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PAPERS

Abstracts of 8 accepted papers

A rare early-type star revealed in the Wing of the Small Magellanic Cloud

C. J. Evans (1), R. Hainich (2), L. M. Oskinova (2), J. S. Gallagher (3), Y.-H. Chu (4), R. A. Gruendl (4), W.-R. Hamann (2), V. Hénault-Brunet (5), H. Todt (2)

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Sk 183 is the visually-brightest star in the N90 nebula, a young star-forming region in the Wing of the Small Magellanic Cloud (SMC). We present new optical spectroscopy from the Very Large Telescope which reveals Sk 183 to be one of the most massive O-type stars in the SMC. Classified as an O3-type dwarf on the basis of its nitrogen spectrum, the star also displays broadened He 1 absorption which suggests a later type. We propose that Sk 183 has a composite spectrum and that it is similar to another star in the SMC, MPG 324. This brings the number of rare O2- and O3-type stars known in the whole of the SMC to a mere three. We estimate physical parameters for Sk 183 from analysis of its spectrum. For a single-star model, we estimate an effective temperature of 46+/-2 kK, a low mass-loss rate of ~10^-7 Msun yr^-1, and a spectroscopic mass of 46^9_-8 Msun (for an adopted distance modulus of 18.7 mag to the young population in the SMC Wing). An illustrative binary model requires a slightly hotter temperature (~47.5 kK) for the primary component. In either scenario, Sk 183 is the earliest-type star known in N90 and will therefore be the dominant source of hydrogen-ionising photons. This suggests Sk 183 is the primary influence on the star formation along the inner edge of the nebula.

Reference: Accepted by ApJ
Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/1205.2387

Comments:

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9 Sgr: uncovering an O-type spectroscopic binary with an 8.6 year period

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Context. The O-type object 9 Sgr is a well-known synchrotron radio emitter. This feature is usually attributed to colliding-wind binary systems, but 9 Sgr was long considered a single star.
Aims. We have conducted a long-term spectroscopic monitoring of this star to investigate its multiplicity and search for evidence for wind-wind interactions.
Methods. Radial velocities are determined and analysed using various period search methods. Spectral disentangling is applied to separate the spectra of the components of the binary system.
Results. We derive the first ever orbital solution of 9 Sgr. The system is found to consist of an O3.5 V((f+)) primary and an O5-5.5 V((f)) secondary moving around each other on a highly eccentric (e = 0.7), 8.6 year orbit. The spectra reveal no variable emission lines that could be formed in the wind interaction zone in agreement with the expected properties of the interaction in such a wide system.
Conclusions. Our results provide further support to the paradigm of synchrotron radio emission from early-type stars being a manifestation of interacting winds in a binary system.

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Comments: Accepted for publication in Astronomy & Astrophysics

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Nitrogen line spectroscopy in O-stars -- III. The earliest O-stars

J.G. Rivero Gonzalez (1), J. Puls (1), P. Massey (2), and F. Najarro (3)

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Context: The classification scheme proposed by Walborn et al. (2002, AJ, 123, 2754), based primarily on the relative strengths of the NIV4058 and NIII4640 emission lines, has been used in a variety of studies to spectroscopically classify early O-type stars. Owing to the lack of a solid theoretical basis, this scheme has not yet been universally accepted though.

Aims: We provide first theoretical predictions for the NIV4058/NIII4640 emission line ratio in dependence of various parameters, and confront these predictions with results from the analysis of a sample of early-type LMC/SMC O-stars.

Methods:Stellar and wind parameters of our sample stars are determined by line profile fitting of hydrogen, helium and nitrogen lines, exploiting the helium and nitrogen ionization balance. Corresponding synthetic spectra are calculated by means of the NLTE atmosphere/spectrum synthesis code FASTWIND.

Results: Though there is a monotonic relationship between the NIV/NIII emission line ratio and the effective temperature, all other parameters being equal, theoretical predictions indicate additional dependencies on surface gravity, mass-loss, metallicity, and, particularly, nitrogen abundance. For a given line ratio (i.e., spectral type), more enriched objects should be typically hotter. These basic predictions are confirmed by results from the alternative model atmosphere code CMFGEN.

The effective temperatures for the earliest O-stars, inferred from the nitrogen ionization balance, are

partly considerably hotter than indicated by previous studies. Consistent with earlier results, effective temperatures increase from supergiants to dwarfs for all spectral types in the LMC. The relation between observed NIV4058/NIII4640 emission line ratio and effective temperature, for a given luminosity class, turned out to be quite monotonic for our sample stars, and to be fairly consistent with our model predictions. The scatter within a spectral sub-type is mainly produced by abundance effects.

