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THE MASSIVE STAR NEWSLETTER

formerly known as the hot star newsletter

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Editors: Philippe Eenens (University of Guanajuato) eenens@gmail.com

Raphael Hirschi (Keele University) http://www.astroscu.unam.mx/massive_stars

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News

Massive Star Workshop 2016/17 -- Announcement and input request

dear colleagues,

the Organizing Committee of the Massive Star Working Group, together with John Eldridge (in the following, OC refers to both) is preparing the proposal for our next Massive Stars Workshop, that will take place in New Zealand.
After some discussion, the OC decided to have the meeting at the end of 2016, in the week from November 28 to December 2.

As we want to get support from the IAU, we have to write a Letter of Interest. For Symposia to be held in 2016, the deadline for LoIs is September 15, 2014.
This LoI has to contain some information, in particular about the scientific content of the Symposium.

We are a group interested on massive stars, so massive stars will be our main scientific focus. But massive stars have many related or adjacent fields,and to remain an open community, involved with the rest of Astrophysics,we want to also dedicate some time (1-1,5 out of our 4,5 workshop days) to one of these fields. The OC thought that participation of the whole group in this decission would be a positive innitiative.

Therefore we ask you to send comments and opinions about which field of astrophysics should complement our meeting. To mention just a few examples, you could support to have some time for Supernovae, the cosmic reionization, starburst, HII regions, massive star forming regions... (or a combination of them).

Comments can be sent through the massive stars facebook page or to a dedicated email account we have set:
massivestarmeeting2017@yahoo.com
In the first case, OC members already in facebook will collect and synthesize the input and in the second case, the whole OC will have direct acces to the emails received. After input by the community, the OC will take a decision on the complementary subject and write a proposal for the IAU.

As the IAU deadline is September 15, we ask those interested in participating to send their comments before August 15.

best regards,
Artemio Herrero
chair, on behalf of the Massive Stars Organizing Committee

Weblink:

Email: massivestarmeeting2017@yahoo.com

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PAPERS

Abstracts of 11 accepted papers

The wind of Variable C in M33 (an LBV in eruption)

Roberta M. Humphreys (1), Kris Davidson(1), Michael S. Gordon(1), Kerstin Weis(2), Birgitta Burggraf(2), D. J. Bomans(2), and John C. Martin(3)

(1) University of Minnesota
(2) Ruhr Universitaet, Bochum
(3) University of Illinois, Springfield

We discuss the spectrum of Var C in M33 obtained just before the onset of its current brightening and recent spectra during its present "eruption" or optically thick wind stage. These spectra illustrate the typical LBV transition in apparent spectral type or temperature that characterizes the classical LBV or S Dor-type variability. LBVs are known to have slow, dense winds during their maximum phase. Interestingly, Var C had a slow wind even during its hot, quiescent stage in comparison with the normal hot supergiants with similar temperatures. Its outflow or wind speeds also show very little change between these two states.

Reference: Astrophysical Journal Letters, 2014, 782, L21
Status: Manuscript has been accepted

Weblink:

Comments:

Email: roberta@umn.edu

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3D Radiative Transfer in η Carinae: Application of the SimpleX Algorithm to 3D SPH Simulations of Binary Colliding Winds

N. Clementel (1), T. I. Madura (2), C. J. H. Kruip (1), V. Icke (1), T. R. Gull (2)

(1) Leiden Observatory, Leiden University, P.O. Box 9513, 2300 RA Leiden, the Netherlands
(2) Astrophysics Science Division, Code 667, NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA

Eta Carinae is an ideal astrophysical laboratory for studying massive binary interactions and evolution, and stellar wind-wind collisions. Recent three-dimensional (3D) simulations set the stage for understanding the highly complex 3D flows in η Car. Observations of different broad high- and low-ionization forbidden emission lines provide an excellent tool to constrain the orientation of the system, the primary's mass-loss rate, and the ionizing flux of the hot secondary. In this work we present the first steps towards generating synthetic observations to compare with available and future HST/STIS data. We present initial results from full 3D radiative transfer simulations of the interacting winds in η Car. We use the SimpleX algorithm to post-process the output from 3D SPH simulations and obtain the ionization fractions of hy- drogen and helium assuming three different mass-loss rates for the primary star. The resultant ionization maps of both species constrain the regions where the observed forbidden emission lines can form. Including collisional ionization is necessary to achieve a better description of the ionization states, especially in the areas shielded from the secondary's radiation. We find that reducing the primary's mass-loss rate increases the volume of ionized gas, creating larger areas where the forbidden emission lines can form. We conclude that post processing 3D SPH data with SimpleX is a viable tool to create ionization maps for η Car.

