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PAPERS

Abstracts of 13 accepted papers

The Yellow and Red Supergiants of M33

Maria R. Drout (1, 2), Philip Massey (2), and Georges Meynet (3)

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Yellow and red supergiants are evolved massive stars whose numbers and lo- cations on the HR diagram can provide a stringent test for models of massive star evolution. Previous studies have found large discrepancies between the rel- ative number of yellow supergiants observed as a function of mass and those predicted by evolutionary models, while a disagreement between the predicted and observed locations of red supergiants on the HR diagram was only recently resolved. Here we extend these studies by examining the yellow and red super- giant populations of M33. Unfortunately, identifying these stars is difficult as this portion of the color-magnitude diagram is heavily contaminated by foreground dwarfs. We identify the red supergiants through a combination of radial velocities and a two-color surface gravity discriminant and, after re-characterizing the rotation curve of M33 with our newly selected red supergiants, we identify the yellow supergiants through a combination of radial velocities and the strength of the OI 7774 triplet. We examine about 1300 spectra in total and identify 121 yellow supergiants (a sample which is unbiased in luminosity above log(L/Lsun) = 4.8) and 189 red supergiants. After placing these objects on the HR diagram, we find that the latest generation of Geneva evolutionary tracks show excellent agree- ment with the observed locations of our red and yellow supergiants, the observed relative number of yellow supergiants with mass and the observed red supergiant upper mass limit. These models therefore represent a drastic improvement over previous generations.

Reference: ApJ, in press
Status: Manuscript has been accepted

Weblink: http://arxiv.org/pdf/1203.0247v1.pdf

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A dynamical magnetosphere model for periodic Halpha emission from the slowly rotating magnetic O star HD191612

Jon O. Sundqvist(1), Asif ud-Doula(2), Stanley P. Owocki(1), Richard H. D. Townsend(3), Ian D. Howarth(4), Gregg A. Wade(5), and the MiMeS Collaboration

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The magnetic O-star HD191612 exhibits strongly variable, cyclic Balmer line emission on a 538-day period. We show here that its variable Halpha emission can be well reproduced by the rotational phase variation of synthetic spectra computed directly from full radiation magneto-hydrodynamical simulations of a magnetically confined wind. In slow rotators such as hd, wind material on closed magnetic field loops falls back to the star, but the transient suspension of material within the loops leads to a statistically overdense, low velocity region around the magnetic equator, causing the spectral variations. We contrast such ``dynamical magnetospheres" (DMs) with the more steady-state ``centrifugal magnetospheres" of stars with rapid rotation, and discuss the prospects of using this DM paradigm to explain periodic line emission from also other non-rapidly rotating
magnetic massive stars.

Reference: MNRAS letters, in press
Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/1203.1050

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The Quintuplet Cluster III. Hertzsprung-Russell diagram and cluster age

A. Liermann (1), W.-R. Hamann (2), L. M. Oskinova (2)

1 - Max-Planck-Institute for Radioastronomy, Bonn;
2 - University of Potsdam

The Quintuplet, one of three massive stellar clusters in the Galactic center, is located about 30pc in projection from Sagittarius A*. Based on near-infrared K-band spectra we determine temperatures and luminosities for all stars in our sample and construct the
Herztsprung-Russell diagram. We find two distinct groups: early-type OB stars and late-type KM stars, well separated from each other. By comparison with Geneva stellar evolution models we derive initial masses exceeding 8 solar masses for the OB stars, that are located along an isochrone corresponding to a cluster age of about 4 million years. In addition, we derive number ratios (e. g. N_WR/N_O$) and compare them with predictions of population synthesis models. We find that an instantaneous burst of star formation at about 3.3 to 3.6 Myr ago is the most likely scenario to form the Quintuplet cluster. The late-type stars in the sample are red giant branch (RGB) stars or red supergiants (RSGs) according to their spectral signatures. It is discussed if they could physically belong to the Quintuplet cluster. Furthermore, we apply a mass-luminosity relation to construct the initial mass function (IMF) of the cluster. We find indications for a slightly top-heavy IMF.

