

THE MASSIVE STAR NEWSLETTER

formerly known as *the hot star newsletter*

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Accepted Papers

VLT/NACO near-infrared imaging and spectroscopy of N159A in the LMC HII complex N159

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We present near-infrared imaging and spectroscopic observations of the HII region N159A (~ 10 pc) in the giant star-forming region N159 (50 pc) in the LMC. N159A was observed in the J and Ks bands at high spatial resolution $\sim 0.2''$ using the ESO Very Large Telescope UT4 (VLT), equipped with the NAOS adaptative optics system. Our data reveal the morphology of this region in unprecedented detail. The protostar P2, one of the first YSOs of Class I identified in the LMC is now resolved in two YSO candidates. The ultracompact HII region LI-LMC 1501W is found to be a tight cluster embedded in a compact HII region ionised by a late O source. A new multiple system composed of a tight star cluster and an YSO candidate, all embedded in a compact nebular region (0.4 pc) is also detected at the north-east edge of N159A. The stellar population of the whole N159A region appears composed of two main stellar populations, one with an age ≤ 3 Myr and the other one with a large range of age (300 Myr - 10 Gyr). Using spectroscopy, one of the two exciting O stars in the HII region N159A is classified O5-O6.

Reference: Astronomy and Astrophysics

Status: Manuscript has been accepted

On the web at: <http://luth2.obspm.fr/~luthier/testor/testor4697.ps>

Preprints from: testor@mesio.org

Remarks on statistical errors in equivalent widths

Klaus Vollmann and Thomas Eversberg

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Equivalent width measurements for rapid line variability in atomic spectral lines are degraded by increasing error bars with shorter exposure times. We derive an expression for the error of the line equivalent width $\sigma(W_\lambda)$ with respect to pure photon noise statistics and provide a correction value for previous calculations.

Reference: *Astronomical Notes*

Status: Manuscript has been accepted

On the web at: www.stsci.de

Preprints from: eversberg@stsci.de

Early-type stars in the young open cluster IC1805 (II): The probably single stars HD15570 and HD15629, and the massive binary/triple system HD15558

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Aims: We address the issue of the multiplicity of the three brightest early-type stars of the young open cluster IC1805, namely HD15570, HD15629 and HD15558.

Methods: For the three stars, we measured the radial velocity by fitting Gaussian curves to line profiles in the optical domain. In the case of the massive binary HD15558, we also used a spectral disentangling method to separate the spectra of the primary and of the secondary in order to derive the radial velocities of the two components. These measurements were used to compute orbital solutions for HD15558.

Results: For HD15570 and HD15629, the radial velocities do not present any significant trend attributable to a binary motion on time scales of a few days, nor from one year to the next. In the case of HD15558 we obtained an improved SB1 orbital solution with a period of about 442 days, and we report for the first time on the detection of the spectral signature of its secondary star. We derive spectral types O5.5III(f) and O7V for the primary and the secondary of HD15558. We tentatively compute a first SB2 orbital solution although the radial velocities from the secondary star should be considered with caution. The mass ratio is rather high, i.e. about 3, and leads to very extreme minimum masses, in particular for the primary object. Minimum masses of the order of 150 ± 50 and $50 \pm 15 M_\odot$ are found respectively for the primary and the secondary.

Conclusions: We propose that HD15558 could be a triple system. This scenario could help to reconcile the very large minimum mass derived for the primary object with its spectral type. In addition, considering new and previously published results, we find that the binary frequency among O-stars in IC1805 has a lower limit of 20%, and that previously published values (80%) are probably overestimated.

Reference: A&A, in press

Status: Manuscript has been accepted

Comments: 12 pages, including 6 figures (+ 4 pages of online material)

On the web at: <http://arxiv.org/abs/astro-ph/0606379>

Preprints from: debecker@astro.ulg.ac.be

Measurements and analysis of helium-like triplet ratios in the X-ray spectra of O-type stars

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We discuss new methods of measuring and interpreting the forbidden-to-intercombination line ratios of helium-like triplets in the X-ray spectra of O-type stars, including accounting for the spatial distribution of the X-ray emitting plasma and using the detailed photospheric UV spectrum. Measurements are made for four O stars using archival *Chandra* HETGS data. We assume an X-ray emitting plasma spatially distributed in the wind above some minimum radius R_0 . We find minimum radii of formation typically in the range of $1.25 < R_0/R_* < 1.67$, which is consistent with results obtained independently from line profile fits. We find no evidence for anomalously low f/i ratios and we do not require the existence of X-ray emitting plasmas at radii that are too small to generate sufficiently strong shocks.

Reference: Accepted in ApJ.