Conclusions: Our findings suggest that the Walborn et al.(2002) classification scheme is able to provide a meaningful relation between spectral type and effective temperature, as long as it is possible to discriminate for the luminosity class. In terms of spectral morphology, this might be difficult to achieve in low-Z environments such as the SMC, owing to rather low wind-strengths. According to our predictions, the major bias of the classification scheme is due to nitrogen content, and the overall spectral type-Teff relation for low-metallicity (e.g., SMC) O-stars might be non-monotonic around O3.5/O4.

Reference: Accepted by Astronomy & Astrophysics
Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/1205.4444

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Radiation-driven winds of hot luminous stars XVII. Parameters of selected central stars of PN from consistent optical and UV spectral analysis and the universality of the mass-luminosity relation

C. B. Kaschinski, A.W.A. Pauldrach, T. L. Hoffmann

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Context: The commonly accepted mass-luminosity relation of central stars of planetary nebulae (CSPNs) might not be universally valid. While earlier optical analyses could not derive masses and luminosities independently (instead taking them from theoretical evolutionary models) hydrodynamically consistent modelling of the stellar winds allows using fits to the UV spectra to consistently determine also stellar radii, masses, and luminosities without assuming a mass-luminosity relation. Recent application to a sample of CSPNs raised questions regarding the validity of the theoretical mass-luminosity relation of CSPNs.
Aims: The results of the earlier UV analysis are reassessed by means of a simultaneous comparison of observed optical and UV spectra with corresponding synthetic spectra.
Methods: Using published stellar parameters (a) from a consistent UV analysis and (b) from fits to optical H and He lines, we calculate simultaneous optical and UV spectra with our model atmosphere code, which has been improved by implementing Stark broadening for H and He lines.
Results: Spectra computed with the parameter sets from the UV analysis yield good agreement to the observations, but spectra computed with the stellar parameters from the published optical analysis and using corresponding consistent wind parameters show large discrepancies to both the observed optical and UV spectra. The published optical analyses give good fits to the observed spectrum only because the wind parameters assumed in these analyses are inconsistent with their stellar parameters. By enforcing

consistency between stellar and wind parameters, stellar parameters are obtained which disagree with the core-mass-luminosity relation for the objects analyzed. This disagreement is also evident from a completely different approach: an investigation of the dynamical wind parameters.

Reference: Publication in A&A
Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/1204.1200

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Numerical Models for the Diffuse Ionized Gas in Galaxies. I. Synthetic spectra of thermally excited gas with turbulent magnetic reconnection as energy source

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Aims: The aim of this work is to verify whether turbulent magnetic reconnection can provide the additional energy input required to explain the up to now only poorly understood ionization mechanism of the diffuse ionized gas (DIG) in galaxies and its observed emission line spectra.
Methods: We use a detailed non-LTE radiative transfer code that does not make use of the usual restrictive gaseous nebula approximations to compute synthetic spectra for gas at low densities. Excitation of the gas is via an additional heating term in the energy balance as well as by photoionization. Numerical values for this heating term are derived from three-dimensional resistive magnetohydrodynamic two-fluid plasma--neutral-gas simulations to compute energy dissipation rates for the DIG under typical conditions.
Results: Our simulations show that magnetic reconnection can liberate enough energy to by itself fully or partially ionize the gas. However, synthetic spectra from purely thermally excited gas are incompatible with the observed spectra; a photoionization source must additionally be present to establish the correct (observed) ionization balance in the gas.

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Status: Manuscript has been accepted

Weblink: arXiv:1206.0394v1

Comments:

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A peculiar Of star in the Local Group galaxy IC,1613

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Context. Results from the theory of radiatively driven winds are nowadays incorporated in stellar evolutionary and population synthesis models, and are used in our interpretation of the observations of the deep Universe. Yet, the theory has been confirmed only until Small Magellanic Cloud (SMC) metallicities. Observations and analyses of O-stars at lower metallicities are difficult, but much needed to prove the theory.

Aims. We have observed GHV-62024, an O6.5 IIIf star in the low-metallicity galaxy IC,1613 (Z~0.15 Zsun) to study its evolution and wind. According to a previous preliminary analysis that was subject to significant restrictions this star could challenge the radiatively driven wind theory at low metallicities. Here we present a complete analysis of this star.

Methods. Our observations were obtained with VIMOS at VLT, at R~2000 and covered approximately between 400 and 700 nm. The observations were analysed using the latest version of the model atmosphere code FASTWIND, which includes the possibility of calculating the N III spectrum.

Results. We obtain the stellar parameters and conclude that the star follows the average wind momentum--luminosity relationship (WLR) expected for its metallicity, but with a high value for the exponent of the wind velocity law, beta. Comparing this with values of other stars in the literature, we suggest that this high value may be reached because GHV-62024 could be a fast rotator seen at a low inclination angle. We also suggest that this could favour the appearance of the spectral "f"-characterictics. While the derived beta value does not change by adopting a lower wind terminal velocity, we show that a wrong V_infty has a clear impact on the position of the star in the WLR diagram. The N and He abundances are very high, consistent with strong CNO mixing that could have been caused by the fast rotation, although we cannot discard a different origin with present data. Stellar evolutionary model predictions are consistent with the star being still a fast rotator. We find again the well-known mass-discrepancy for this star.