Reference: Clementel et al., 2014, MNRAS (accepted)
Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/1406.7240

Comments:

Email: clementel@strw.leidenuniv.nl

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Luminous and Variable Stars in M31 and M33. II. Luminous Blue Variables,Candidate LBVs, Fe II Emission Line Stars, and Other Supergiants

**Roberta M. Humphreys(1), Kerstin Weis(2),
Kris Davidson(1), D.~J.Bomans(2), and
Birgitta Burggraf(2)**

1. University of Minnesota
2. Ruhr-Universitaet Bochum, Germany

An increasing number of non-terminal eruptions are being found in the numerous
surveys for optical transients. Very little is known about these giant eruptions, their progenitors and their evolutionary state. A greatly improved census of the likely progenitor class, including the most luminous evolved stars, the Luminous Blue Varaibles (LBVs), and the warm and cool hypergiants is now needed for a complete picture of the final pre-SN stages of very massive stars. We have begun a survey of the evolved and unstable luminous star
populations in several nearby resolved galaxies. In this second paper on M31 and M33, we review the spectral characteristics, spectral energy distributions, circumstellar ejecta, and evidence for mass loss for 82 luminous and variable stars. We show that many of these stars have warm circumstellar dust including several of the Fe II emission line stars, but conclude that the confirmed LBVs in M31 and M33 do not. The confirmed LBVs have relatively low wind speeds even in their hot, quiescent or visual minimum state compared to the B-type supergiants and Of/WN stars which they spectroscopically resemble. The nature of the Fe II emission line stars and their relation to the LBV state remains uncertain, but some have properties in common with the warm hypergiants and the sgB[e] stars. Several individual stars are

discussed in detail. We identify three possible candidate LBVs and three additional post-red supergiant candidates. We suggest that M33-013406.63 (UIT301,B416) is not an LBV/S Dor variable, but is a very luminous late O-type supergiant and one of the most luminous stars or pair of stars in M33.

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Weblink:

Comments:

Email: roberta@umn.edu

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The VLT-FLAMES Tarantula Survey XVII. Physical and wind properties of massive stars at the top of the main sequence

Joachim M. Bestenlehner(1), Götz Gräfener(1), Jorick S. Vink(1), F. Najarro(2), A. de Koter(3,4), H. Sana(5), C. J. Evans(6), P. A. Crowther(7), V. Hénault-Brunet(8), A. Herrero(9,10), N. Langer(11), F. R. N. Schneider(11), S. Simón-Díaz(9,10), W. D. Taylor(6), and N. R. Walborn(12)

1 - Armagh Observatory, College Hill, Armagh BT61 9DG, United Kingdom; 2 - Centro de Astrobiología (CSIC-INTA), Ctra. de Torrejón a Ajalvir km-4, E-28850 Torrejón de Ardoz, Madrid, Spain; 3 - Astronomical Institute Anton Pannekoek, Amsterdam University, Science Park 904, 1098 XH, Amsterdam, The Netherlands; 4 - Instituut voor Sterrenkunde, Universiteit Leuven, Celestijnenlaan 200 D, 3001, Leuven, Belgium; 5 - ESA/STScI, 3700 San Martin Drive, Baltimore, MD21210, USA; 6 - UK Astronomy Technology Centre, Royal Observatory Edinburgh, Blackford Hill, Edinburgh, EH9 3HJ, UK; 7 - Dept. of Physics & Astronomy, Hounsfield Road, University of Sheffield, S3 7RH, UK; 8 - Department of Physics, Faculty of Engineering and Physical Sciences, University of Surrey, Guildford, GU2 7XH, UK; 9 - Instituto de Astrofísica de Canarias, E-38200 La Laguna, Tenerife, Spain;10 - Departamento de Astrofísica, Universidad de La Laguna, E-38205 La Laguna, Tenerife, Spain; 11 - Argelander-Institut für Astronomie der Universität Bonn, Auf dem Hügel 71, 53121 Bonn, Germany; 12 - Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218, USA

The evolution and fate of very massive stars (VMS) is tightly connected to their mass-loss properties. Their initial and final masses differ significantly as a result of mass loss. VMS have strong stellar winds and extremely high ionising fluxes, which are thought to be critical sources of both mechanical and radiative feedback in giant H ii regions. However, how VMS mass-loss properties change during stellar evolution is poorly understood. In the framework of the VLT-Flames Tarantula Survey (VFTS), we explore the mass-loss transition region from optically thin O star winds to denser WNh Wolf-Rayet star winds, thereby testing theoretical predictions. To this purpose we select 62 O, Of, Of/WN, and WNh stars, an unprecedented sample of stars with the highest masses and luminosities known. We perform a spectral analysis of optical VFTS as well as near-infrared VLT/SINFONI data using the non-LTE radiative transfer code CMFGEN to obtain both stellar and wind parameters. For the first time, we observationally resolve the transition between optically thin O star winds and optically thick hydrogen-rich WNh Wolf-Rayet winds. Our results suggest the existence of a ``kink'' between both mass-loss regimes, in agreement with recent Monte Carlo simulations. For the optically thick regime, we confirm the steep dependence on the classical Eddington factor Gamma_e from previous theoretical and observational studies. The transition occurs on the main sequence near a luminosity of 10^6.1 Lsun, or a mass of 80...90 Msun. Above this limit, we find that -- even when accounting for moderate wind clumping (with f_v = 0.1) -- wind mass-loss rates are enhanced with respect to standard prescriptions currently adopted in stellar evolution calculations. We also show that this results in substantial helium