Status: Manuscript has been accepted

On the web at: <http://arxiv.org/abs/astro-ph/0606370>

Preprints from: maurice@astro.columbia.edu

The VLT-FLAMES Survey of Massive Stars: Observations centered on the Magellanic Cloud clusters NGC 330, NGC 346, NGC 2004, and the N11 region

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We present new observations of 470 stars using the Fibre Large Array Multi-Element Spectrograph (FLAMES) instrument in fields centered on the clusters NGC 330 and NGC 346 in the Small Magellanic Cloud (SMC), and NGC 2004 and the N11 region in the Large Magellanic Cloud (LMC). A

further 14 stars were observed in the N11 and NGC 330 fields using the Ultraviolet and Visual Echelle Spectrograph (UVES) for a separate programme. Spectral classifications and stellar radial velocities are given for each target, with careful attention to checks for binarity. In particular we have investigated previously unexplored regions around the central LH9/LH10 complex of N11, finding 25 new O-type stars from our spectroscopy. We have observed a relatively large number of Be-type stars that display permitted Fe II emission lines. These are primarily not in the cluster cores and appear to be associated with classical Be-type stars, rather than pre main-sequence objects. The presence of the Fe II emission, as compared to the equivalent width of $H\alpha$, is not obviously dependent on metallicity. We have also explored the relative fraction of Be- to normal B-type stars in the field-regions near to NGC 330 and NGC 2004, finding no strong evidence of a trend with metallicity when compared to Galactic results. A consequence of service observations is that we have reasonable time-sampling in three of our FLAMES fields. We find lower limits to the binary fraction of O- and early B-type stars of 23 to 36%. One of our targets (NGC346-013) is especially interesting with a massive, apparently hotter, less luminous secondary component.

Reference: A&A, astro-ph/0606405

Status: Manuscript has been accepted

On the web at: <http://www.roe.ac.uk/~cje/flamesMC.ps.gz>

Preprints from: cje@roe.ac.uk

The Role of Evolutionary Age and Metallicity in the Formation of Classical Be Circumstellar Disks I. New Candidate Be Stars in the LMC, SMC, and Milky Way

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We present B, V, R, and $H\alpha$ photometry of 8 clusters in the Small Magellanic Cloud, 5 in the Large Magellanic Cloud, and 3 Galactic clusters, and use 2 color diagrams (2-CDs) to identify candidate Be star populations in these clusters. We find evidence that the Be phenomenon is enhanced in low metallicity environments, based on the observed fractional early-type candidate Be star content of clusters of age 10-25 Myr. Numerous candidate Be stars of spectral types B0 to B5 were identified in clusters of age 5-8 Myr, challenging the suggestion of Fabregat & Torrejon (2000) that classical Be stars should only be found in clusters at least 10 Myr old. These results suggest that a significant number of B-type stars must emerge onto the zero-age-main-sequence as rapid rotators. We also detect an enhancement in the fractional content of early-type candidate Be stars in clusters of age 10-25 Myr, suggesting that the Be phenomenon does become more prevalent with evolutionary age. We briefly discuss the mechanisms which might contribute to such an evolutionary effect. A discussion of the limitations of utilizing the 2-CD technique to investigate the role evolutionary age and/or metallicity play in the development of the Be phenomenon is offered, and we provide evidence that other B-type objects of very different nature, such as candidate Herbig Ae/Be stars may contaminate the claimed detections of “Be stars” via 2-CDs.

Reference: ApJ

Status: Manuscript has been accepted

On the web at: <http://arxiv.org/abs/astro-ph/0606525>

UBVJHK synthetic photometry of Galactic O stars

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The development of powerful infrared observational technics enables the study of very extincted objects and young embedded star forming regions. This is especially interesting in the context of massive stars which form and spend a non negligible fraction of their life still enshrouded in their parental molecular cloud. Spectrophotometric calibrations are thus necessary to constrain the physical properties of heavily extincted objects.

Here, we derive UBVJHK magnitudes and bolometric corrections from a grid of atmosphere models for O stars. Bessel passbands are used. Bolometric corrections (BC) are derived as a function of Teff and are subsequently used to derive BC - spectral type (ST) and Absolute Magnitudes - ST relations.

Infrared magnitudes and, for the first time, bolometric corrections are given for the full range of spectral types and luminosity classes. Infrared colors are essentially constant. Intrinsic H-K colors are 0.05 mag bluer than previously proposed. Optical calibrations are also provided and are similar to previous work, except for (B-V)₀ which is found to be at minimum -0.28 for standard O stars, slightly larger (0.04 mag) than commonly accepted.

