ISSN 1783-3426

THE MASSIVE STAR NEWSLETTER

formely known as *the hot star newsletter*

⋆

No. 95 2006 September-October

editor: Philippe Eenens http://www.astroscu.unam.mx/massive_stars

eenens@gmail.com ftp://ftp.sron.nl/pub/karelh/UPLOADS/WRBIB/

Contents of this newsletter

Accepted Papers

High resolution X-ray spectroscopy of bright O type stars

L.M. Oskinova, A. Feldmeier, W.-R. Hamann

University Potsdam

Archival X-ray spectra of the four prominent single, non-magnetic O stars Zeta Pup, Zeta Ori, Ksi Per and Zeta Oph, obtained in high resolution with Chandra HETGS/MEG have been studied. The resolved X-ray emission line profiles provide information about the shocked, hot gas which emits the X-radiation, and about the bulk of comparably cool stellar wind material which partly absorbs this radiation. In this paper, we synthesize X-ray line profiles with a model of a clumpy stellar wind. We find that the geometrical shape of the wind inhomogeneities is important: better agreement with the observations can be achieved with radially compressed clumps than with spherical clumps. The parameters of the model, i.e. chemical abundances, stellar radius, mass-loss rate and terminal wind velocity, are taken from existing analyses of UV and optical spectra of the programme stars. On this basis, we also calculate the continuum-absorption coefficient of the cool-wind material, using the Potsdam Wolf-Rayet (PoWR) model atmosphere code. The radial location of X-ray emitting gas is restricted from analysing the fir line ratios of helium-like ions. The only remaining free parameter of our model is the typical distance between the clumps; here, we assume that at any point in the wind there is one clump passing by per one dynamical time-scale of the wind. The total emission in

a model line is scaled to the observation. There is a good agreement between synthetic and observed line profiles. We conclude that the X-ray emission line profiles in O stars can be explained by hot plasma embedded in a cool wind which is highly clumped in the form of radially compressed shell fragments.

Reference: MNRAS, in press, online early DOI: 10.1111/j.1365-2966.2006.10858.x

On the web at: astro-ph/0603286

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

Very massive close binaries and the puzzling temporal evolution of ^{14}N in the solar neighbourhood

D. Vanbeveren and E. De Donder

Astrophysical Institute, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussels, Belgium

Low metallicity very massive stars with an initial mass between 140 $M_\odot$ and 260 $M_\odot$ can be subdivided into two groups: those between 140 $M_\odot$ and 200 $M_\odot$ which produce a relatively small amount of Fe, and those with a mass between 200 $M_\odot$ and 260 $M_\odot$ where the Fe-yield ejected during the supernova explosion is enormous. We first demonstrate that the inclusion of the second group into a chemical evolutionary model for the Solar Neighbourhood predicts an early temporal evolution of Fe which is at variance with observations whereas it can not be excluded that the first group could have been present. We then show that a low metallicity binary with very massive components (with a mass corresponding to the first group) can be an efficient site of primary ^{14}N production through the explosion of a binary component that has been polluted by the pair instability supernova ejecta of its companion. When we implement these massive binary ^{14}N yields in a chemical evolution model, we conclude that very massive close binaries may be important sites of ^{14}N enrichment during the early evolution of the Galaxy.

Reference: New Astronomy

Preprints from: dvbevere@vub.ac.be

Low-excitation blobs in the Magellanic Clouds

Meynadier, F. (1,2) and Heydari-Malayeri, M. (1)

(1) LERMA - Observatoire de Paris, France (2) UPMC Universit Paris 6, France

Aims : We study an unknown, or very poorly known, interstellar HII component in the Magellanic Clouds. This is the first study ever devoted to this class of objects, which we call Low-excitation blobs (LEBs).

Methods : We used low-dispersion spectroscopy carried out at ESO to obtain emission line intensities of Ha, Hb, and [OIII] (4959+5007) for 15 objects in the Large Magellanic Cloud and 14 objects in the Small Magellanic Cloud. Results are displayed in excitation ([oiii]/Hb ratio) versus Hb luminosity diagrams.