surface enrichment. Finally, based on our spectroscopic analyses, we are able to provide the most accurate ionising fluxes for VMS known to date, confirming the pivotal role of VMS in ionising and shaping their environments.

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Status: Manuscript has been accepted

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Comments:

Email: jbl@astro.uni-bonn.de

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On the use of the Fourier Transform to determine the projected rotational velocity of line-profile variable B stars

C. Aerts, S. Simon-Diaz, P. G. Groot, P. Degroote

Institute of Astronomy, KULeuven, Belgium

Dept. of Astrophysics, IMAPP, Radboud University Nijmegen, the Netherlands

Instituto de Astrofisica de Canarias, 38200, La Laguna, Tenerife, Spain

Departamento de Astrofisica, Universidad de La Laguna, 38205, La Laguna, Tenerife, Spain

The Fourier Transform method is a popular tool to derive the rotational velocities of stars from their spectral line profiles. However, its domain of validity does not include line-profile variables with time-dependent profiles. We investigate the performance of the method for such cases, by interpreting the line-profile variations of spotted B stars, and of pulsating B stars, as if their spectral lines were caused by uniform surface rotation along with macroturbulence. We perform time-series analysis and harmonic least-squares fitting of various line diagnostics and of the outcome of several implementations of the Fourier Transform method. We find that the projected rotational velocities derived from the Fourier Transform vary appreciably during the pulsation cycle whenever the pulsational and rotational velocity fields are of similar magnitude. The macroturbulent velocities derived while ignoring the pulsations can vary with tens of km/s during the pulsation cycle. The temporal behaviour of the deduced rotational and macroturbulent velocities are in antiphase with each other. The rotational velocity is in phase with the second moment of the line profiles. The application of the Fourier method to stars with considerable pulsational line broadening may lead to an appreciable spread in the values of the rotation velocity, and, by implication, of the deduced value of the macroturbulence. These two quantities should therefore not be derived from single snapshot spectra if the aim is to use them as a solid diagnostic for the evaluation of stellar evolution models of slow to moderate rotators.

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Comments:

Email: conny.aerts@ster.kuleuven.be

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Investigating the origin of cyclical wind variability in hot, massive stars - I. On the dipolar magnetic field hypothesis

A. David-Uraz^{1,2}, G. A. Wade^1, V. Petit^3, A. ud-Doula^4, J. O. Sundqvist^{3,5}, J. Grunhut^6, M. Shultz^{1,2,7}, C. Neiner^8, E. Alecian^{9,8}, H. F. Henrichs^{10}, J.-C. Bouret^{11,12} and the MiMeS Collaboration

1 - Department of Physics, Royal Military College of Canada, PO Box 17000, Stn Forces, Kingston, Canada, K7K 4B4
2 - Department of Physics, Engineering Physics and Astronomy, Queen's University, 99 University Avenue, Kingston, Canada, K7L 3N6
3 - Bartol Research Institute, University of Delaware, Newark, DE 19716, USA
4 - Penn State Worthington Scranton, Dunmore, PA 18512, USA
5 - Institut fur Astronomie und Astrophysik der Universitat Munchen, Scheinerstr. 1, D-81679 Munchen, Germany
6 - European Organisation for Astronomical Research in the Southern Hemisphere, Karl-Schwarzschild-Str. 2, 85748,
Garching bei Munchen, Germany
7 - European Organisation for Astronomical Research in the Southern Hemisphere, Casilla 19001, Santiago 19, Chile
8 - LESIA, UMR 8109 du CNRS, Observatoire de Paris, UPMC, Universit´e Paris Diderot, 5 place Jules Janssen, F-92195
Meudon Cedex, France
9 - UJF-Grenoble 1/CNRS-INSU, Institut de Planetologie et d'Astrophysique de Grenoble (IPAG) UMR 5274, Grenoble, F-38041, France
10 - Astronomical Institute Anton Pannekoek, University of Amsterdam, Science Park 904, NL-1098 XH Amsterdam, the Netherlands
11 - Laboratoire d'Astrophysique de Marseille, CNRS-Universite de Provence, Pole de l'Etoile Site de Chateau-Gombert, ´
38, rue Frederic Joliot-Curie 13388 Marseille cedex 13, France
12 - NASA/Goddard Space Flight Center, Greenbelt, MD 20771 USA