Reference: A&A, accepted

Status: Manuscript has been accepted

On the web at: <http://www.mpe.mpg.de/~martins/publications.html>

Preprints from: martins@mpe.mpg.de

The VLT-FLAMES survey of massive stars: Mass loss and rotation of early-type stars in the SMC

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(9) The Isaac Newton Group of Telescopes, La Palma

(10) Instituto de Estructura de la Materia, Consejo Superior de Investigaciones Cientificas, CSIC

(11) Grantecan S.A.

We have studied the optical spectra of a sample of 31 O- and early B-type stars in the Small Magellanic Cloud, 21 of which are associated with the young massive cluster NGC 346. Stellar parameters are determined using an automated fitting method (Mokiem et al. 2005), which combines the stellar atmosphere code FASTWIND (Puls et al. 2005) with the genetic algorithm based optimisation routine PIKAIA (Charbonneau 1995). Comparison with predictions of stellar evolution that account for stellar rotation does not result in a unique age, though most stars are best represented by an age of 1-3 Myr. The automated method allows for a detailed determination of the projected rotational velocities. The present day $v \sin i$ distribution of the 21 dwarf stars in our sample is consistent with an underlying rotational velocity (v_r) distribution that can be characterised by a mean velocity of about 160-190 km/s and an effective half width of 100-150 km/s. The v_r distribution must include a small percentage of slowly rotating stars. If predictions of the time evolution of the equatorial velocity for massive stars within the environment of the SMC are correct (Maeder & Meynet 2001), the young age of the cluster implies that this underlying distribution is representative for the initial rotational velocity distribution. The location in the Hertzsprung-Russell diagram of the stars showing helium enrichment is in qualitative agreement with evolutionary tracks accounting for rotation, but not for those ignoring v_r . The mass loss rates of the SMC objects having luminosities of $\log L/L_\odot > 5.4$ are in excellent agreement with predictions by Vink, de Koter & Lamers (2001). However, for lower luminosity stars the winds are too weak to determine \dot{M} accurately from the optical spectrum. Two of three spectroscopically classified Vz stars from our sample are located close to the theoretical zero age main sequence, as expected. Three additional objects of lower luminosity, which are not given this classification, are also found to lie near the ZAMS. We argue that this is related to a temperature effect inhibiting relatively cool stars from displaying the spectral features characteristic for the Vz luminosity class.

Reference: A&A

Status: Manuscript has been accepted

On the web at: <http://arxiv.org/abs/astro-ph/0606403>

Preprints from: mokiem@science.uva.nl

The atypical emission-line star Hen3-209

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We analyse observations, spanning 15 years, dedicated to the extreme emission-line object Hen3-209. Our photometric data indicate that the luminosity of the star undergoes marked variations with a peak-to-peak amplitude of 0.65mag. These variations are recurrent, with a period of 16.093 \pm 0.005d. The spectrum of Hen3-209 is peculiar with many different lines (HI, HeI, FeII,...) showing P Cygni profiles. The line profiles are apparently changing in harmony with the photometry. The spectrum also contains [OIII] lines that display a saddle profile topped by three peaks, with a maximum separation of about 600km/s. Hen3-209 is most likely an evolved luminous object suffering from mass ejection events and maybe belonging to a binary system.

Reference: to be published by MNRAS

Status: Manuscript has been accepted

On the web at: <http://arxiv.org/abs/astro-ph/0606627>

Preprints from: naze@astro.ulg.ac.be

The XMM-Newton view of Plaskett's star and its surroundings.

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XMM-Newton data of Plaskett's star (HD 47129) are used in order to analyse its X-ray spectrum and variability and hence to derive further constraints on the wind interaction in this early-type binary (O6 I + O7.5 I) system. Conventional models fail to provide a consistent fit of the EPIC and RGS spectra. The lines seen in the RGS spectrum have a temperature of maximum emissivity between 0.18 and 1.4 keV. The EPIC and RGS spectra are best fitted by a non-equilibrium model consisting of a bremsstrahlung continuum at 2.2 ± 0.1 keV and a number of independent emission lines. Our tests also suggest that an overabundance in nitrogen by a factor 6 might be indicated to best represent the RGS spectrum. On the other hand, a short term variability study of the light curves of the system indicates that the X-ray flux of Plaskett's star did not display any significant variability during our observation. This result holds for all time scales investigated here (from a few minutes to about one hour). Combining our XMM-Newton data with ROSAT archival observations, we find however a significant variability on the orbital time scale. If this behaviour is indeed phase-locked, it suggests a minimum in the X-ray flux when the primary star is in front. This might be attributed to an occultation of the colliding wind region by the body of the primary. Finally, 71 other X-ray sources have been detected in the field around Plaskett's star and most of them have a near-IR counterpart with colours that are consistent with those of slightly reddened main-sequence objects. Actually, a sizeable fraction of the X-ray sources in the EPIC images could be either foreground or background sources with no direct connection to HD 47129.