Results : We show the presence of an LEB component in the Magellanic Clouds and study its relationship with the already known class of high-excitation blobs (HEBs). The newly found LEBs are

lower excitation counterparts of HEBs and are powered by less massive exciting stars. Further study of LEBs is expected to provide new pieces of information for a better understanding the low mass end of the upper initial mass function in the Magellanic Clouds.

Reference: Accepted in A&A

On the web at: http://arxiv.org/abs/astro-ph/0610189

Preprints from: Frederic.Meynadier@obspm.fr

On the Hα emission from the β Cephei system

R.S. Schnerr[1], H.F. Henrichs[1], R.D. Oudmaijer[2] and J.H. Telting[3]

1 - Astronomical Institute "Anton Pannekoek", University of Amsterdam, Kruislaan 403, 1098 SJ Amsterdam, Netherlands 2 - School of Physics and Astronomy, EC Stoner Building, University of Leeds, Leeds LS2 9JT, UK 3 - Nordic Optical Telescope, Apartado 474, 38700 Santa Cruz de La Palma, Spain

Be stars, which are characterised by intermittent emission in their hydrogen lines, are known to be fast rotators. This fast rotation is a requirement for the formation of a Keplerian disk, which in turn gives rise to the emission. However, the pulsating, magnetic B1IV star β Cephei is a very slow rotator that still shows Hα emission episodes like in other Be stars, contradicting current theories. We investigate the hypothesis that the Hα emission stems from the spectroscopically unresolved companion of β Cep. Spectra of the two unresolved components have been separated in the 6350-6850Å range with spectro-astrometric techniques, using 11 longslit spectra obtained with ALFOSC at the Nordic Optical Telescope, La Palma. We find that the Hα emission is not related to the primary in β Cep, but is due to its 3.4 magnitudes fainter companion. This companion has been resolved by speckle techniques, but it remains unresolved by traditional spectroscopy. The emission extends from about -400 to $+400$ km s^{-1}. The companion star in its 90-year orbit is likely to be a classical Be star with a spectral type around B6-8. By identifying its Be-star companion as the origin of the Hα emission behaviour, the enigma behind the Be status of the slow rotator β Cep has been resolved.

Reference: A&A, (astro-ph/0610198)

On the web at: astro-ph/0610198

Preprints from: rschnerr@science.uva.nl

Physical Properties of Wolf-Rayet Stars

Paul A Crowther

University of Sheffield

The striking broad emission line spectroscopic appearance of Wolf-Rayet stars have long defied analysis due to the extreme physical conditions of their line and continuum forming regions. Recently, model atmosphere studies have advanced sufficiently to enable the determination of stellar temperatures, luminosities, elemental abundances, ionizing fluxes and wind properties. The observed distribution of nitrogen (WN) and carbon (WC) sequence WR stars in the Milky Way and nearby star forming galaxies is discussed, from which lower limits to progenitor masses are 25, 40, 75 Msun for hydrogen-depleted (He-burning) WN, WC, and H-rich (H-burning) WN stars, respectively. WR stars in massive

binaries permit studies of wind-wind interactions and dust formation in WC systems, plus current mass determinations, revealing typically 10-25 Msun, although extending up to 80Msun for H-rich WN stars. Theoretical and observational evidence in favour of a metallicity dependence of WR winds is presented, with implications for evolutionary models, ionizing fluxes, and the role of WR stars within the context of core-collapse supernovae and long-duration gamma ray bursts.

Reference: Review Paper, to appear in Annual Review of Astronomy and Astrophysics, Volume 45 (2007).

On the web at: `astro-ph/0610356`

Preprints from: `Paul.Crowther@sheffield.ac.uk`

An XMM-Newton view of the young open cluster NGC 6231 – II. The OB star population

H. Sana[1,2], G. Rauw[1], Y. Naze[1], E. Gosset[1], J.-M. Vreux

[1] Institut d'Astrophysique et de Geophysique, University of Liege, Belgium [2] European Southern Observatory, Casilla 19001, Santiago 19, Chile