OB stars exhibit various types of spectral variability associated with wind structures, including the apparently ubiquitous discrete absorption components (DACs). These are proposed to be caused by either magnetic fields or non-radial pulsations (NRPs). In this paper, we evaluate the possible relation between large-scale, dipolar magnetic fields and the DAC phenomenon by investigating the magnetic properties of a sample of 13 OB stars exhibiting well-documented DAC behaviour.
Using high-precision spectropolarimetric data acquired in part in the context of the Magnetism in Massive Stars (MiMeS) project, we find no evidence for surface dipolar magnetic fields in any of these stars.

Using Bayesian inference, we compute upper limits on the strengths of the fields and use these limits to assess two potential mechanisms by which the field may influence wind outflow: magnetic wind confinement and local photospheric brightness enhancements. Within the limits we derive, both mechanisms fail to provide a systematic process capable of producing DACs in all of the stars of our

sample. Therefore, this implies that dipolar fields are highly unlikely to be responsible for these structures in all massive stars, meaning that some other mechanism must come into play.

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Comments:

Email: adavid-uraz@astro.queensu.ca

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Time-dependent modeling of extended thin decretion disks of critically rotating stars

P. Kurfürst (1), A. Feldmeier (2), J. Krtička (1)

1-Department of Theoretical Physics and Astrophysics, Masaryk University, Kotlářská 2, CZ-611,37 Brno, Czech Republic;
2-Institut für Physik und Astronomie, Universität Potsdam, Karl-Liebknecht-Strasse 24/25, 14476 Potsdam-Golm, Germany

During their evolution massive stars can reach the phase of critical rotation when a further increase in rotational speed is no longer possible. Direct centrifugal ejection from a critically or near-critically rotating surface forms a gaseous equatorial decretion disk. Anomalous viscosity provides the efficient mechanism for transporting the angular momentum outwards.
The outer part of the disk can extend up to a very large distance from the parent star. We study the evolution of density, radial and azimuthal velocity, and angular momentum loss rate of equatorial decretion disks out to very distant regions. We investigate how the physical characteristics of the disk depend on the distribution of temperature and viscosity.
We calculated stationary models using the Newton-Raphson method. For time-dependent hydrodynamic modeling we developed the numerical code based on an explicit finite difference scheme on an Eulerian grid including full Navier-Stokes shear viscosity.
The sonic point distance and the maximum angular momentum loss rate strongly depend on the temperature profile and are almost independent of viscosity. The rotational velocity at large radii rapidly drops accordingly to temperature and viscosity distribution. The total amount of disk mass and the disk angular momentum increase with decreasing temperature and viscosity. The time-dependent one-dimensional models basically confirm the results obtained in the stationary models as well as the assumptions of the analytical approximations. Including full Navier-Stokes viscosity we systematically avoid the rotational velocity sign change at large radii. The unphysical drop of the rotational velocity and angular momentum
loss at large radii (present in some models) can be avoided in the models with decreasing temperature and viscosity.

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Comments:

Email: petrk@physics.muni.cz

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The HD5980 multiple system: Masses and evolutionary status

Gloria Koenigsberger, Nidia Morrell, D. John Hiller, Fabian R.N. Schneider, Nicolas Gonzalez-Jimenez,
Norbert Langer, and Rodolfo Barba

1) Instituto de Ciencias Fisicas, Universidad Nacional Autonoma de Mexico; 2) Las Campanas Observatory, The Carnegie Observatories; 3) Department of Physics and Astronomy, & Pittsburgh Partile Physis, Astrophysics and Cosmology Center, University of Pittsburgh; 4) Facultad de Ciencias Astronomicas y Geofisicas, Universidad Nacional de La Plata, and Instituto de Astrofisica de La Plata; 5) Argelander-Institut fur Astronomie; 6) Departamento de Fisica, Universidad de la Serena

New spectroscopic observations of the LBV/WR multiple system HD5980 in the Small Magellanic Cloud are used to address the question of the masses and evolutionary status of the two very luminous stars in the 19.3d eclipsing binary system. Two distinct components of the N V 4944 A line are detected in emission and their radial velocity variations are used to derive masses of 61 and 66 Mo, under the assumption that binary interaction effects on this atomic transition are negligible. We propose that this binary system is the product of quasi-chemically homogeneous evolution with little or no mass transfer. Thus, both of these binary stars may be candidates for gamma-ray burst progenitors or even pair instability supernovae. Analysis of the photospheric absorption lines belonging to the third-light object in the system confirm that it consists of an O-type star in a 96.56d eccentric orbit (e=0.82) around an unseen companion. The 5:1 period ratio and high eccentricities of the two binaries suggest that they may constitute a hierarchical quadruple system.

