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THE MASSIVE STAR NEWSLETTER

formerly known as the hot star newsletter

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Nolan Walborn - in memory

Dear Members of the G2 Commission, It is with deep sadness that we have come to learn that one of the giants in our field, our colleague and friend Nolan Walborn, passed away on the night of 21 to 22 february 2018.

Nolan received his PhD from the University of Chicago under the supervision of W.W. Morgan, followed by postdoctoral positions in Toronto and at Cerro Tololo Inter-American Observatory in La Serena. This allowed him to renew his links to the Latin American culture, to which he had strong ties, as he spent several years in Argentina as a child. After Cerro Tololo and a short stint at NASA's Goddard Space Flight Center, he joined the Space Telescope Science Institute in 1984, where he remained working until the very last moment.

He was a very active member of our community and a strong advocate of hot stars, to which he dedicated his professional life with true passion. He always found those objects extremely interesting, and anyone talking to him was immediately caught by his enthusiasm. His pioneering work on spectral properties and classification of hot, massive stars, both in the optical and ultraviolet, are a primary reference and his contributions set a high standard in the field. In recognition of his outstanding contributions, the IAU approved to name Minor Planet 25942 after him.

It is without doubt an immense loss for our community - and we will deeply miss him. Our thoughts and prayers are with his family and his loved ones he left behind during this difficult time.

The Organizing Committee of the Massive Stars Commission
Artemio Herrero, Jorick Vink, Nicole St.-Louis, Asif ud-Doula, You-Hua Chu, Gregor Rauw, Jose Groh

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PAPERS

Abstracts of 10 accepted papers

On the Rotation of Supermassive Stars

Lionel Haemmerlé (1), Tyrone E. Woods (2), Ralf S. Klessen (3,4), Alexander Heger (2), Daniel J. Whalen (5)

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2 - Monash Centre for Astrophysics, School of Physics and Astronomy, Monash University, VIC 3800, Australia
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Ueberle-Str. 2, D-69120 Heidelberg, Germany
4 - Universität Heidelberg, Interdisziplinäres Zentrum für Wissenschaftliches Rechnen, Im Neuenheimer Feld 205, D-69120 Heidelberg, Germany
5 - Institute of Cosmology and Gravitation, University of Portsmouth, Dennis Sciama Building, Portsmouth PO1 3FX, UK

Supermassive stars born from pristine gas in atomically-cooled haloes are thought to be the progenitors of supermassive black holes at high redshifts. However, the way they accrete their mass is still an unsolved problem. In particular, for accretion to proceed, a large amount of angular momentum has to be extracted from the collapsing gas. Here, we investigate the constraints stellar evolution imposes on this angular momentum problem. We present an evolution model of a supermassive Population III star including simultaneously accretion and rotation. We find that, for supermassive stars to form by accretion, the accreted angular momentum has to be about 1% of the Keplerian angular momentum. This tight constraint comes from the OmegaGamma-limit, at which the combination of radiation pressure and centrifugal force cancels gravity. It implies that supermassive stars are slow rotators, with a surface velocity less than 10-20% of their first critical velocity, at which the centrifugal force alone cancels gravity. At such low velocities, the deformation of the star due to rotation is negligible. **Reference:** ApJL,in press
Status: Manuscript has been accepted

Weblink: http://arxiv.org/pdf/1711.09916.pdf

Comments:

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BRITE-Constellation reveals evidence for pulsations in the enigmatic binary Eta Carinae

Noel D. Richardson, Herbert Pablo, Christiaan Sterken, Andrzej Pigulski, Gloria Koenigsberger, Anthony F. J. Moffat, Thomas I. Madura, Kenji Hamaguchi, Michael F. Corcoran, Augusto Damineli, Theodore R. Gull, D. John Hillier, Gerd Weigelt, Gerald Handler, Adam Popowicz, Gregg A. Wade, Werner W. Weiss, Konstanze Zwintz

University of Toledo +

eta Car is a massive, eccentric binary with a rich observational history. We obtained the first high-cadence, high-precision light curves with the BRITE-Constellation nanosatellites over 6 months in 2016 and 6 months in 2017. The light curve is contaminated by several sources including the Homunculus nebula and neighboring stars, including the eclipsing binary CPD−59 2628. However, we found two coherent oscillations in the light curve. These may represent pulsations that are not yet understood but we postulate that they are related to tidally excited oscillations of eta Car's primary star, and would be similar to those detected in lower-mass eccentric binaries. In particular, one frequency was previously detected by van Genderen et al. and Sterken et al. through the time period of 1974 to 1995 through timing measurements of photometric maxima. Thus, this frequency seems to have been detected for nearly four decades, indicating that it has been stable in frequency over this time span. These pulsations could help provide the first direct constraints on the fundamental parameters of the primary star if confirmed and refined with future observations.