In this second paper of the series, we pursue the analysis of the 180 ks XMM-Newton campaign towards the young open cluster NGC 6231 and we focus on its rich OB star population. We present a literature-based census of the OB stars in the field of view with more than one hundred objects, among which 30% can be associated with an X-ray source. All the O-type stars are detected in the X-ray domain as soft and reasonably strong emitters. In the 0.5-10.0 keV band, their X-ray luminosities scale with their bolometric luminosities as $\log L_{\rm X} - \log L_{\rm bol} = -6.912 \pm 0.153$. Such a scaling law holds in the soft (0.5-1.0 keV) and intermediate (1.0-2.5 keV) bands but breaks down in the hard band. While the two colliding wind binaries in our sample clearly deviate from this scheme, the remaining O-type objects show a very limited dispersion (40% or 20% according to whether 'cool' dwarfs are included or not), much smaller than that obtained from previous studies. At our detection threshold and with our sample, the sole identified mechanism that produces significant modulations in the O star X-ray emission is related to wind interaction. We thus propose that the intrinsic X-ray emission of non-peculiar O-type stars can be considered as constant for a given star. In addition, the level of X-ray emission is accurately related to the star luminosity or, equivalently, to its wind properties. Among B-type stars, the detection rate is only about 25% in the sub-type range B0-B4 and remains mostly uniform throughout the different sub-populations while it drops significantly at later sub-types. The associated X-ray spectra are harder than those of O-type stars. Our analysis points towards the detected emission being associated with a physical (in a multiple system) PMS companion. However, we still observe a correlation between the bolometric luminosity of the B stars and the measured X-ray luminosity. The best fit power law in the 0.5-10.0 keV band yields $\log L_{\rm X} = 0.22(\pm 0.06) \log L_{\rm bol} + 22.8(\pm 2.4)$.

Reference: Sana et al. 2006, MNRAS 661, 678

On the web at: `http://arxiv.org/abs/astro-ph/0607486`

Preprints from: `hsana@eso.org`

Submitted Papers

The formation and evolution of very massive stars

H. Belkus, J. Van Bever and D. Vanbeveren

Astrophysical Institute, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussels, Belgium

Core collapse of dense massive star clusters is unavoidable and this leads to the formation of massive objects, with a mass up to 1000 Mo and even larger. When these objects become stars, stellar wind mass loss determines their evolution and final fate, and decides upon whether they form black holes (with normal mass or with intermediate mass) or explode as a pair instability supernova. In the present paper, we discuss the evolution of very massive stars and we present a convenient evolution recipe that can be implemented in a gravitational N-body code to study the dynamics of dense massive clusters.

Reference: Letter to the Editor

Preprints from: dvbevere@vub.ac.be

Evidence for the importance of resonance scattering in X-ray emission line profiles of the O star ζ Puppis

Maurice A. Leutenegger[1], Stanley P. Owocki[2], Steven M. Kahn[3], Frits B. S. Paerels[1]

1 - Department of Physics and Columbia Astrophysics Laboratory, Columbia University 2 - Bartol Research Institute, University of Delaware 3 - Kavli Institute for Particle Astrophysics and Cosmology, Stanford Linear Accelerator Center and Stanford University

We fit the Doppler profiles of the He-like triplet complexes of O 7 and N 6 in the X-ray spectrum of the O star ζ Pup, using XMM-Newton RGS data collected over $\sim$ 400 ks of exposure. We find that they cannot be well fit if the resonance and intercombination lines are constrained to have the same profile shape. However, a significantly better fit is achieved with a model incorporating the effects of resonance scattering, which causes the resonance line to become more symmetric than the intercombination line for a given characteristic continuum optical depth τ_*. We discuss the plausibility of this hypothesis, as well as its significance for our understanding of Doppler profiles of X-ray emission lines in O stars.

Reference: ApJ

Comments: 29 pages, 8 figures

On the web at: http://arXiv.org/abs/astro-ph/0610181/

Preprints from: maurice@astro.columbia.edu

Proceedings

Spectral Synthesis of Massive Stars in Clusters

Claus Leitherer

STScI

Stellar clusters are thought to be the simplest stellar systems and the closest observational counterparts to theoretical models for single stellar populations. Progress in our understanding of the atmospheres and evolution of massive stars has led to generally reliable synthesis models. The future release of new evolution models with rotation, however, will require non-trivial updates to previously published synthesis models, in particular for all Wolf-Rayet and red supergiant related quantities. Cluster synthesis work is currently progressing from a purely stellar approach to a more comprehensive stellar+cluster perspective. The photometric evolution of stars and the dynamical evolution of clusters are delicately interwoven. Recent work attempts to combine these seemingly related fields.

