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THE MASSIVE STAR NEWSLETTER

formely known as *the hot star newsletter*

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Contents of this newsletter

Accepted Papers

Effects of rotation on the evolution of primordial stars

S. Ekström[1], G. Meynet[1], C. Chiappini[1,2], R. Hirschi[3], A. Maeder[1]

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(Abridged) Rotation has been shown to play a determinant role at very low metallicity, bringing heavy mass loss where almost none was expected. Is this still true when the metallicity strictly equals zero? The aim of our study is to get an answer to this question, and to determine how rotation changes the evolution and the chemical signature of the primordial stars. We have calculated 14 differentially-rotating and non-rotating stellar models at zero metallicity, with masses between 9 and 200 Msol. The evolution has been followed up to the pre-supernova stage. We find that Z=0 models rotate with an internal profile Omega(r) close to local angular momentum conservation, because of a very weak core-envelope coupling. Rotational mixing drives a H-shell boost due to a sudden onset of CNO cycle in the shell. This boost leads to a high 14N production. Generally, the rotating models produce much more metals than their non-rotating counterparts. The mass loss is very low, even for the models that reach the critical velocity during the main sequence. Due to the low mass loss and the weak coupling, the core retains a high angular momentum at the end of the evolution. The high rotation rate at death probably leads to a much stronger explosion than previously expected, changing the fate of the

models. The inclusion of our yields in a chemical evolution model of the Galactic halo predicts log values of N/O, C/O and 12C/13C ratios of -2.2, -0.95 and 50 respectively at log O/H +12 = 4.2.

Reference: Accepted by A&A

On the web at: `http://arxiv.org/abs/0807.0573`

Preprints from: `sylvia.ekstrom@obs.unige.ch`

Evidence for short-term variations in two O-type stars

De Becker M., Linder N., Rauw G.

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Only a few O-type stars are known to display short-term (a fraction of a day) variations. Intense spectroscopic monitoring of the ON8V star HD 13268 revealed low amplitude variations with periods of several hours. In addition, observations of the SB1 system HD 15137 revealed variations on a time scale of a few hours. We consider these stars to be a good candidates for non radial pulsations, even though variations related to inhomogeneities in a circumstellar disk can not be rejected.

Reference: IBVS, 5841

Comments: Four pages, two figures

On the web at: `http://www.konkoly.hu/cgi-bin/IBVS?5841`

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

Two extremely luminous WN stars in the Galactic center with circumstellar emission from dust and gas

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

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We study relatively isolated massive WN-type stars in the Galactic center. The K-band spectra of WR102ka and WR102c are exploited to infer the stellar parameters and to compute synthetic stellar spectra using the Potsdam Wolf-Rayet (PoWR) model atmosphere code. These models are combined with dust-shell models for analyzing the Spitzer IRS spectra of these objects. Archival IR images complement the interpretation. We report that WR102ka and WR102c are among the most luminous stars in the Milky Way. The mid-IR continua for both objects are dominated by dust emission. For the first time we report the presence of dust in the close vicinity of WN stars. Also for the first time, we have detected lines of pure-rotational transitions of molecular hydrogen in a massive-star nebula. A peony-shaped nebula around 102ka is resolved by the Spitzer MIPS camera. We attribute the formation of this nebula to the recent evolutionary history of WR102ka.

Reference: A&A 486/3 arXiv:0807.2476

Comments: See NASA/Spitzer Press Release at the provided weblink

On the web at: `http://www.spitzer.caltech.edu/Media/releases/ssc2008-13/`

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

Numerical simulations of continuum-driven winds of super-Eddington stars

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We present the results of numerical simulations of continuum-driven winds of stars that exceed the Eddington limit and compare these against predictions from earlier analytical solutions. Our models are based on the assumption that the stellar atmosphere consists of clumped matter, where the individual clumps have a much larger optical thickness than the matter between the clumps. This 'porosity' of the stellar atmosphere reduces the coupling between radiation and matter, since photons tend to escape through the more tenuous gas between the clumps. This allows a star that formally exceeds the Eddington limit to remain stable, yet produce a steady outflow from the region where the clumps become optically thin. We have made a parameter study of wind models for a variety of input conditions in order to explore the properties of continuum-driven winds.

The results show that the numerical simulations reproduce quite closely the analytical scalings. The mass loss rates produced in our models are much larger than can be achieved by line driving. This makes continuum driving a good mechanism to explain the large mass loss and flow speeds of giant outbursts, as observed in *eta* Carinae and other luminous blue variable (LBV) stars. Continuum driving may also be important in population III stars, since line driving becomes ineffective at low metalicities. We also explore the effect of photon tiring and the limits it places on the wind parameters.