Reference: A&A in press; arXiv:1203.2435
Status: Manuscript has been accepted

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Modeling high-energy light curves of the PSR B1259-63/LS 2883 binary based on 3-D SPH simulations

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Temporal changes of X-ray to very-high-energy gamma-ray emissions from the pulsar-Be star binary PSR~B1259-63/LS~2883 are studied based on 3-D SPH simulations of pulsar wind interaction with Be-disk and wind. We focus on the periastron passage of the binary and calculate the variation of the synchrotron and inverse-Compton emissions using the simulated shock geometry and pressure distribution of the pulsar wind. The characteristic double-peaked X-ray light curve from observations is reproduced by our simulation under a dense Be disk condition (base density ~10^{-9} g~cm^{-3}). We interpret the pre- and post-periastron peaks as being due to a significant increase in the conversion efficiency from pulsar spin down power to the shock-accelerated particle energy at orbital phases when the pulsar crosses the disk before periastron passage, and when the pulsar wind creates a cavity in the disk gas after periastron passage, respectively. On the contrary, in the model TeV light curve, which also shows a double peak feature, the first peak appears around the periastron phase. The possible effects of cooling processes on the TeV light curve are briefly discussed.

Reference: Accepted for publication in ApJ.
Status: Manuscript has been accepted

Weblink: http://arXiv.org/abs/1203.2179

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Discovery of a young and massive stellar cluster: Spectrophotometric near-infrared study of Masgomas-1

S. Ramírez Alegría (1,2), A. Marín-Franch (3,4) & A. Herrero (1,2)

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(4) Departamento de Astrofísica, Universidad Complutense de Madrid, E-38040, Madrid, Spain.

Context: Recent near-infrared data have contributed to the discovery of new (obscured) massive stellar clusters and massive stellar populations in previously known clusters in our Galaxy. These discoveries lead us to view the Milky Way as an active star-forming machine.

Aims: The main purpose of this work is to determine physically the main parameters (distance, size, total mass and age) of Masgomas-1, the first massive cluster discovered by our systematic search programme.

Methods: Using near-infrared (J, H, and K_S) photometry we selected 23 OB-type and five red supergiant candidates for multi-object H- and K-spectroscopy and spectral classification.

Results: Of the 28 spectroscopically observed stars, 17 were classified as OB-type, four as supergiants, one as an A-type dwarf star, and six as late-type giant stars. The presence of a supergiant population implies a massive nature of Masgomas-1, supported by our estimate of the cluster initial total mass of (1.94pm0.28)cdot10^4 M_{Sun}, obtained after integrating the cluster mass function. The distance estimate of 3.53 kpc locates the cluster closer than the Scutum-Centaurus base but still within that Galactic arm. The presence of an O9V star and red supergiants in the same population indicates that the cluster age is in the range of 8 to 10 Myr.

Reference: 2012, A&A, accepted
Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/1203.4174

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Clumped stellar winds in supergiant high-mass X-ray binaries: X-ray variability and photoionization

L. M. Oskinova, A. Feldmeier, P. Kretschmar

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The clumping of massive star winds is an established paradigm, which is confirmed by multiple lines of evidence and is supported by stellar wind theory. The purpose of this paper is to bridge the gap between detailed models of inhomogeneous stellar winds in single stars and the phenomenological description of donor winds in supergiant high-mass X-ray binaries (HMXBs). We use the results from time-dependent

hydrodynamical models of the instability in the line-driven wind of a massive supergiant star to derive the time-dependent accretion rate on to a compact object in the Bondi–Hoyle–Lyttleton approximation. The strong density and velocity fluctuations in the wind result in strong variability of the synthetic X-ray light curves. The model predicts a large-scale X-ray variability, up to eight orders of magnitude, on relatively short time-scales. The apparent lack of evidence for such strong variability in the observed HMXBs indicates that the details of the accretion process act to reduce the variability resulting from the stellar wind velocity and density jumps.