Conclusions. We conclude that the star follows the WLR expected for its metallicity. The results are consistent with GHV-62024 being a fast rotator seen close to pole-on, strongly contaminated at the surface with CNO products and with a wind structure altered by the fast rotation but without modifying the global WLR. We suggest that this could be a general property of fast rotators.

Reference: Astronomy & Astrophysics
Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/1206.1238v1

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The Transition Mass-loss Rate: Calibrating the Role of Line-driven Winds in Massive Star Evolution

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A debate has arisen regarding the importance of stationary versus eruptive mass loss for massive star evolution. The reason is that stellar winds have been found to be clumped, which results in the reduction of unclumped empirical mass-loss rates. Most stellar evolution models employ theoretical mass-loss rates which are already reduced by a moderate factor of ~2-3 compared to non-corrected empirical rates. A key question is whether these reduced rates are of the correct order of magnitude, or if they should be reduced even further, which would mean that the alternative of eruptive mass loss becomes necessary. Here we introduce the transition mass-loss rate (dM/dt)_trans between O and Wolf-Rayet (WR) stars. Its novelty is that it is model independent. All that is required is postulating the spectroscopic transition point in a given data-set, and determining the stellar luminosity, which is far less model dependent than the mass-loss rate. The transition mass-loss rate is subsequently used to calibrate stellar wind strength by its application to the Of/WNh stars in the Arches cluster. Good agreement is found with two alternative modelling/theoretical results, suggesting that the rates provided by current theoretical models are of the right order of magnitude in the ~50Msun mass range. Our results do not confirm the specific need for eruptive mass loss as Luminous Blue Variables, and current stellar evolution modelling for Galactic massive stars seems sound. Mass loss through alternative mechanisms might still become necessary at lower masses, and/or metallicities, and the quantification of alternative mass loss is desirable.

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Low-frequency GMRT observations of the magnetic Bp star HR Lup (HD 133880)

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We present radio observations of the magnetic chemically peculiar Bp star HR Lup (HD 133880) at 647 and 277 MHz with the GMRT. At both frequencies the source is not detected but we are able to determine upper limits to the emission. The 647 MHz limits are particularly useful, with a 5$sigma$ value of 0.45 mJy. Also, no large enhancements of the emission were seen. The non-detections, along with previously published higher frequency detections, provide evidence that an optically thick gyrosynchrotron model is

the correct mechanism for the radio emission of HR Lup.

Reference: accepted for publication in the Bulletin of the Astronomical Society of India, to appear in the June issue; http://arxiv.org/abs/1206.1155
Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/1206.1155

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Abstracts of 1 conference proceedings

Diagnosing small- and large-scale structure in the winds of hot, massive OB-stars

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It is observationally as well as theoretically well established that the winds of hot, massive OB-stars are highly structured on a broad range of spatial scales. This paper first discusses consequences of the small-scale structures associated with the strong instability inherent to the line-driving of these winds. We demonstrate the importance of a proper treatment of such wind clumping to obtain reliable estimates of mass-loss rates, and also show that instability simulations that are perturbed at the lower boundary indeed display significant clumping quite close to the wind base, in general agreement with observations.
But a growing subset of massive stars has also been found to possess strong surface magnetic fields, which may channel the star's outflow and induce also large-scale wind structures and cyclic behavior of spectral diagnostics. The paper concludes by showing that multi-dimensional, magneto-hydrodynamical wind simulations, together with detailed radiative-transfer modeling, can reproduce remarkably well the periodic Balmer line emission observed in slowly rotating magnetic O stars like HD191612.

Reference: To appear in the proceedings of "Circumstellar Dynamics at High Resolution", Foz do Iguacu, Feb. 2012. Available at astro-ph.
Status: Conference proceedings

Weblink: http://arxiv.org/abs/1205.3190

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JOBS

Positions on Massive Stars at the National Observatory of Athens

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Applications are invited for (i) a 2 to 3-year postdoctoral research position and (ii) a 3-year PhD position, on characterizing massive stars in the Milky Way and in nearby galaxies at the National Observatory of Athens, Greece. Applicants with previous experience in optical and infrared spectroscopy, photometry, and the field of massive stars are particularly encouraged to apply. For more information visit: http://www.astro.noa.gr/~bonanos/Homepage/Job_Openings.html

Attention/Comments: Consideration of applications will begin on August 1st, 2012 and will continue until the positions are filled. A starting date in the Fall of 2012 is anticipated.

Weblink: http://www.astro.noa.gr/~bonanos/Homepage/Job_Openings.html

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Deadline: August 1, 2012

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