Reference: MNRAS (accepted)

On the web at: http://lanl.arxiv.org/abs/0806.4536

Preprints from: marle@udel.edu

Detection of Magnetic Massive Stars in the Open Cluster NGC 3766

M. Virginia McSwain

Lehigh University

A growing number of observations indicate that magnetic fields are present among a small fraction of massive O- and B-type stars, yet the origin of these fields remains unclear. Here we present the results of a VLT/FORS1 spectropolarimetric survey of 15 B-type members of the open cluster NGC 3766. We have detected two magnetic B stars in the cluster, including one with a large field of nearly 2 kG, and we find marginal detections of two additional stars. There is no correlation between the observed longitudinal field strengths and the projected rotational velocity, suggesting that a dynamo origin for the fields is unlikely. We also use the Oblique Dipole Rotator model to simulate populations of magnetic stars with uniform or slightly varying magnetic flux on the ZAMS. None of the models

successfully reproduces our observed range in $B_e ll$ and the expected number of field detections, and we rule out a purely fossil origin for the observed fields.

Reference: ApJ in press, astro-ph/0807.1932

Preprints from: mcswain@lehigh.edu

Long-term monitoring of θ^1 Ori C: the spectroscopic orbit and an improved rotational period

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The young O-type star θ^1 Ori C, the brightest star of the Trapezium cluster in Orion, is one of only two known magnetic rotators among the O stars. However, not all spectroscopic variations of this star can be explained by the magnetic rotator model. We present results from a long-term monitoring to study these unexplained variations and to improve the stellar rotational period. We want to study long-term trends of the radial velocity of θ^1 Ori C, to search for unusual changes, to improve the established rotational period and to check for possible period changes. We combine a large set of published spectroscopic data with new observations and analyze the spectra in a homogeneous way. We study the radial velocity from selected photo-spheric lines and determine the equivalent width of the Halpha and HeII4686 lines. We find evidence for a secular change of the radial velocity of θ^1 Ori C that is consistent with the published interferometric orbit. We refine the rotational period of θ^1 Ori C and discuss the possibility of detecting period changes in the near future.

Reference: Astron. Astrophys. (accepted)

On the web at: http://de.arxiv.org/abs/0805.0701

Preprints from: O.Stahl@lsw.uni-heidelberg.de

Multiple ring nebulae around blue supergiants

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In the course of the life of a massive star, wind-wind interaction can give rise to the formation of circumstellar nebulae which are both predicted and observed in the nature. We present generic model

calculations to predict the properties of such nebulae for blue supergiants. From stellar evolution calculations including rotation, we obtain the time dependence of the stellar wind properties and of the stellar radiation field. These are used as input for hydro-calculations of the circumstellar medium throughout the star's life. Here, we present the results for a rapidly rotating 12 solar masses single star. This star undergoes a blue loop during its post main sequence evolution, at the onset of which its contraction spins it up close to critical rotation. Due to the consequent anisotropic mass loss, the blue supergiant wind sweeps up the preceding slow wind into an hour glass structure. Its collision with the previously formed spherical red supergiant wind shell forms a short-lived luminous nebula consisting of two polar caps and a central inner ring. With time, the polar caps evolve into mid-latitude rings which gradually move toward the equatorial plane while the central ring is fading. These structures are reminiscent to the observed nebulae around the blue supergiant Sher 25 and the progenitor of SN 1987A. The simple model of an hour glass colliding with a spherical shell retrieves most of the intriguing nebula geometries discovered around blue supergiants, and suggests them to form an evolutionary sequence. Our results indicate that binarity is not required to obtain them.

Reference: A&A (accepted)

On the web at: `http://arXiv.org/abs/0807.3049`

Preprints from: `S.M.Chita@uu.nl`

New insights into the nature of the peculiar star θ Carinae

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θ Carinae belongs to a group of peculiar early-type stars (OBN) with enhanced nitrogen and carbon deficiency. It is also known as a binary system, but it is not clear yet whether the chemical anomalies can be explained by mass transfer between the two components. On the basis of the previously reported spectral variability of a few metal lines it may be expected that θ Car possesses a weak magnetic field.

A study of the physical nature of this hot massive binary which is furthermore a well-known blue straggler lying sim2,mag above the turnoff of the young open cluster IC 2602 is important to understand the origin of its strong chemical anomalies.

We acquired high resolution spectroscopic and low resolution spectropolarimetric observations to achieve the following goals: a) to improve the orbital parameters to allow a more in-depth discussion on the possibility of mass transfer in the binary system, b) to carry out a non-local thermodynamic equilibrium (NLTE) abundance analysis, and c) to search for the presence of a magnetic field.

