the G305 complex, an average of all measurements giving a distance of 3.8 ± 0.6 kpc. From analysis of the stellar populations and the pre-main-sequence stars, we find that Danks 2 is the elder of the two clusters, with an age of 3+3- 1 Myr. Danks 1 is clearly younger with an age of 1.5+1.5- 0.5 Myr, and is dominated by three very luminous H-rich Wolf-Rayet stars which may have masses ≳100 Msun. The two clusters have mass functions consistent with the Salpeter slope, and total cluster masses of 8000 ± 1500 and 3000 ± 800 Msun for Danks 1 and Danks 2, respectively. Danks 1 is significantly the more compact cluster of the two, and is one of the densest clusters in the Galaxy with log (ρ/Msun pc-3) = 5.5+0.5- 0.4. In addition to the clusters, there is a population of apparently isolated Wolf-Rayet stars within the molecular cloud's cavity. Our results suggest that the star-forming history of G305 began with the formation of Danks 2, and subsequently Danks 1, with the origin of the diffuse evolved population currently uncertain. Together, the massive stars at the centre of the G305 region appear to be clearing away what is left of the natal cloud, triggering a further generation of star formation at the cloud's periphery.

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A newly discovered young massive star cluster at the far end of the Galactic Bar

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We present a near-infrared study of the candidate star cluster Mercer 81, located at the centre of the G338.4+0.1 H II region and close to the TeV gamma-ray source HESS 1640-465. Using Hubble Space Telescope/NICMOS imaging and VLT/ISAAC spectroscopy, we have detected a compact and highly reddened cluster of stars, although the bright stars in the centre of the field are in fact foreground objects. The cluster contains nine stars with strong Pα emission, one of which we identify as a Wolf-Rayet (WR)

star, as well as an A-type supergiant. The line-of-sight extinction is very large, AV˜ 45, illustrating the challenges of locating young star clusters in the Galactic plane. From a quantitative analysis of the WR star, we argue for a cluster age of 3.7? Myr, and, assuming that all emission-line stars are WR stars, a cluster mass of ≳104 Msun. A kinematic analysis of the cluster's surrounding H II region shows that the cluster is located in the Galactic disc at a distance of 11 ± 2 kpc. This places the cluster close to where the far end of the Bar intersects the Norma spiral arm. This cluster, as well as the nearby cluster [DBS2003]179, represents the first detections of active star cluster formation at this side of the Bar, in contrast to the near side which is well known to have recently undergone a ˜106 Msun starburst episode.

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Yellow and Red Supergiants in the Large Magellanic Cloud

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Due to their transitionary nature, yellow supergiants provide a critical challenge for evolutionary modeling. Previous studies within M31 and the SMC show that the Geneva evolutionary models do a poor job at predicting the lifetimes of these short-lived stars. Here we extend this study to the LMC while also investigating the galaxy's red supergiant content. This task is complicated by contamination by Galactic foreground stars that color and magnitude criteria alone cannot weed out. Therefore, we use proper motions and the LMC's large systemic radial velocity (~278 km/s) to separate out these foreground dwarfs. After observing nearly 2,000 stars, we identified 317 probable yellow supergiants, 6 possible yellow supergiants and 505 probable red supergiants. Foreground contamination of our yellow supergiant sample was ~80%, while that of the the red supergiant sample was only 3%. By placing the yellow supergiants on the H-R diagram and comparing them against the evolutionary tracks, we find that new Geneva evolutionary models do an exemplary job at predicting both the locations and the lifetimes of these transitory objects.

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Asteroseismology of the Nearby SN-II Progenitor Rigel Part II. $epsilon-$Mechanism Triggering Gravity-Mode Pulsations?

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The cores of luminous B and A-type (BA) supergiant stars are the seeds of later core collapse supernovae.