Reference: To appear in "Mass loss from stars and the evolution of stellar clusters". Proc. of a workshop held in honor of Henny Lamers, Lunteren, The Netherlands, May 29 - June 1, 2006. Editors Alex de Koter, Linda Smith and Rens Waters (San Francisco: ASP)

On the web at: http://xxx.lanl.gov/abs/astro-ph/0608698

Preprints from: leitherer@stsci.edu

Using polarization to study the winds of massive stars

Ben Davies (1,2), Jorick S. Vink (3), Rene D. Oudmaijer (1)

(1) University of Leeds, UK; (2) R.I.T., USA; (3) University of Keele, UK.

The topic of wind-clumping has been the subject of much activity in recent years, due to the impact that it can have on derived mass-loss rates. Here we present an alternative method of investigating wind-clumping, that of polarimetry. We present simulations of the polarization produced by a clumpy wind, and argue that the observations may be reproduced just by statistical deviations from spherical symmetry when the outflow is only slightly fragmented. Here, the polarization scales with $\dot{M}$, which is consistent with observations of LBVs, WRs and O supergiants. Finally, we find clumping factors in the inner $2R_{\star}$ of $\sim 2-3$, and speculate as to the clumping stratification of hot stars.

Reference: to appear in proceedings of 'Mass loss from stars and the evolution of stellar clusters

Comments: updated weblink.

On the web at: http://xxx.lanl.gov/abs/astro-ph/0609368

Preprints from: bd@ast.leeds.ac.uk

Close Pairs as Probes of the Galaxy's Chemical Evolution

Dany Vanbeveren and Erwin De Donder

Astrophysical Institute, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussels, Belgium

Understanding the galaxy in which we live is one of the great intellectual challenges facing modern science. With the advent of high quality observational data, the chemical evolution modeling of our galaxy has been the subject of numerous studies in the last years. However, all these studies have one missing element which is the evolution of close binaries. Reason: their evolution is very complex and single stars only perhaps can do the job. (Un)Fortunately at present we know that a significant fraction of the observed intermediate mass and massive stars are members of a binary or multiple system and that certain objects can only be formed through binary evolution. Therefore galactic studies that do not account for close binaries may be far from realistic. We implemented a detailed binary population in a galactic chemical evolutionary model. Notice that this is not something simple like replacing chemical yields. Here we discuss three topics: the effect of binaries on the evolution of 14N, the evolution of the type Ia supernova rate and the effects on the G-dwarf distribution, the link between the evolution of the r-process elements and double neutron star mergers (candidates of short gamma-ray burst objects).

Reference: Invited paper at IAUS240, IAU XXVI GA, Prague

On the web at: `Astro-ph/0609402`

Preprints from: `dvbevere@vub.ac.be`

A Grid of FASTWIND NLTE Model Atmospheres of Massive Stars

K.Lefever, J.Puls, C.Aerts

Instituut voor Sterrenkunde, KULeuven, Leuven Universitatssternwarte, Munchen

In the last few years our knowledge of the physics of massive stars has improved tremendously. However, further investigations are still needed, especially regarding accurate calibrations of their fundamental parameters. To this end, we have constructed a comprehensive grid of NLTE model atmospheres and corresponding synthetic spectra in the massive star domain. The grid covers the complete B type spectral range, extended to late O on the hot side and early A on the cool side, from supergiants to dwarfs and from weak stellar winds to very strong ones. It has been calculated with the latest version of the FASTWIND code. The analysis of an extensive sample of OB stars in the framework of the COROT space mission will lead to accurate calibrations of effective temperatures, gravities, mass loss rates etc. This paper contains a detailed description of the grid, which has been baptised as BSTAR06 and which will be available for further research in the near future.

Reference: to appear in ASPC proceedings of 'Standardisation Workshop', held in Blankenberge on 8-11 May

On the web at: `http://arXiv.org/ps/astro-ph/0609628`

Preprints from: `karolien@ster.kuleuven.be`

GRB progenitors at low metallicities

R. Hirschi[1], G. Meynet[2], A. Maeder[2]

1- University of Basel, CH; 2- Geneva Observatory, CH

We calculated pre-supernova evolution models of single rotating massive stars. These models reproduce observations during the early stages of the evolution very well, in particular Wolf–Rayet (WR) populations and ratio between type II and type Ib,c supernovae at different metallicities (Z). Using these models we found the following results concerning long and soft gamma–ray burst (GRB) progenitors:

- GRBs coming from WO–type (SNIc) WR stars are only produced at low Z (LMC or lower).