The study of the radial velocities using CORALIE spectra allowed us to significantly improve the orbital parameters. A comparative NLTE abundance analysis was undertaken for θ Car and two other early B-type stars with recently detected magnetic fields, tau,Sco and xi^1,CMa. The analysis revealed significantly different abundance patterns: a one-order-of-magnitude nitrogen overabundance

and carbon depletion was found in θ Car, while the oxygen abundance is roughly solar. For the stars xi^1,CMa and tau,Sco the carbon abundance is solar and, while an N excess is also detected, it is of much smaller amplitude (0.4–0.6,dex). Such an N overabundance is typical of the values already found for other slowly-rotating (magnetic) B-type dwarfs. For θ Car, we attribute instead the chemical peculiarities to a past episode of mass transfer between the two binary components. The results of the search for a magnetic field using FORS 1 at the VLT consisting of 26 measurements over a time span of sim1.2,h are rather inconclusive: only few measurements have a significance level of $3sigma$. Although we detect a periodicity of the order of sim8.8,min in the dataset involving the measurements on all hydrogen Balmer lines with the exception of the H$alpha$ and H$beta$ lines, these results have to be confirmed by additional time-resolved magnetic field observations.

Reference: accepted for publication in A&A

On the web at: `http://arxiv.org/abs/0807.2067`

Preprints from: `mschoell@eso.org`

The mysterious Of?p class and the magnetic O-star θ Ori C

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In recent years, the stars of the Of?p category have revealed a wealth of peculiar phenomena: varying line profiles, photometric changes, and X-ray overluminosity are only a few of their characteristics. Here we review their physical properties, to facilitate comparisons among the Galactic members of this class. As one of them has been proposed to resemble the magnetic oblique rotator θ Ori C, though with a longer period, this latter object is also included in our study to illuminate its similarities and differences with the Of?p category.

Reference: accepted for publication by Revista Mexicana AA

On the web at: `http://arxiv.org/abs/0807.3496`

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

High resolution optical spectroscopy of Plaskett's star

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We present here the analysis of an extensive set of high resolution optical spectra of HD 47 129. We use a disentangling method to separate the individual spectra of each star. We derive a new orbital solution and discuss the spectral classification of both components. A Doppler tomography technique applied to the emission lines H alpha and He II 4686 yields a Doppler map that illustrates the wind interactions in the system. Finally, an atmosphere code is used to determine the different chemical abundances of the system components and the wind parameters.

HD 47 129 appears to be an O8 III/I + O7.5 III binary system in a post RLOF evolutionary stage, where matter has been transferred from the primary to the secondary star. The He overabundance of the secondary supports this scenario. In addition, the N overabundance and C underabundance of the primary component confirm previous results based on X-ray spectroscopy and indicate that the primary is an evolved massive star. Furthermore, the secondary star has a large rotational velocity that deforms its surface, leading to a non-uniform distribution in effective temperature. This could explain the variations in the equivalent widths of the secondary lines with phase. We suggest that the wind of the secondary star is confined near the equatorial plane because of its high rotational velocity, affecting the ram pressure equilibrium in the wind interaction zone.

Reference: A&A (accepted)

On the web at: `http://arxiv.org/abs/0807.4823`

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

Discovery of a young massive stellar cluster near HESS J1813-178

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Ben Davies, R. Michael Rich, E. Valenti, R.P. Kudritzki

Rochester Institute of Technology, UCLA, ESO, IfA

We present the serendipitous discovery of a young stellar cluster in the Galactic disk at l=12deg. Using Keck/NIRSPEC, we obtained high- and low-resolution spectroscopy of several stars in the cluster, and we identified one red supergiant and two blue supergiants. The radial velocity of the red supergiant provides a kinematic cluster distance of 4.7pm0.4 kpc, implying luminosities of the stars consistent with their spectral types. Together with the known Wolf-Rayet star located 2.4' from the cluster center, the presence of the red supergiant and the blue supergiants suggests a cluster age of 6-8 Myr, and an initial mass of 2000 Msun. Several stars in the cluster are coincident with X-ray sources, including the blue supergiants and the Wolf-Rayet star. This is indicative of a high binary fraction, and is reminiscent of the massive young cluster Westerlund 1. The cluster is coincident with two supernova remnants, SNR G12.72-0.0 and G12.82-0.02, and the highly magnetized pulsar associated with the TeV gamma-ray source HESS J1813-178. The mixture of spectral types suggests that the progenitors of these objects had initial masses of 20 - 30 Msun.