Reference: Accepted to MNRAS
Status: Manuscript has been accepted

Weblink: https://arxiv.org/abs/1801.05445

Comments:

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The magnetic variability of the β Cep star ξ1 CMa

S. P. Järvinen (1), S. Hubrig (1), M. Schöller (2), I. Ilyin (1)

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2 - European Southern Observatory, Karl-Schwarzschild-Str. 2, 85748 Garching, Germany

ξ1 CMa is a known magnetic star showing rotationally modulated magnetic variability with a period of 2.17937 d. However, recent work based on high-resolution spectropolarimetry suggests that the rotation period is longer than 30 years. We compare our new spectropolarimetric measurements with FORS 2 at the VLT acquired on three consecutive nights in 2017 to previous FORS 1/2 measurements of the longitudinal magnetic field strength. The new longitudinal magnetic field values are in the range from 115 to 240 G and do not support the presence of a long period.

Reference: 2018, New Astronomy, 62, 37
Status: Manuscript has been accepted

Weblink: http://cdsads.u-strasbg.fr/abs/2018arXiv180107017J

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Identifying two groups of massive stars aligned in the l~38º Galactic direction

Ramírez Alegría, S. (1), Herrero, A. (2,3), Rübke, K. (2,3), Marín-Franch, A. (4), García, M. (5), & Borissova, J. (6,7)

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(5) Centro de Astrobiología, CSIC-INTA, Spain
(6) Instituto de Física y Astronomía, Universidad de Valparaíso, Chile
(7) Millennium Institute of Astrophysics, Chile

Recent near-infrared data have contributed to unveil massive and obscured stellar populations in both new and previously known clusters in our Galaxy. These discoveries lead us to view the Milky Way as an active star-forming machine. We look for young massive cluster candidates as over-densities of OB-type stars. The first search, focused on the Galactic direction l=38º, resulted in the detection of two objects with a remarkable population of OB-type star candidates. With a modified version of the friends-of-friends algorithm AUTOPOP and using 2MASS and UKIDSS-GPS near-infrared (J, H, and K)

photometry for one of our cluster candidates (named Masgomas-6) we selected 30 stars for multi-object and long-slit H- and K-spectroscopy. With the spectral classification and the near-infrared photometric data, we derive individual distance, extinction and radial velocity. Of the 30 spectroscopically observed stars, 20 are classified as massive stars, including OB-types (dwarfs, giants and supergiants), two red supergiants, two Wolf-Rayet (WR122-11 and the new WR122-16), and one transitional object (the LBV candidate IRAS 18576+0341). The individual distances and radial velocities do not agree with a single cluster, indicating that we are observing two populations of massive stars in the same line-of-sight: Masgomas-6a and Masgomas-6b. The first group of massive stars, located at 3.9 kpc, contains both Wolf-Rayets and most of the OB-dwarfs, and Masgomas-6b, at 9.6 kpc, hosts the LBV candidate and an evolved population of supergiants. We are able to identify massive stars at two Galactic arms, but we can not clearly identify whether these massive stars form clusters or associations.

Reference: https://arxiv.org/abs/1801.08683
Status: Manuscript has been accepted

Weblink: https://arxiv.org/abs/1801.08683

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A combined multiwavelength VLA/ALMA/Chandra study unveils the complex magnetosphere of the B-type star HR5907

P. Leto(1), C. Trigilio(1), L.M. Oskinova(2), R. Ignace(3), C.S. Buemi(1), G. Umana(1), A. Ingallinera(1), F. Leone(4,1), N.M. Phillips(5,6), C. Agliozzo(5), H. Todt(2), L. Cerrigone(6,7)

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We present new radio/millimeter measurements of the hot magnetic star HR5907 obtained with the VLA and ALMA interferometers. We find that HR5907 is the most radio luminous early type star in the cm-mm band among those presently known. Its multi-wavelength radio light curves are strongly variable with an amplitude that increases with radio frequency. The radio emission can be explained by the populations of the non-thermal electrons accelerated in the current sheets on the outer border of the magnetosphere of this fast rotating magnetic star. We classify HR5907 as another member of the growing class of strongly magnetic fast rotating hot stars where the gyro-synchrotron emission mechanism efficiently operates in their magnetospheres. The new radio observations of HR5907 are combined with archival X-ray data to study the physical condition of its magnetosphere. The X-ray spectra of HR5907 show tentative evidence for the presence of non-thermal spectral component. We suggest that non-thermal X-rays originate a stellar X-ray aurora due to streams of non-thermal electrons impacting on the stellar surface. Taking advantage of the relation between the spectral indices of the X-ray power-law spectrum and the non-thermal electron energy distributions, we perform 3-D modeling of the radio emission for HR5907. The wavelength-dependent radio light-curves probe magnetospheric layers at different heights above the stellar surface. A detailed comparison between simulated and observed radio light-curves leads us to conclude that the stellar magnetic field of HR5907 is likely non-dipolar, providing further indirect evidence of the complex magnetic field topology of HR5907.