Thus, constraining the near-core conditions in this class of stars can place tighter constraints on the size, mass and chemical composition of supernova remnants.
Asteroseismology of these massive stars is one possible approach into such investigations.
Recently, Moravveji et al. (2012, hereafter Paper I) extracted 19 significant frequencies from a 6-year radial velocity monitoring or Rigel ($beta$ Ori, B8 Ia).
The periods they determined broadly range from 1.22 to 74.74 days.
Based on our differentially rotating stellar structure and evolution model, Rigel, at it’s current evolutionary state, is undergoing core He burning and shell H burning.
Linear fully non-adiabatic non-radial stability analyses result in the excitation of a dense spectrum of non-radial gravity-dominated mixed modes.
The fundamental radial mode ($ell=0$) and its overtones are all stable.
When the hydrogen burning shell is located even partially in the radiative zone, a favorable condition for destabilization of
g-modes through the so-called $epsilon-$mechanism becomes viable.
Only those g-modes that have high relative amplitudes in the hydrogen burning (radiative) zone can survive the strong radiative damping.
From the entire observed range of variability periods of Rigel (found in Paper I), and based on our model, only those modes with periods ranging between 21 to 127 days can be theoretically explained by the $epsilon-$mechanism.
The origin of the short-period variations (found in Paper I) still remain unexplained.
Because Rigel is similar to other massive BA supergiants, we believe that the $epsilon-$mechanism may be able to explain the long-period variations in $alpha$ Cygni class of pulsating stars.

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Variability in X-ray line ratios in helium-like ions of massive stars: the radiation-driven case

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Line ratios in "fir" triplets of helium-like ions have proven to be a powerful diagnostic of conditions in X-ray emitting gas surrounding massive stars. Recent observations indicate that these ratios can be variable with time.
The possible causes of variation in line ratios are limited: changes in the radiation field or changes in density, and changes in mass-loss or geometry. In this paper, we investigate the ability of changes in the radiation field to induce variability in the ratio R=f/i.
To isolate the radiative effect, we use a heuristic model of temperature and radius changes in variable stars in the B and O range with low-density, steady-state winds. We model the changes in emissivity of X-ray emitting gas close to the star due to differences in level-pumping from available UV photons at the location of the gas.
We find that under these conditions, variability in R is dominated by the stellar temperature. Although the relative amplitude of variability is roughly comparable for most lines at most temperatures, detectable variations are limited to a few lines for each spectral type. We predict that variable values in R due to stellar variability must follow predictable trends found in our simulations.
Our model uses radial pulsations as a mode of stellar variability that maximizes the amplitude of variation in R. This model is robust enough to show which ions will provide the best opportunity for observing variability in the f/i ratio at different stellar temperatures, and the correlation of that variability with other observable parameters. In real systems, the effects would be more complex than in our model, with differences in phase and suppressed amplitude in the presence of non-radial pulsations. This suggests that changes in R across many lines concurrently are not likely to be produced by a variable radiation field.

Reference: astro-ph (accepted to A&A)
Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/1202.3193

Comments:

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X-ray Emission Line Profiles from Wind Clump Bow Shocks in Massive Stars

R. Ignace^1, W.L. Waldron^2, J.P. Cassinelli^3

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The consequences of structured flows continue to be a pressing topic in relating spectral data to physical processes occurring in massive star winds. In a preceding paper, our group reported on hydrodynamic simulations of hypersonic flow past a rigid spherical clump to explore the structure of bow shocks that can form around wind clumps. Here we report on profiles of emission lines that arise from such bow shock morphologies. To compute emission line profiles, we adopt a two component flow structure of wind and clumps using two "beta" velocity laws. While individual bow shocks tend to generate double horned emission line profiles, a group of bow shocks can lead to line profiles with a range of shapes with blueshifted peak emission that depends on the degree of X-ray photoabsorption by the interclump wind medium, the number of clump structures in the flow, and the radial distribution of the clumps. Using the two beta law prescription, the theoretical emission measure and temperature distribution throughout the wind can be derived. The emission measure tends to be power law, and the temperature distribution broad in terms of wind velocity. Although restricted to the case of adiabatic cooling, our models highlight the influence of bow shock effects for hot plasma temperature and emission measure distributions in stellar winds and their impact on X-ray line profile shapes. Previous models have focused on geometrical considerations of the clumps and their distribution in the wind. Our results represent the first time that the temperature distribution of wind clump structures are explicitly and self-consistently accounted in modeling X-ray line profile shapes for massive stars.