We study the absorption of X-rays in the clumped stellar wind by means of a two-dimensional stochastic wind model. The monochromatic absorption in the cool stellar wind, depending on the orbital phase, is computed for realistic stellar wind opacity. We find that the absorption of X-rays changes strongly at different orbital phases. The degree of the variability resulting from the absorption in the wind depends on the shape of the wind clumps, and this is stronger for oblate clumps.

We address the photoionization in the clumped wind, and we show that the degree of ionization is affected by the wind clumping. We derive a correction factor for the photoionization parameter, and we show that the photoionization parameter is reduced by a factor inline image compared to the smooth wind models with the same mass-loss rate, where inline image is the wind inhomogeneity parameter. We conclude that wind clumping must also be taken into account when comparing the observed and model spectra of the photoionized stellar wind.

Reference: 2012, MNRAS, 5 March
Status: Manuscript has been accepted

Weblink: http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2966.2012.20507.x/full

Comments: Supporting Information: Synthetic X-ray light curves for Bondi-Hoyle accretion of a non-stationary stellar wind on to a NS is provided in the on-lne version of the paper or on demand from authors

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The Effects of Stellar Rotation. I. Impact on the Ionizing Spectra and Integrated Properties of Stellar Populations

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We present a sample of synthetic massive stellar populations created using the Starburst99 evolutionary synthesis code and new sets of stellar evolutionary tracks, including one set that adopts a detailed treatment of rotation. Using the outputs of the Starburst99 code, we compare the populations' integrated properties, including ionizing radiation fields, bolometric luminosities, and colors. With these comparisons we are able to probe the specific effects of rotation on the properties of a stellar population. We find that a population of rotating stars produces a much harder ionizing radiation field and a higher bolometric luminosity, changes that are primarily attributable to the effects of rotational mixing on the lifetimes, luminosities, effective temperatures, and mass loss rates of massive stars. We consider the implications of the profound effects that rotation can have on a stellar population, and discuss the

importance of refining stellar evolutionary models for future work in the study of extragalactic, and particularly high-redshift, stellar populations.

Reference: ApJ, in press
Status: Manuscript has been accepted

Weblink: http://xxx.lanl.gov/abs/1203.5109

Comments:

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Grids of stellar models with rotation
II. WR populations and supernovae/GRB progenitors at Z = 0.014

Cyril Georgy^1, Sylvia Ekström^2, Georges Meynet^2, Philip Massey^3, Emily M. Levesque^4, Raphael Hirschi^{5,6}, Patrick Eggenberger^2, André Maeder^2

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Context: In recent years, many very interesting observations have appeared concerning the positions of Wolf-Rayet (WR) stars in the Hertzsprung-Russell diagram (HRD), the number ratios of WR stars, the nature of type Ibc supernova (SN) progenitors, long and soft gamma ray bursts (LGRB), and the frequency of these various types of explosive events. These observations represent key constraints on massive star evolution.
Aims: We study, in the framework of the single-star evolutionary scenario, how rotation modifies the evolution of a given initial mass star towards the WR phase and how it impacts the rates of type Ibc SNe. We also discuss the initial conditions required to obtain collapsars and LGRB.
Methods: We used a recent grid of stellar models computed with and without rotation to make predictions concerning the WR populations and the frequency of different types of core-collapse SNe. Current rotating models were checked to provide good fits to the following features: solar luminosity and radius at the solar age, main-sequence width, red-giant and red-supergiant (RSG) positions in the HRD, surface abundances, and rotational velocities.
Results: Rotating stellar models predict that about half of the observed WR stars and at least half of the type Ibc SNe may be produced through the single-star evolution channel. Rotation increases the duration of the WNL and WNC phases, while reducing those of the WNE and WC phases, as was already shown in previous works. Rotation increases the frequency of type Ic SNe. The upper mass limit for type II-P SNe is $\sim$ 24.9 M$\odot$ for the non rotating models and $\sim$ 19.9 M$\odot$ for the rotating ones. This last value agrees better with observations. Moreover, present rotating models provide a very good fit to the progenitor of SN 2008ax. We discuss future directions of research for further improving the agreement between the models and the observations. We conclude that the mass-loss rates in the WNL and RSG phases are probably underestimated at present. We show that up to an initial mass of 40 M$\odot$, a surface magnetic field inferior to about 200 G may be sufficient to produce some braking. Much lower values are

needed at the red supergiant stage. We suggest that the presence/absence of any magnetic braking effect may play a key role in questions regarding rotation rates of young pulsars and the evolution leading to LGRBs.