- The upper metallicity limit for GRBs is reduced to Z 0.004 (SMC) when the effects of magnetic fields are included.

- GRBs are predicted from the second (and probably the first) stellar generation onwards.

Reference: "Swift and GRBs: Unveiling the Relativistic Universe", San Servolo, Venice, 5-9 June 2006

Comments: 5 pages

On the web at: `http://arxiv.org/abs/astro-ph/0610276`

Preprints from: `raphael.hirschi@unibas.ch`

Pre-supernova models at very low metallicity

R. Hirschi

University of Basel, CH

A series of fast rotating models at very low metallicity (Z=1e-8) was computed in order to explain the surface abundances observed at the surface of CEMP stars, in particular for nitrogen. The main results are the following:

- Strong mixing occurs during He-burning and leads to important primary nitrogen production.

- Important mass loss takes place in the RSG stage for the most massive models. The 85 solar mass model loses about three quarter of its initial mass, becomes a WO star and could produce a GRB.

- The CNO elements of HE1327-2326 could have been produced in massive rotating stars and ejected by their stellar winds.

Reference: Nuclei in the Cosmos IX

Comments: 5 pages, 3 figures

On the web at: `http://pos.sissa.it//archive/conferences/028/116/NIC-IX_116.pdf`

Preprints from: `raphael.hirschi@unibas.ch`

Massive Star Postdoctoral Researcher (#3)

Don Figer
RIT 54 Lomb Memorial Dr COS/Ctr for Imaging Sci, 76-2246 Rochester, NY 146235604

Rochester Institute of Technology invites applications from postdoctoral researchers to pursue research with Dr. Don Figer. This position is for 2 years with possible extension to 3 years.

As part of a 5-year funded NASA Long Term Space Astrophysics project, we seek an energetic postdoctoral scholar to identify and characterize the most massive stars in the Galaxy. The following is the abstract for this project.

Until the Spitzer Space Telescope, there was no wide area survey that could identify massive stars at all distances in the Galaxy. Indeed, the sample of known O-stars is woefully incomplete, as it has largely been generated using optical observations that suffer from the absorption produced by dust in the disk. We are now at the cusp of a revolution in massive star research that Spitzer will trigger, and we propose to capitalize on that opportunity by performing the first survey of massive stars covering the majority of the Galactic volume. We will find and measure the physical properties of the most massive stars in the Galaxy using HST, Spitzer, Chandra, SOFIA, and ground-based observatories, using a survey technique that probes the majority of the Galaxy. This program addresses fundamental questions whose answers are basic requirements for studying many of the most important topics in Astrophysics: the formation and evolution of the most massive stars, the effects of massive stars on lower mass protostellar/protoplanetary systems, gamma-ray burst (GRB) progenitors, nature of the first stars in the Universe, chemical enrichment of the interstellar medium, Galactic gas dynamics, star formation in starbursts and merging galaxies (particularly in the early Universe). The results of our program will influence the science programs for future NASA projects, i.e. JWST, SOFIA, SIM, TPF-C, and TPC-I.

Enquiries about this program may be directed to Dr. Don Figer (figer@cis.rit.edu). Applications should include: a cover letter, a CV, and a statement of research interests. Applicants should also provide names of three references. Applications and letters of reference received before December 1, 2006 will receive full consideration. Applicants must have a PhD. Please refer to job PC#9143.