Reference: Astronomical Journal (in press)
Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/1408.0556

Comments:

Email: gloria@astro.unam.mx

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Magnetic braking of stellar cores in red giants and supergiants

Andre Maeder and Georges Meynet

Geneva Observatory, Geneva University

Magnetic configurations, stable on the long term, appear to exist in various evolutionary phases, from Main-Sequence stars to white dwarfs and neutron stars. The large scale ordered nature of these fields, often approximately dipolar, and their scaling according to the flux conservation scenario favor the model of a fossil field Duez et al. (2010). We make some first estimates of the
magnetic coupling between the stellar cores and the outer layers in red giants and supergiants. Analytical

expressions of the truncation radius of the field coupling are established for a convective envelope and for a rotating radiative zone with horizontal turbulence. The timescales of the internal exchanges of angular momentum are considered.

Numerical estimates are made on the basis of recent model grids. The direct magnetic coupling of the core to the extended convective envelope of red giants and supergiants appears unlikely. However, we find that the intermediate radiative zone is fully coupled to the core during the He-burning and later phases. This coupling is able to produce a strong spin down of the core of red giants and supergiants, also leading to relatively slowly rotating stellar remnants, like white dwarfs and pulsars. Some angular momentum is also transferred to the outer convective envelope of red giants and supergiants during the He-burning phase and later.

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Comments:

Email: georges.meynet@unige.ch

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The three-dimensional structure of the Eta Carinae Homunculus

W. Steffen^1, M. Teodoro^2, T. I. Madura^2, J. H. Groh^3, T. R. Gull^2, A. Mehner^4, M. F. Corcoran^{5,6}, A. Damineli^7, and K. Hamaguchi^{5,8}

1 - Instituto de Astronomía, Universidad Nacional Autónoma de México, Apdo Postal 106, Ensenada 22800, Baja California, México; 2 - Astrophysics Science Division, Code 667, NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA; 3 - Geneva Observatory, Geneva University, Chemin des Maillettes 51, CH-1290 Sauverny, Switzerland; 4 - ESO, Alonso de Cordova 3107, Vitacura, Santiago de Chile, Chile; 5 - CRESST and X-ray Astrophysics Laboratory, NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA; 6 - Universities Space Research Association, 7178 Columbia Gateway Drive, Columbia, MD 21046, USA; 7 - Instituto de Astronomia, Geofísica e Ciências Atmosféricas, Universidade de São Paulo, Rua do Matão 1226, Cidade Universitária, São Paulo 05508-900, Brazil; 8 - Department of Physics, University of Maryland, Baltimore County, 1000 Hilltop Circle, Baltimore, MD 21250, USA

We investigate, using the modelling code SHAPE, the three-dimensional structure of the bipolar Homunculus nebula surrounding Eta Carinae as mapped by new ESO Very Large Telescope/X-Shooter observations of the H2 λ = 2.121 25 μm emission line. Our results reveal for the first time important deviations from the axisymmetric bipolar morphology: (1) circumpolar trenches in each lobe positioned point symmetrically from the centre and (2) off-planar protrusions in the equatorial region from each lobe at longitudinal (∼55°) and latitudinal (10°-20°) distances from the projected apastron direction of the binary orbit. The angular distance between the protrusions (∼110°) is similar to the angular extent of each polar trench (∼130°) and nearly equal to the opening angle of the wind–wind collision cavity (∼110°). As in previous studies, we confirm a hole near the centre of each polar lobe and no detectable near-IR H2 emission from the thin optical skirt seen prominently in visible imagery. We conclude that the interaction between the outflows and/or radiation from the central binary stars and their orientation in space has had, and possibly still has, a strong influence on the Homunculus. This implies that prevailing theoretical models of the Homunculus are incomplete as most assume a single-star origin that produces an axisymmetric nebula. We discuss how the newly found features might be related to the Homunculus ejection, the central binary, and the interacting stellar winds.