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Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/1203.5243

Comments:

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

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

Reference: Publication in A&A
Pre-print available on astro-ph
Status: Manuscript has been accepted

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

Comments: 22 pages, 18 fugres

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A hydrodynamical model of the circumstellar bubble created by two massive stars

Allard Jan van Marle^{1,2}
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Numerical models of the wind-blown bubble of massive stars usually account only for the wind of a single star. However, since massive stars are usually formed in clusters, it would be more realistic to follow the evolution of a bubble created by several stars. We make a 2D model of the circumstellar bubble created by two massive stars: a 40 solar mass star and a 25 solar mass star and follow its evolution. The stars have a separation of approx. 16 pc and surrounded by a cold medium with a density of 20 particles per cubic cm. We use the MPI-AMRVAC hydrodynamics code to solve the conservation equations of hydrodynamics on a 2D cylindrical grid using time-dependent models for the parameters of the wind of the two stars. At the end of the stellar evolution (4.5 and 7.0 million years for the 40 and 25 solar mass stars respectively) we simulate the supernova explosion of each star. Initially, each star creates its own bubble. However, as the bubbles expand they merge, creating a combined, a-spherical bubble. The combined bubble evolves over time, influenced by the stellar winds and supernova explosions. The evolution of a wind-blown bubble, created by two stars deviates from that of the bubbles around single stars. In particular, once one of the stars has exploded, the bubble is too large to maintain for the wind of the remaining star and the outer shell starts to fall apart. The lack of thermal pressure inside the bubble also changes the behavior of circumstellar features close to the remaining star. The supernovae are contained inside the bubble, which reflects part of the energy back into the circumstellar medium.

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Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/1204.2078

Comments: additional data to be published online

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The long period eccentric orbit of the particle accelerator HD167971 revealed by long baseline interferometry

M. De Becker (1), H. Sana (2), O. Absil (1), J.-B. Le Bouquin (3), R. Blomme (4)

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4. Royal Observatory of Belgium, Belgium

Using optical long baseline interferometry, we resolved for the first time the two wide components of HD167971, a candidate hierarchical triple system known to efficiently accelerate particles. Our multi-epoch VLTI observations provide direct evidence for a gravitational link between the O8 supergiant and the close eclipsing O + O binary. The separation varies from 8 to 15 mas over the three-year baseline of our observations, suggesting that the components evolve on a wide and very eccentric orbit (most probably e>0.5). These results provide evidence that the wide orbit revealed by our study is not coplanar with the orbit of the inner eclipsing binary. From our measurements of the near-infrared luminosity ratio, we constrain the spectral classification of the components in the close binary to be O6-O7, and confirm that these stars are likely main-sequence objects. Our results are discussed in the context of the bright non-thermal radio emission already reported for this system, and we provide arguments in favour of a maximum radio emission coincident with periastron passage. HD167971 turns out to be an efficient O-type particle accelerator that constitutes a valuable target for future high angular resolution radio imaging using VLBI facilities.

Reference: MNRAS (in press)
Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/1204.3537

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Magnetometry of a sample of massive stars in Carina

Y. Naze (1), S. Bagnulo (2), V. Petit (3), T. Rivinius (4), G. Wade (5), G. Rauw (1), M. Gagne (3)

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X-ray surveys of the Carina nebula have revealed a few hard and luminous sources associated with early-type stars. Such unusual characteristics for the high-energy emission may be related to magnetically-confined winds. To search for the presence of magnetic fields in these objects, we performed a limited spectropolarimetric survey using the FORS instrument. The multi-object mode was used, so that a total of 21 OB stars could be investigated during a one-night-long run. A magnetic field was detected in two objects of the sample, with a 6 sigma significance; Tr16-22 and 13. Such a detection was expected for Tr16-22, as its X-ray emission is too bright, variable and hard, compared to other late-type O or O+OB systems. It is more surprising for Tr16-13, a poorly known star which so far has never shown any peculiar characteristics. Subsequent monitoring is now needed to ascertain the physical properties of these objects and enable a full modelling of their magnetic atmospheres and winds.