Reference: MNR10611

Status: Manuscript has been accepted

On the web at: <http://vela/Preprints/P107/index.html>

Preprints from: linder@astro.ulg.ac.be

FUSE observations of HD 5980: The Wind Structure of the Eruptor

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HD 5980 is a unique system containing one massive star (star A) that is apparently entering the luminous blue variable phase, and an eclipsing companion (star B) that may have already evolved beyond this phase to become a Wolf-Rayet star. In this paper we present the results from FUSE observations

obtained in 1999, 2000, and 2002 and one far-UV observation obtained by ORFEUS/BEFS in 1993 shortly before the first eruption of HD 5980. The eight phase-resolved spectra obtained by FUSE in 2002 are analyzed in the context of a wind-eclipse model. This analysis shows that the wind of the eruptor obeyed a very fast velocity law in 2002, which is consistent with the line-driving mechanism. Large amplitude line-profile variations on the orbital period are shown to be due to the eclipse of star B by the wind of star A, although the eclipse due to gas flowing in the direction of star B is absent. This can only be explained if the wind of star A is not spherically symmetric, or if the eclipsed line radiation is “filled-in” by emission originating from somewhere else in the system, e.g., in the wind-wind collision region. Except for a slightly lower wind speed, the ORFEUS/BEFS spectrum is very similar to the spectrum obtained by FUSE at the same orbital phase: there is no indication of the impending eruption. However, the trend for decreasing wind velocity suggests the occurrence of the “bi-stability” mechanism, which in turn implies that the restructuring of the circumbinary environment caused by the transition from “fast, rarefied wind” to “slow, dense wind” was observed as the eruptive event. The underlying mechanism responsible for the long-term decrease in wind velocity that precipitated this change remains an open issue.

Reference: A.J.

Status: Manuscript has been accepted

On the web at: <http://arxiv.org/abs/astro-ph/0606705>

Preprints from: gloria@fis.unam.mx

In Proceedings

Quantitative X-ray spectroscopy of O stars

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Radiative transfer in a clumped winds is used to describe X-ray emission line profiles observed in the XMM-Newton RGS spectrum of the OI star Zeta Puppis. It is shown that this X-ray spectrum can be explained as originating from a multi-temperature collisional plasma located in the wind acceleration zone. The X-rays are attenuated in the clumped stellar wind, which gives characteristic profiles to the emergent lines. We specifically study the N VII emission line in the spectrum of Zeta Pup. Long RGS exposures reveal that the N VII line profile is structured. On the basis of our Zeta Pup atmosphere model, we rule out the presence of N VII in the cool wind component. We suggest that the detailed N VII line structure is due to self-absorption in the hot plasma. Wind clumping also affects the transfer of ionizing radiation in high-mass X-ray binaries (HMXBs). We derive analytical formulae for the ionisation parameter in dependence on the parameters of wind clumping.

Reference: in Proc. MSSL Workshop no.2 "High resolution X-ray spectroscopy: towards XEUS and Con-X", MSSL, 27 - 28 March 2006

Status: Conference proceedings

On the web at: astro-ph/0605560

Preprints from: lida@astro.physik.uni-potsdam.de

Research Astronomer Positions at Armagh Observatory

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Two permanent Research Astronomer positions are available from 2006 December 1. The Observatory has full access to all UK facilities and is a member of the UK SALT Consortium.

Applicants must have a PhD in an appropriate discipline and current or previous postdoctoral employment in astronomy or a related science. It is desirable that candidates have strong research interests in any branch of solar physics, solar-terrestrial physics including climate, and stellar or Galactic astrophysics, which should strengthen or complement the Observatory's existing research profile in these areas. Candidates should also have observational, theoretical, computational or modelling expertise, and experience of obtaining and/or managing grants and running an independent research programme.

Starting salary in the range 31927 – 47866 pounds (under review), depending on qualifications and experience. The positions are permanent posts subject to a normal retirement age of 65. Information about the Armagh Observatory may be obtained by consulting the web-site: <http://star.arm.ac.uk/>.

The closing date is 2006 September 8. Applicants should obtain an application pack from the Administrator or from the Observatory web-site, and send the completed application form together with a full curriculum vitae, statement of research interests and complete bibliography to: The Administrator, Armagh Observatory, College Hill, Armagh BT61 9DG, Northern Ireland (Tel: +44-(0)28-3752-2928; FAX: +44-(0)28-3752-7174; e-mail: lfy@arm.ac.uk). References from three referees should be sent to the Administrator by the closing date.

Weblink: <http://star.arm.ac.uk/jobs/res-ast-2006/>

Email contact: lfy@arm.ac.uk

Closing date: 2006 September 8