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Comments:

Email: mairan.teodoro@gmail.com

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MOST Detects Corotating Bright Spots On The Mid-O-Type Giant xi Persei

Tahina Ramiaramanantsoa [1,2], Anthony F. J. Moffat [1,2], Andre-Nicolas Chene [3,4,5], Noel D. Richardson [1,2], Huib F. Henrichs [6], Sebastien Desforges [1,2], Victoria Antoci [7], Jason F. Rowe [8], Jaymie M. Matthews [9], Rainer Kuschnig [9,10], Werner W. Weiss [10], Dimitar Sasselov [11], Slavek M. Rucinski [12] and David B. Guenther [13]

[1] Departement de physique, Universite de Montreal, C.P. 6128, Succ. Centre-Ville, Montreal, QC H3C 3J7, Canada
[2] Centre de Recherche en Astrophysique du Quebec (CRAQ), Canada
[3] Gemini Observatory, Northern Operations Centre, 670 North A'ohoku Place, Hilo, HI 96720, USA
[4] Departamento de Fisica y Astronomia, Universidad de Valparaiso, Av. Gran Bretana 1111, Playa Ancha, Casilla 5030, Chile
[5] Departamento de Astronomia, Universidad de Concepcion, Casilla 160-C, Chile
[6] Astronomical Institute 'Anton Pannekoek', University of Amsterdam, Science Park 904, NL-1098 XH Amsterdam, the Netherlands
[7] Stellar Astrophysics Centre, Department of Physics and Astronomy, Aarhus University, Ny Munkegade 120, DK-8000 Aarhus C, Denmark
[8] NASA Ames Research Center, Moffett Field, CA 94035, USA
[9] Department of Physics and Astronomy, University of British Columbia, 6224 Agricultural Road, Vancouver, BC V6T 1Z1, Canada
[10] Institute for Astronomy, University of Vienna, Turkenschanzstrasse 17, A-1180 Vienna, Austria
[11] Harvard–Smithsonian Center for Astrophysics, 60 Garden Street, Cambridge, MA 02138, USA
[12] Department of Astronomy and Astrophysics, University of Toronto, 50 St George Street, Toronto, ON M5S 3H4, Canada
[13] Institute for Computational Astrophysics, Department of Astronomy and Physics, St Mary’s University, Halifax, NS B3H 3C3, Canada

We have used the MOST (Microvariability and Oscillations of STars) microsatellite to obtain four weeks of contiguous high-precision broad-band visual photometry of the O7.5III(n)((f)) star xi Persei in November 2011. This star is well known from previous work to show prominent DACs (discrete absorption components) on time-scales of about 2 d from UV spectroscopy and non-radial pulsation with one (l = 3) p-mode oscillation with a period of 3.5 h from optical spectroscopy. Our MOST-orbit (101.4 min) binned photometry fails to reveal any periodic light variations above the 0.1 mmag 3 sigma noise level for periods of a few hours, while several prominent Fourier peaks emerge at the 1 mmag level in the two-day period range. These longer period variations are unlikely due to pulsations, including gravity modes. From our simulations based upon a simple spot model, we deduce that we are seeing the photometric modulation of several corotating bright spots on the stellar surface. In our model, the starting

times (random) and lifetimes (up to several rotations) vary from one spot to another yet all spots rotate at the same period of 4.18 d, the best-estimated rotation period of the star. This is the first convincing reported case of corotating bright spots on an O star, with important implications for drivers of the DACs (resulting from corotating interaction regions) with possible bright-spot generation via a breakout at the surface of a global magnetic field generated by a subsurface convection zone.

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Status: Other

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Comments:

Email: tahina@astro.umontreal.ca

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Abstracts of 4 conference proceedings

A New Class of Wolf-Rayet Stars: WN3/O3s

Philip Massey(1), Kathryn F. Neugent (1), Nidia Morrell (2), and D. John Hillier (3)

1) Lowell Observatory, (2) Las Campanas Observatory, Carnegie Observatories, (3) Department of Physics and Astronomy & Pittsburgh Particle Physics, Astrophysics, and Cosmology Center, University of Pittsburgh

Our new survey for Wolf-Rayet stars in the Magellanic Clouds is only 15% complete but has already found 9 new WRs in the LMC. This suggests that the total WR population in the LMC may be underestimated by 10-40%. Eight of the nine are WNs, demonstrating that the "observed" WC to WN ratio is too large, and is biased towards WC stars. The ninth is another rare WO star, the second we have found in the LMC in the past two years. Five (and possibly six) of the 8 WNs are of a new class of WRs, which pose a significant challenge to our understanding. Naively we would classify these stars as "WN3+O3V," but there are several reasons why such a pairing is unlikely, not the least of which is that the absolute visual magnitudes of these stars are faint, with M_V~ -2.3 to -3.1. We have performed a preliminary analysis with CMFGEN, and we find that (despite the faint visual magnitudes) the bolometric luminosities of these stars are normal for early-type WNs. Our fitting suggests that these stars are evolved, with significantly enriched N and He. Their effective temperatures are also normal for early-type WNs. What is unusual about these stars is that they have a surprisingly small mass-loss rate compared to other early-type WNs. How these stars got to be the way they are (single star evolution? binary evolution?) remains an open question. For now, we are designating this class as WN3/O3, in analogy to the late-type WN "slash" stars.