Reference: ApJ Letter, accepted http://arXiv.org/abs/0807.4573

Preprints from: `messineo@cis.rit.edu`

γ^2 Velorum: Orbital Solution and Fundamental Parameter Determination with SUSI

J. R. North, P. G. Tuthill, W. J. Tango & J. Davis

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The first complete orbital solution for the double-lined spectroscopic binary system *gamma*^{2} Velorum, obtained from measurements with the Sydney University Stellar Interferometer (SUSI), is presented.

This system contains the closest example of a Wolf-Rayet star and the promise of full characterisation of the basic properties of this exotic high-mass system has subjected it to intense study as an archetype for its class. In combination with the latest radial-velocity results, our orbital solution produces a distance of 336^{+8}_{-7},pc, significantly more distant than the *Hipparcos* estimation (Schaerer et al. 1997; van der Hucht 1997). The ability to fully specify the orbital parameters has enabled us to significantly reduce uncertainties and our result is consistent with the VLTI observational point Millour et al. 2006, but not with their derived distance. Our new distance, which is an order of magnitude more precise than prior work, demands critical reassessment of all distance-dependent fundamental parameters of this important system. In particular, membership of the Vela OB2 association has been reestablished, and the age and distance are also in good accord with the population of young stars reported by Pozzo et al. (2000). We determine the O-star primary component parameters to be $M_V(O) = -5.63 pm 0.10$,mag, $R(O) = 17 pm 2$,R_{sun} and $calM(O) = 28.5 pm 1.1$, M_{sun}. These values are consistent with calibrations found in the literature if a luminosity class of II–III is adopted. The parameters of the Wolf-Rayet component are $M_v(WR) = -4.33 pm 0.17$,mag and $calM(WR) = 9.0 pm 0.6$,M_{sun}.

Reference: MNRAS, 2007, vol 377, pages 415-424

Preprints from: `j.north@physics.usyd.edu.au`

Magnetic field measurements of O stars with FORS 1 at the VLT

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The presence of magnetic fields in O-type stars has been suspected for a long time. The discovery of such fields would explain a wide range of well documented enigmatic phenomena in massive stars, in particular cyclical wind variability, H*alpha* emission variations, chemical peculiarity, narrow X-ray emission lines and non-thermal radio/X-ray emission.

To investigate the incidence of magnetic fields in O stars, we acquired 38 new spectropolarimetric observations with FORS 1 (FOcal Reducer low dispersion Spectrograph) mounted on the 8-m Kueyen telescope of the VLT.

Spectropolarimetric observations have been obtained at different phases for a sample of 13 O stars. 10 stars were observed in the spectral range 348–589,nm, HD,36879 and HD,148937 were observed in the spectral region 325–621,nm, and HD,155806 was observed in both settings. To prove the feasibility of the FORS 1 spectropolarimetric mode for the measurements of magnetic fields in hot stars, we present in addition 12 FORS 1 observations of the mean longitudinal magnetic field in $theta^1$,Ori,C and compare them with measurements obtained with the MuSiCoS, ESPaDOnS and Narval spectropolarimeters.

Most stars in our sample which have been observed on different nights show a change of the magnetic field polarity, but a field at a significance level of $3sigma$ has been detected only in four

stars, HD,36879, HD,148937, HD,152408, and HD,164794. The largest longitudinal magnetic field, $langle B_z rangle$,=,$-276 pm 88$,G, was detected in the Of?p star HD,148937. We conclude that large-scale organised magnetic fields with polar field strengths larger than 1,kG are not widespread among O-type stars.

Reference: accepted for publication in A&A

On the web at: `http://arxiv.org/abs/0808.2039`

Preprints from: `mschoell@eso.org`

High-resolution X-ray spectroscopy of θ Car

Yael Naze, Gregor Rauw

ULg, Belgium

Context : The peculiar hot star θ Car in the open cluster IC2602 is a blue straggler as well as a single-line binary of short period (2.2d).

Aims : Its high-energy properties are not well known, though X-rays can provide useful constraints on the energetic processes at work in binaries as well as in peculiar, single objects.

Methods : We present the analysis of a 50ks exposure taken with the XMM-Newton observatory. It provides medium as well as high-resolution spectroscopy.