Reference: MNRAS
Status: Manuscript has been accepted

Weblink: https://arxiv.org/pdf/1801.08738.pdf

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Mapping the core of the Tarantula Nebula with VLT-MUSE: I. Spectral and nebular content around R136

N. Castro (1), P. A. Crowther (2), C. J. Evans (3), J. Mackey (4), N. Castro-Rodriguez (5), J. S. Vink (6), J. Melnick (7), F. Selman (7)

(1) University of Michigan, (2) University of Sheffield, (3) UK Astronomy Technology Centre, (4) Dublin Institute for Advanced Studies, (5) GRANTECAN, (6) Armagh Observatory and Planetarium, (7) European Southern Observatory

We introduce VLT-MUSE observations of the central 2′×2′ (30×30 pc) of the Tarantula Nebula in the Large Magellanic Cloud. The observations provide an unprecedented spectroscopic census of the massive stars and ionised gas in the vicinity of R136, the young, dense star cluster located in NGC 2070, at the heart of the richest star-forming region in the Local Group. Spectrophotometry and radial-velocity estimates of the nebular gas (superimposed on the stellar spectra) are provided for 2255 point sources extracted from the MUSE datacubes, and we present estimates of stellar radial velocities for 270 early-type stars (finding an average systemic velocity of 271±41 km/s). We present an extinction map constructed from the nebular Balmer lines, with electron densities and temperatures estimated from intensity ratios of the [SII], [NII], and [SIII] lines. The interstellar medium, as traced by Hα and [NII] λ6583, provides new insights in regions where stars are probably forming. The gas kinematics are complex, but with a clear bi-modal, blue- and red-shifted distribution compared to the systemic velocity of the gas centred on R136. Interesting point-like sources are also seen in the eastern cavity, western shell, and around R136; these might be related to phenomena such as runaway stars, jets, formation of new stars, or the interaction of the gas with the population of Wolf--Rayet stars. Closer inspection of the core reveals red-shifted material surrounding the strongest X-ray sources, although we are unable to investigate the kinematics in detail as the stars are spatially unresolved in the MUSE data. Further papers in this series will discuss the detailed stellar content of NGC 2070 and its integrated stellar and nebular properties.

Reference: ArXiv:1802.01597
Status: Manuscript has been accepted

Weblink: https://arxiv.org/abs/1802.01597

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Intriguing X-ray and optical variations of the gamma Cas analog HD45314

G. Rauw (1), Y. Naze (1), M.A. Smith (2), A.S. Miroshnichenko (3), J. Guarro Flo (4), F. Campos (5), P. Prendergast (6), S. Danford (3), J.N. Gonzalez-Perez (7), A. Hempelmann (7), M. Mittag (7), J.H.M.M. Schmitt (7), K.-P. Schroeder (8), S.V. Zharikov (9)

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A growing number of Be and Oe stars, named the gamma Cas stars, are known for their unusually hard and intense X-ray emission. This emission could either trace accretion by a compact companion or magnetic interaction between the star and its decretion disk. To test these scenarios, we carried out a detailed optical monitoring of HD45314, the hottest member of the class of gamma Cas stars, along with dedicated X-ray observations on specific dates. High-resolution optical spectra were taken to monitor the emission lines formed in the disk, while X-ray spectroscopy was obtained at epochs when the optical spectrum of the Oe star was displaying peculiar properties. Over the last four years, HD45314 has entered a phase of spectacular variations. The optical emission lines have undergone important morphology and intensity changes including transitions between single- and multiple-peaked emission lines as well as shell events, and phases of (partial) disk dissipation. Photometric variations are found to be anti-correlated with the equivalent width of the H-alpha emission. Whilst the star preserved its hard and bright X-ray emission during the shell phase, the X-ray spectrum during the phase of (partial) disk dissipation was significantly softer and weaker. The observed behaviour of HD45314 suggests a direct association between the level of X-ray emission and the amount of material simultaneously present in the Oe disk as expected in the magnetic star-disk interaction scenario.