Reference: To appear in IAU 307, New Windows on Massive Stars: Asteroseismology, Interferometry, and Spectropolarimetry
Status: Conference proceedings

Weblink: http://arxiv.org/abs/1407.4659

Comments:

Email: phil.massey@lowell.edu

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Massive Star Asteroseismology in Action

Conny Aerts

Institute of Astronomy, KULeuven, Belgium

Department of Astrophysic/IMAPP, Radboud University Nijmegen, the Netherlands

After highlighting the principle and power of asteroseismology for stellar physics, we briefly emphasize some recent progress in this research for various types of stars. We give an overview of high-precision high duty-cycle space photometry of OB-type stars. Further, we update the overview of seismic estimates of stellar parameters of OB dwarfs, with specific emphasis on convective core overshoot. We discuss connections between pulsational, rotational, and magnetic variability of massive stars and end with future prospects for asteroseismology of evolved OB stars.

Reference: Invited review paper to appear in Proc. IAU307: New windows on massive stars: asteroseismology, interferometry, and
Status: Conference proceedings

Weblink: http://adsabs.harvard.edu/abs/2014arXiv1407.6479A

Comments:

Email: conny.aerts@ster.kuleuven.be

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The B Fields in OB Stars (BOB) Survey

T. Morel (1), N. Castro (2), L. Fossati (2), S. Hubrig (3), N. Langer (2), N. Przybilla (4), M. Schoeller (5), T. Carroll (3), I. Ilyin (3), A. Irrgang (6), L. Oskinova (7), F. R. N. Schneider (2), S. Simon Diaz (8,9), M. Briquet (1), J. F. Gonzalez (10), N. Kharchenko (11), M.-F. Nieva (4,6), R.-D. Scholz (3), A. de Koter (12,13), W.-R. Hamann (7), A. Herrero (8,9), J. Maiz Apellaniz (14), H. Sana (15), R. Arlt (3), R. Barba (16), P. Dufton (17), A. Kholtygin (18), G. Mathys (19), A. Piskunov (20), A. Reisenegger (21), H. Spruit (22), S.-C. Yoon (23)

(1) Institut d'Astrophysique et de Geophysique, Liege, Belgium
(2) Argelander-Institut fuer Astronomie, Bonn, Germany
(3) Leibniz-Institut fuer Astrophysik Potsdam (AIP), Potsdam, Germany
(4) Institute for Astro- and Particle Physics, University of Innsbruck, Austria
(5) European Southern Observatory, Garching, Germany
(6) Dr. Remeis Observatory & ECAP, Bamberg, Germany
(7) Institut fuer Physik und Astronomie der Universitat Potsdam, Germany
(8) Instituto de Astrofisica de Canarias, La Laguna, Spain
(9) Universidad de La Laguna, Dpto. de Astrofisica, La Laguna, Spain
(10) Instituto de Ciencias Astronomicas, de la Tierra, y del Espacio (ICATE), San Juan, Argentina

(11) Main Astronomical Observatory, Kiev, Ukraine
(12) Astronomical Institute Anton Pannekoek, Amsterdam, The Netherlands
(13) Instituut voor Sterrenkunde, Universiteit Leuven, Belgium
(14) Instituto de Astrofisica de Andalucia-CSIC, Granada, Spain
(15) ESA/Space Telescope Science Institute, Baltimore, USA
(16) Departamento de Fisica, La Serena, Chile
(17) Astrophysics Research Centre, Belfast, UK
(18) Chair of Astronomy, Saint-Petersburg State University, Russia
(19) European Southern Observatory, Santiago, Chile
(20) Institute of Astronomy of the Russian Acad. Sci., Moscow, Russia
(21) Pontificia Universidad Catolica de Chile, Santiago, Chile
(22) Max-Planck-Institut fuer Astrophysik, Garching, Germany
(23) Department of Physics and Astronomy, Seoul National University, Seoul, Republic of Korea

The B fields in OB stars (BOB) survey is an ESO large programme collecting spectropolarimetric observations for a large number of early-type stars in order to study the occurrence rate, properties, and ultimately the origin of magnetic fields in massive stars. As of July 2014, a total of 98 objects were observed over 20 nights with FORS2 and HARPSpol. Our preliminary results indicate that the fraction of magnetic OB stars with an organised, detectable field is low. This conclusion, now independently reached by two different surveys, has profound implications for any theoretical model attempting to explain the field formation in these objects. We discuss in this contribution some important issues addressed by our observations (e.g., the lower bound of the field strength) and the discovery of some remarkable objects.