Results : Our high-resolution spectroscopy analysis reveals a very soft spectrum with multiple temperature components (1–6MK) and an X-ray flux slightly below the 'canonical' value ($log[L_X(0.1-10.)/L_{BOL}] \ -7$). The X-ray lines appear surprisingly narrow and unshifted, reminiscent of those of β Cru and τ Sco. Their relative intensities confirm the anomalous abundances detected in the optical domain (C strongly depleted, N strongly enriched, O slightly depleted). In addition, the X-ray data favor a slight depletion in neon and iron, but they are less conclusive for the magnesium abundance (solar-like?). While no significant changes occur during the XMM-Newton observation, variability in the X-ray domain is detected on the long-term range. The formation radius of the X-ray emission is loosely constrained to $< 5\ R_\odot$, which allows for a range of models (wind-shock, corona, magnetic confinement,...) though not all of them can be reconciled with the softness of the spectrum and the narrowness of the lines.

Reference: accepted for publication by A&A

On the web at: `http://arxiv.org/abs/0808.3353`

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

The multiwavelength picture of star formation in the very young open cluster NGC6383

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We review the properties of the very young (2 Myr) open cluster NGC6383. The cluster is dominated by the massive binary HD159176 (O7V + O7V). The distance to NGC6383 is consistently found to be 1.3 +/- 0.1 kpc and the average reddening is determined to be E(B-V) = 0.32 +/- 0.02. Several pre-main sequence candidates have been identified using different criteria relying on the detection of emission lines, infrared excesses, photometric variability and X-ray emission.

Reference: Handbook of Star Forming Regions (Vol. II, The Southern Sky), ed. Bo Reipurth

On the web at: `http://arxiv.org/abs/0808.3887`

Preprints from: `rauw@astro.ulg.ac.be`

Proceedings

X-ray stellar population of the LMC

Yael Naze

ULg, Belgium

In the study of stars, the high energy domain occupies a place of choice, since it is the only one able to directly probe the most violent phenomena: indeed, young pre-main sequence objects, hot massive stars, or X-ray binaries are best revealed in X-rays. However, previously available X-ray observatories often provided only crude information on individual objects in the Magellanic Clouds. The advent of the highly efficient X-ray facilities XMM-Newton and Chandra has now dramatically increased the sensitivity and the spatial resolution available to X-ray astronomers, thus enabling a fairly easy determination of the properties of individual sources in the LMC.

Reference: Invited review at IAUS 256 "The Magellanic system: stars, gas and galaxies" (July 2008, Keele, UK); proceedings edited by J. Th. van Loon and J. M. Oliveira

On the web at: `http://arxiv.org/abs/0808.3924`

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

Revision of Star-Formation Measures

Claus Leitherer

STScI

Rotation plays a major role in the evolution of massive stars. A revised grid of stellar evolutionary tracks accounting for rotation has recently been released by the Geneva group and implemented into the Starburst99 evolutionary synthesis code. Massive stars are predicted to be hotter and more luminous than previously thought, and the spectral energy distributions of young populations mirror this trend. The hydrogen ionizing continuum in particular increases by a factor of up to 3 in the presence of

rotating massive stars. The effects of rotation generally increase towards shorter wavelengths and with decreasing metallicity. Revised relations between star-formation rates and monochromatic luminosities for the new stellar models are presented.

Reference: IAU Symp. 255, Low-Metallicity Star Formation, ed. L. Hunt, S. Madden, & R. Schneider (Cambridge: CUP)

On the web at: `http://xxx.lanl.gov/abs/0807.1913`

Preprints from: `leitherer@stsci.edu`

Jobs

Postdoctoral Position at STScI

Claus Leitherer
Space Telescope Science Institute 3700 San Martin Dr. Baltimore, MD 21218

Applications are invited for a postdoctoral research position at the Space Telescope Science Institute (STScI) starting as early as January 2009 and lasting for up to three years. The successful applicant will work with Dr. Claus Leitherer and collaborators on studies of the interstellar medium and the stellar populations of star-forming galaxies. The successful candidate will spend part of her/his time on the analysis of data collected with the Cosmic Origins Spectrograph, which is currently scheduled for installation in the Hubble Space Telescope in October 2008. Research experience in computational astrophysics and numerical methods is desirable. A PhD in astronomy or astrophysics is required.

STScI is located on Johns Hopkins University Campus in Baltimore, Maryland. STScI's pay is commensurate to the year of Ph.D. The appointment will be made for an initial period of one year with the possibility for extension to three years contingent on performance and funding. STScI offers an excellent benefit package, competitive salaries and a stimulating research environment.

Applicant are required to apply on-line at the given web address. Completed applications received by October 31, 2008 are assured of full consideration. EEO/AA/M/F/D/V

Attention/Comments: Questions may be directed to leitherer@stsci.edu

Weblink:
`https://www.ultirecruit.com/SPA1004/jobboard/JobDetails.aspx?__ID=*E1B7F3EC81E06E69`

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Closing date: 10/31/2008