Reference: A&A in press
Status: Manuscript has been accepted

Weblink: https://arxiv.org/abs/1802.05512

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The long-period massive binary HD 54662 revisited

E. Mossoux (1), L. Mahy (2,1) and G. Rauw (1)

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Context. HD 54662 is an O-type binary star belonging to the CMa OB1 association. Because of its long-period orbit, this system is an interesting target to test the adiabatic wind shock model. Aims. The goal of this study is to improve our knowledge of the orbital and stellar parameters of HD 54662 and to analyze its X-ray emission to test the theoretical scaling of X-ray emission with orbital separation for adiabatic wind shocks. Methods. We applied a spectral disentangling code to a set of optical spectra to determine the radial velocities and the individual spectra of the primary and secondary stars. The orbital solution of the system was established and the reconstructed individual spectra were analyzed by means of the CMFGEN model atmosphere code. We fitted two X-ray spectra using a Markov Chain Monte Carlo

algorithm and compared these spectra to the emission expected from adiabatic shocks. Results. We determine an orbital period of 2103.4 days, a surprisingly low orbital eccentricity of 0.11, and a mass ratio m2/m1 of 0.84. Combined with the orbital inclination inferred in a previous astrometric study, we obtain surprisingly low masses of 9.7 and 8.2 Msun. From the disentangled primary and secondary spectra, we infer O6.5 spectral types for both stars, of which the primary is about two times brighter than the secondary. The softness of the X-ray spectra for the two observations, the very small variation of best-fitting spectral parameters, and the comparison of the X-ray-to-bolometric luminosity ratio with the canonical value for O-type stars allow us to conclude that X-ray emission from the wind interaction region is quite low and that the observed emission is rather dominated by the intrinsic emission from the stars. We cannot confirm the runaway status previously attributed to HD 54662 by computing the peculiar radial and tangential velocities. We find no X-ray emission associated with the bow shock detected in the infrared. Conclusions. The lack of hard X-ray emission from the wind-shock region suggests that the mass-loss rates are lower than expected and/or that the pre-shock wind velocities are much lower than the terminal wind velocities. The bow shock associated with HD 54662 possibly corresponds to a wind-blown arc created by the interaction of the stellar winds with the ionized gas of the CMa OB1 association rather than by a large differential velocity between the binary and the surrounding interstellar medium.

Reference: A&A in press
Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/1802.06535

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The life cycles of Be viscous decretion discs: fundamental disc parameters of 54 SMC Be stars

L. R. Rimulo (1), A. C. Carciofi (1), R. G. Vieira (1), Th. Rivinius (2), D. M. Faes (1), A. L. Figueiredo (1), J. E. Bjorkman (3), C. Georgy (4), M. R. Ghoreyshi (1), I. Soszynski (5)

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Be stars are main-sequence massive stars with emission features in their spectrum, which originates in circumstellar gaseous discs. Even though the viscous decretion disc (VDD) model can satisfactorily explain most observations, two important physical ingredients, namely the magnitude of the viscosity (α) and the disk mass injection rate, remain poorly constrained. The light curves of Be stars that undergo events of disc formation and dissipation offer an opportunity to constrain these quantities. A pipeline was developed to model these events that uses a grid of synthetic light curves, computed from coupled hydrodynamic and radiative transfer calculations. A sample of 54 Be stars from the OGLE survey of the Small Magellanic Cloud (SMC) was selected for this study. Because of the way our sample was selected (bright stars with clear disc events), it likely represents the densest discs in the SMC. Like their siblings in the Galaxy, the mass of the disc in the SMC increases with the stellar mass. The typical mass and angular momentum loss rates associated with the disk events are of the order of ~1e-10Msun/yr and 5e36 gcm^2s^{-2}, respectively. The values of α found in this work are typically of a few tenths, consistent with recent results in the literature and with the ones found in dwarf novae, but larger than current theory predicts.

Considering the sample as a whole, the viscosity parameter is roughly two times larger at build-up ($\langle\alpha_{bu}\rangle$=0.63) than at dissipation ($\langle\alpha_{d}\rangle$=0.26). Further work is necessary to verify whether this trend is real or a result of some of the model assumptions.

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

Weblink: http://arxiv.org/abs/1802.07641

Comments:

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An LTE effective temperature scale for red supergiants in the Magellanic clouds

Hugo M. Tabernero (1), Ricardo Dorda (1), Ignacio Negueruela (1), Carlos González-Fernández (1,2)

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We present a self-consistent study of cool supergiants (CSGs) belonging to the magellanic clouds. We calculated stellar atmospheric parameters using LTE KURUCZ and MARCS atmospheric models for more than 400 individual targets by fitting a careful selection of weak metallic lines. We explore the existence of a T eff scale and its implications in two different metallicity environments (each Magellanic cloud). Critical and in-depth tests have been performed to assess the reliability of our stellar parameters (i.e. internal error budget, NLTE systematics). In addition, several Montercarlo tests have been carried out to infer the significance of the Teff scale found. Our findingspoint towards a unique Teff scale that seems to be independent of the environment.