Reference: to appear in ApJ
Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/1202.5492

Comments:

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HST/STIS spectroscopy of the magnetic Of?p star HD 108: the low state at ultraviolet wavelengths

W. L. F. Marcolino, J. -C. Bouret, N. R. Walborn, I. D. Howarth, Y. Naze, A. W. Fullerton, G. A. Wade, D. J. Hillier, A. Herrero

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We present the first ultraviolet spectrum of the peculiar, magnetic Of?p star HD 108 obtained in its spectroscopic low state. The new data, obtained with the Space Telescope Imaging Spectrograph (STIS) on the Hubble Space Telescope, reveal significant changes compared to IUE spectra obtained in the high state: N V 1240, Si IV 1400, and C IV 1550 present weaker P-Cygni profiles (less absorption) in the new data, while N IV 1718 absorption is deeper, without the clear wind signature evident in the high state. Such changes contrast with those found in other magnetic massive stars, where more absorption is observed in the resonance doublets when the sightline is close to the plane of the magnetic equator. The new data show also that the photospheric Fe IV forest, at 1600--1700 angstroms, has strengthened compared to previous observations. The ultraviolet variability is large compared to that found in typical, non-magnetic O stars, but moderate when compared to the high-/low-state changes reported in the optical spectrum of HD 108 over several decades. We use non-LTE expanding-atmosphere models to analyze the new STIS observations. Overall, the results are in accord with a scenario in which the optical variability is mainly produced by magnetically constrained gas, close to the photosphere. The relatively modest changes found in the main ultraviolet wind lines suggest that the stellar wind is not substantially variable on a global scale. Nonetheless, multidimensional radiative-transfer models may be needed to understand some of the phenomena observed.

Reference: MNRAS
Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/1202.6041

Comments: 9 pages, 8 figures

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3-D radiative transfer in clumped hot star winds
I. Influence of clumping on the resonance line formation

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The true mass-loss rates from massive stars are important for many branches of astrophysics. For the correct modeling of the resonance lines, which are among the key diagnostics of stellar mass-loss, the stellar wind clumping turned out to be very important. In order to incorporate clumping into radiative transfer calculation, 3-D models are required. Various properties of the clumps may have strong impact on the resonance line formation and, therefore, on the determination of empirical mass-loss rates.
We incorporate the 3-D nature of the stellar wind clumping into radiative transfer calculations and investigate how different model parameters influence the resonance line formation. We develop a full 3-D Monte Carlo radiative transfer code for inhomogeneous expanding stellar winds. The number density of clumps follows the mass conservation. For the first time, realistic 3-D models that describe the dense as well as the tenuous wind components are used to model the formation of resonance lines in a clumped stellar wind. At the same time, non-monotonic velocity fields are accounted for.
The 3-D density and velocity wind inhomogeneities show very strong impact on the resonance line formation. The different parameters describing the clumping and the velocity field results in different line strengths and profiles. We present a set of representative models for various sets of model parameters and investigate how the resonance lines are affected. Our 3-D models show that the line opacity is reduced for larger clump separation and for more shallow velocity gradients within the clumps.
Our new model demonstrates that to obtain empirically correct mass-loss rates from the UV resonance lines, the wind clumping and its 3-D nature must be taken into account.

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Evidence for a physically bound third component in HD 150136

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(3) Instituto de Astronomía, Universidad Católica del Norte, Avenida Angamos 0610, Antofagasta, Chile

Context. HD 150136 is one of the nearest systems harbouring an O3 star. Although this system was for a long time considered as
binary, more recent investigations have suggested the possible existence of a third component.
Aims. We present a detailed analysis of HD 150136 to confirm the triple nature of this system. In addition, we investigate the physical properties of the individual components of this system.
Methods. We analysed high-resolution, high signal-to-noise data collected through multi-epoch runs spread over ten years. We applied a disentangling program to refine the radial velocities and to obtain the individual spectra of each star. With the radial velocities, we computed the orbital solution of the inner system, and we describe the main properties of the orbit of the outer star such as the preliminary mass ratio, the eccentricity, and the orbital-period range. With the individual spectra, we determined the stellar parameters
of each star by means of the CMFGEN atmosphere code.
Results. We offer clear evidence that HD150136 is a triple system composed of an O3V((f*))–3.5V((f+)), an O5.5–6V((f)), and an
O6.5–7V((f)) star. The three stars are between 0–3 Myr old. We derive dynamical masses of about 64, 40, and 35 Msun for the primary, the secondary and the third components by assuming an inclination of 49° (sin^3 i = 0.43). It currently corresponds to one of the most massive systems in our galaxy. The third star moves with a period in the range of 2950 to 5500 d on an outer orbit with an eccentricity of at least 0.3. However, because of the long orbital period, our dataset is not sufficient to constrain the orbital solution of the tertiary
component with high accuracy.
Conclusions. We confirm the presence of a tertiary star in the spectrum of HD 150136 and show that it is physically bound to the
inner binary system. This discovery makes HD 150136 the first confirmed triple system with an O3 primary star.