Reference: accepted by MNRAS
Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/1204.4267

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Spectral Types of Red Supergiants in NGC 6822 and the Wolf-Lundmark-Melotte Galaxy

Emily M. Levesque, Philip Massey

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We present moderate-resolution spectroscopic observations of red supergiants (RSGs) in the low-metallicity Local Group galaxies NGC 6822 (Z = 0.4Zsun) and Wolf-Lundmark-Melotte (WLM; Z = 0.1Zsun). By combining these observations with reduction techniques for multislit data reduction and flux calibration, we are able to analyze spectroscopic data of 16 RSGs in NGC 6822 and spectrophotometric data of 11 RSGs in WLM. Using these observations we determine spectral types for these massive stars, comparing them to Milky Way and Magellanic Clouds RSGs and thus extending observational evidence of the abundance-dependent shift of RSG spectral types to lower metallicities. In addition, we have uncovered two RSGs with unusually late spectral types (J000158.14-152332.2 in WLM, with a spectral type of M3 I, and J194453.46-144552.6 in NGC 6822, with a spectral type of M4.5 I) and a third RSG (J194449.96-144333.5 in NGC 6822) whose spectral type has varied from a M2.5 in 1997 to a K5 in 2008. All three of these stars could potentially be members of a recently-discovered class of extreme RSG variables.

Reference: Astronomical Journal
Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/1204.4450

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JOBS

Postdoctoral Research Fellow

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A postdoctoral research position in theoretical modeling of spectropolarimetry of massive stars is available. The research will involve radiative transfer in polarization with applications to massive stars and their circumstellar environments. The work is primarily theoretical modeling, but can include observational components. The position starts no earlier than August 1st. The individual filling the position must hold a PhD in astronomy or physics by the time the appointment begins. Consideration of applications will begin May 15th and will continue until the position is filled.

Applications, including a cover letter, CV, contact information for references, and an ETSU application form, must be submitted through an institutional website. Please see the link below. Questions can be directed to Richard Ignace at ignace@etsu.edu.

Attention/Comments:

Weblink: https://jobs.etsu.edu/applicants/jsp/shared/position/JobDetails_css.jsp?postingId=151138

Email: ignace@etsu.edu

Deadline:

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MEETINGS

A Workshop on Outstanding Problems in Massive Star Research --- the final stages

September 30 to October 3, 2012

Venue: St. Paul, Minnesota, USA (on the banks of the Mississippi)

Current transient surveys are finding SN-like events which are not true supernovae. Some of the "supernova impostors" are suspected to be giant eruptions resembling eta Carinae, possibly related to the Luminous Blue Variables. Meanwhile, the most luminous true
supernovae are believed to be explosions into debris formed by previous mass ejections, and two SNae were observed to have outbursts prior to their final events. All these developments emphasize the importance of instabilities and episodic mass loss in the most massive stars, but
the mechanisms remain mysterious. Do they involve the outer layers, or the core regions, or both? How

do stars above 50 solar masses end their lives? Do they just collapse to black holes? Recent studies confirm that classical Type II SN progenitors have much lower initial masses. Many of the outstanding questions about final stages of very massive stars are primarily theoretical, but observations are scarce, especially of the progenitor class.

The meeting will be a three day topical workshop to bring together theorists and observers studying very massive stars, their instabilities, SNe and their progenitors, and the outcomes of the final eruptions. The emphasis of the workshop will be on the final stages of massive star evolution and the unsolved theoretical and observational questions.

SOC members:
Dave Arnett
Kris Davidson
Alexander Heger - co-chair
Roberta Humphreys- co-chair
Norbert Langer
Vuk Mandic
Peter Meszaros
Yong Qian
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