Weblink: `http://finweb.rit.edu/HumanResources/CareerZone/servlet.html?cmd=jobmart.user.ViewPositionPage&position.id=1714`

Email contact: `figer@cis.rit.edu`

Closing date: December 1, 2006

Postdoctoral Research Position - Massive Stars

Douglas R. Gies
GEORGIA STATE UNIVERSITY Dept. of Physics and Astronomy P. O. Box 4106 Atlanta, Georgia 30302-4106 U.S.A. Tel: (404) 651-1366 FAX: (404) 651-1389

Applications are invited for a postdoctoral research position in the Center for High Angular Resolution Astronomy (CHARA) and Department of Physics and Astronomy at Georgia State University. The successful applicant will work with Dr. Douglas Gies and collaborators on observational and computational studies of massive stars. Current projects include spectroscopic and interferometric studies of massive binaries, Be stars, and rapidly rotating stars. Observational and/or computational experience in these areas would be useful. CHARA operates the CHARA Array, an optical/IR interferometer consisting of six 1.0-m telescopes, located at Mount Wilson, California. We expect the appointee will work at Mount Wilson most of the time and will partially support the research effort there. The initial appointment is for one year, renewable to a total of three years. Curriculum vitae, a bibliography, a one-page summary of research interests, and names of three references (plus contact information) should be sent to Professor Gies at the above address. The deadline for receipt of these materials is 31 January 2007. AAE/EEO.

Email contact: `gies@chara.gsu.edu`

Closing date: 31 January 2007

Meetings

First Stars III

July 16-20, 2007
Santa Fe, NM, USA

First Stars III is the third in a series of international conferences to bring together experts in the related fields studying the physics of formation, life and death of the earliest stars and their impact on subsequent structure formation and chemical evolution of the Universe.

In 1999, a three day workshop entitled "The First Stars" was a joint ESO/MPA/MPE conference held in Garching, Germany. First Stars II was hosted by the department of Astronomy and Astrophysics at Pennsylvania State University at State College Pennsylvania in 2003. First Stars III is hosted by Los Alamos National Laboratory, and will be held in Santa Fe, July 16-20, 2007 (reception on July 15).

In the eight years since the first workshop much has been learned about primordial stars theoretically and many more observational constraints have been found. With a view towards ongoing programs to connect the chemical yields of the first stars directly to observational evidence in the local universe, First Stars III will have an additional focus on the physics of the first explosions.

TOPICS

* Formation and IMF of the first stars * Stellar evolution and explosions at very low metallicities * Feedback from the first stars and galaxies and its influence on structure formation * Star formation at very low metallicities * High redshift Gamma Ray Bursts and quasars * Nucleosynthesis in metal-free and metal-poor stars * Early feedback processes: ionization and IGM abundance patterns * Searches for Pop. III and very low metallicity stars and observed abundance patterns

SCIENTIFIC ORGANIZATION COMMITTEE:

Timothy Beers (Michigan State), Benedetta Ciardi (MPA), Richard Ellis (CalTech), Chris Fryer (LANL), Thomas Janka (MPA), John Lattanzio (Monash), Norbert Langer (Utrecht), Piero Madau (UCSC), Chris McKee (Berkeley), Ken Nomoto (U. Tokyo), Michael Norman (UCSD), Jeremiah Ostriker (Princeton), Max Pettini (Cambridge), Francesca Primas (ESO), Yong-Zhong Qian (U. Minn), Joe Silk (Oxford), Chris Sneden (U Texas), Jim Truran (Chicago), Masayuki Umemura (U. Tsukuba), Kim Venn (U. Victoria), Achim Weiss (MPA), Simon White (MPA), Stan Woosley (UCSC), Naoki Yoshida (U. Nagoya)

Weblink: `http://firststars3.org`

Email contact: `bwoshea@lanl.gov`

Core-collapse Supernovae and their massive progenitors

10 Nov 2006
RAS (London)

Low and intermediate mass stars end their lives quietly as white dwarfs, whilst massive stars (>8Mo) die violently as core-collapse supernovae (SNe). During their lives they provide feedback to the ISM via their powerful stellar winds, ionizing fluxes and chemically processed material. Neutron stars or black holes are produced during their core-collapse, associated with either Type II or Ib/c SN. In rare Type Ic hypernovae, long-soft Gamma Ray Bursts are als observed. Recent theoretical and observational studies of the end points of massive stellar evolution are now being linked with the diversity of SN properties. This discussion meeting will discuss theory and observations of core collapse SNe and their massive star progenitors and how this impacts upon our understanding of the explosions.

Weblink: `http://www.shef.ac.uk/physics/people/pacrowther/ras.html`

Email contact: `Paul.Crowther@sheffield.ac.uk`