Reference: To appear in proceedings of IAU Symposium 307, New Windows on Massive Stars (Geneva, June 2014)
Status: Conference proceedings

Weblink: http://www.astro.ulg.ac.be/~morel/articles/IAUS307_morel_talk.pdf

Comments:

Email: morel@astro.ulg.ac.be

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Physics of rotation: problems and challenges

Andre Maeder and Georges Meynet

Geneva Observatory, University of Geneva

We examine some debated points in current discussions about rotating stars: the shape, the gravity darkening, the critical velocities, the mass loss rates, the hydrodynamical instabilities, the internal mixing and N--enrichments. The study of rotational mixing requires high quality data and careful analysis. From recent studies where such conditions are fulfilled, rotational mixing is well confirmed. Magnetic coupling with stellar winds may produce an apparent contradiction, i.e. stars with a low rotation and a high N--enrichment. We point out that it rather confirms the large role of shears in differentially rotating stars for the transport processes. New models of interacting binaries also show how shears and mixing may be enhanced in close binaries which are either spun up or down by tidal interactions.

Reference: IAU Symposium 307, New windows on massive stars: asteroseismology, interferometry, and spectropolarimetry, G. Meynet, C. Georgy, J.H. Groh & Ph. Stee, eds.
Status: Conference proceedings

Weblink: http://arxiv.org/abs/1408.1768

Comments: 10 pages, 4 figures

Email: georges.meynet@unige.ch

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JOBS

Faculty Position: Numerical Modelling of Stellar Interiors

Conny Aerts

Institute of Astronomy
University of Leuven
Celestijnenlaan 200D
3001 Leuven
Belgium

http://fys.kuleuven.be/ster/vacancies/numerical-modelling-of-stellar-interiors

Attention/Comments: Online applications only.

Weblink: http://fys.kuleuven.be/ster/vacancies/numerical-modelling-of-stellar-interiors

Email: conny.aerts@ster.kuleuven.be

Deadline: 30 September 2014

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Research Associate in Theoretical Stellar Astrophysics

Raphael Hirschi

Keele University, Keele, ST5 5BG, United Kingdom

Fixed Term for 2 Years

Starting salary: Grade 7 £31,342

Keele University wishes to appoint a Research Associate for a duration of 2 years starting 1 January 2015, in order to conduct research on theoretical stellar astrophysics.

You will work in the group led by Dr Raphael Hirschi within the Astrophysics Group at Keele University as part of an ERC-funded project entitled “Stellar HYdrodynamics, Nucleosynthesis and Evolution” (SHYNE).

You will lead the explosive nucleosynthesis component of this project, which includes grids of models as well as impact studies of key nuclear reactions. You will also contribute to the other components of the project and be encouraged to develop your own research program and your leadership skills.

You should have or be expecting to obtain a PhD in astrophysics or a related area within a year of appointment and should have a demonstrated aptitude for research. Experience in theoretical stellar astrophysics is essential and experience with parallel computer programming is highly desirable.

For more details of this post and the Keele Astrophysics Group, and for information on how to apply, see http://www.astro.keele.ac.uk.

For further enquiries please contact Dr Raphael Hirschi at r.hirschi@keele.ac.uk.

Keele University is committed to the principles of the Athena SWAN charter, and values equality and diversity across our workforce. We strive to ensure that our workforce is representative of broader society, and therefore, we would actively welcome applications from women for this role.

For full post details and to apply, please visit: http://tinyurl.com/RE14-10

Shortlisting will take place on 8th October 2014

Closing date for applications: 1st October 2014

Interviews may be conducted remotely if needed (via skype or similar technology)

Post reference: RE14/10

Attention/Comments:

Weblink: http://tinyurl.com/RE14-10

Email: r.hirschi@keele.ac.uk

Deadline: 1 October 2014

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Fizeau exchange visitors program: call for applications

J. Hron & L. Misoni

European Interferometry Initiative

The Fizeau exchange visitors program in optical interferometry funds (travel and accommodation) visits of researchers to an institute of his/her choice (within the European Community) to perform collaborative work and training on one of the active topics of the European Interferometry Initiative. The visits will typically last for one month, and strengthen the network of astronomers engaged in technical, scientific and training work on optical/infrared interferometry. The program is open for all levels of astronomers (Ph.D. students to tenured staff), non-EU based missions will only be funded if considered essential by the Fizeau Committee. Applicants are strongly encouraged to seek also partial support from their home or host institutions.

The deadline for applications is September 15. Fellowships can be awarded for missions starting in

November 2014.

Further informations and application forms can be found at
www.european-interferometry.eu

The program is funded by OPTICON/FP7.

Please distribute this message also to potentially interested colleagues outside of the your community!

Looking forward to your applications,
Josef Hron & Laszlo Mosoni
(for the European Interferometry Initiative)

Reference: Deadline Sept. 15
Status: Other

Weblink: www.european-interferometry.eu

Comments: Please circulate not later than Sept. 1

Email: fizeau@european-interferometry.eu

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