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Astronomy & Astrophysics, accepted for publication

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JOBS

PDRA: Very Massive Stars

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United Kingdom

A PDRA position, funded by the UK Science and Technology Facilities Council, is available for three years from 1 Jul 2012 to support a HST/STIS programme http://pacrowther.staff.shef.ac.uk/R136_stis.html which seeks to construct the mass function of very massive stars within the young, rich star cluster R136 via a comprehensive census of the central parsec at UV and optical wavelengths.

The successful applicant will take a lead role in the reduction and analysis of the HST datasets, and should have a PhD in astronomy or a closely related field. Preference will be given to applicants with observational or theoretical experience in one or more of the following fields: stellar atmospheres, evolution of massive stars, young star clusters. A good track record of published research is also expected.

Applications (including CV, list of publications and a statement of research interests) should be submitted via weblink, with three reference letters sent separately. On-line application queries to e-Recruitment@sheffield.ac.uk

Salary: £28,401 per annum

Attention/Comments: Reference Number UOS 004056

Weblink: http://www.sheffield.ac.uk/jobs

Email: Paul.Crowther@sheffield.ac.uk

Deadline: 30 Apr 2012

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MEETINGS

The IR view of massive stars: the main sequence and beyond

23-24 August 2012

Venue: IAU GA in Beijing

Though multiwavelength astronomy was born about fifty years ago, the full use of multiwavelength diagnostics is quite recent. Even in the last decade, astronomers still mostly relied on the optical domain. This is certainly going to change, as most current and future instruments are dedicated to the infrared, from the near- to the far-IR bands.

While this domain is a known "must" for low-mass stars, especially the very low-mass ones, the infrared emission of high-mass stars has been often neglected. Many advantages of the infrared must however be underlined, like its strong potential for circumstellar material and atmosphere diagnostics, and its insensitivity to obscuration. Its interest with regards to the first generation of stars, thought to be very massive, is also well known.

It is thus important to discuss the results obtained for massive stars from existing IR facilities (VLTs/VLTI, Spitzer, Herschel, CRIRES, GAIA, ...) as well as tools for interpreting IR data (e.g. atmosphere modeling) and observing capabilities of future facilities (ELTs, JWST, ...). To this aim, we will hold a 1.5-day special session (SpS) at the next IAU General Assembly meeting in Beijing.

Note there will also be a joint discussion on 'Very Massive Stars in the Local Universe' during the same GA.

Weblink: http://www.gaphe.ulg.ac.be/IAU_XXVIII/index.html

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The Evolution of Massive Stars and Progenitors of GRBs

June 17 - July 1

Venue: Aspen Center for Physics, Aspen, CO

APPLICATION DEADLINE: TUESDAY, JAN 31, 2012

Long-duration gamma-ray bursts (LGRBs), associated with the core-collapse deaths of unusual massive stars, are the fleeting signatures of extraordinarily high-energy events occurring throughout our universe. These phenomena hold enormous promise as cosmological tools, but the full potential of LGRBs cannot be realized without first gaining a thorough understanding of their massive stellar progenitors. Recent advances in the massive star community on binarity, mass loss, and the effects of metallicity are all critical to current debates surrounding the nature of LGRB progenitors. Simultaneously, new results in the LGRB community have yielded important insights into the physical properties, environmental dependences, and interior structures of the most extreme massive stars. However, the study of massive stellar evolution and the study of LGRBs have long been seen as separate pursuits within astronomy, with only limited communication between the two subfields. This multi-disciplinary workshop will bring together leaders in these complementary disciplines, offering an opportunity for participants to exchange expertise, share recent results, and consider the most pressing current questions that will shape the future of LGRB and massive star research for years to come.

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IAU-general assembly

August 2012

Venue: Beijing, China

Deadline for early registration has been extended to March 17 ; abstract submission is requested before Feb 29. For info, there are two massive stars meetings at the GA...

Weblink: http://www.astronomy2012.org/dct/page/65615

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