Reference: MNRAS, in press

Weblink: https://arxiv.org/abs/1802.03219

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CLOSED JOB OFFERS

Postdoctoral Research Assistant - Stellar Wind modelling

Prof Dr Jorick S Vink (jsv@arm.ac.uk)

Armagh Observatory and Planetarium
College Hill, Armagh
Northern Ireland
United Kingdom

The Armagh Observatory and Planetarium invites applications for a Postdoctoral Research Assistant in Astrophysics. The successful applicant will work with Prof. Dr. Jorick S. Vink on developing models for the atmospheres and winds of massive stars. The goal is to compute accurate, dynamically consistent mass-loss rates that can be employed in stellar evolution models of massive stars. Situated near the centre of Armagh, Northern Ireland, the historic Armagh Observatory has active research groups working in stellar, galactic, solar and solar-system astronomy. This is a fixed-term position funded by the UK Science and Technology Facilities Council (STFC). Applicants should have a recent PhD in Astrophysics with a strong research record in relevant areas, including substantial experience in the use of major stellar physics software. The position is available for three years, and can commence on 1 April 2018 or as soon as possible thereafter.

Starting salary will be in the range GBP 28,323 - 30,929.

Full details of the post are available via our website at www.armagh.ac.uk. Applicants should submit a CV, statement of research interests, and the names of three referees, who may be approached, to: Human Resources, Armagh Observatory, College Hill, Armagh BT61 9DG, UK (dcn@arm.ac.uk), to arrive no later than 3pm on Friday 19 of February 2018.

Attention/Comments:

Weblink: www.armagh.ac.uk

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Deadline: Feb 19 2018

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Research fellow in stellar astrophysics

Robert Izzard

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Applications are invited for a Research Fellow position in the Astrophysics Research Group of the University of Surrey. The post is funded by the Science and Technology Facilities Council. The Research Fellow will undertake research to improve the binary_c framework for stellar population modelling, development of which is led in Surrey. Binary_c with be extended to include evolution of very massive

single and binary stars, and algorithms to model ongoing accretion onto very massive stars. This will then be applied to stellar population statistics of very massive single and binary stars with applications to stellar clusters, supernova statistics, close binary evolution and galactic chemical evolution.

This is a three year fixed-term position to start from April 2018 with salary £30,688 to £34,520 per year.

Further details can be found at https://jobs.surrey.ac.uk/vacancy.aspx?ref=003818

Attention/Comments:

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Deadline: Wednesday 14 February 2018

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MEETINGS

The gamma-Cas phenomenon in Be stars

3-5 September 2018

Venue: Strasbourg's Observatory (France)

The nature of the massive Be star with strong and hard X-ray emission, gamma Cassiopae, remains enigmatic. In the last decades it became clear, that gamma Cas is a prototype for the whole new class of stars - there may be thousands of Cas analogues lurking in the Galaxy! "The gamma-Cas phenomenon in Be stars" workshop to be held in Strasbourg, 3-5 September 2018 will assemble the experts in magnetism, binary evolution, X-ray & UV observations, massive star astrophysics, and stellar disks. The goal of the workshop is to obtain a comprehensive overview of gamma Cas analogues, review existing theoretical scenarios on the origin and physics of these objects, and pave new ways to finally resolve the gamma Cas puzzle. We invite everybody to join this 3 day intensive workshop and try your luck in cracking one of the outstanding problems in modern stellar astrophysics.

Registration and abstract submission are open.

Weblink: https://gammacas-enigma.sciencesconf.org/

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Dwarf Galaxies: From the Deep Universe to the Present

August 20-24 2018

Venue: Vienna, IAU general assembly

Session on Metallicity, Massive Stars, and Chemical Evolution

Contributions are welcome to the Symposium on Dwarf Galaxies to be held during the Vienna general assembly of the IAU, and specifically the session on "Metallicity, Massive Stars, and Chemical Evolution".

Our community is becoming increasingly interested in dwarf irregular galaxies as reservoir of very metal-poor massive stars. Unveiling and characterizing massive stars in these environments is a necessary step to understand their physics at the low-Z end. However, our findings can additionally provide unique insight into the latest episodes of star formation of the host galaxies, their initial mass function, chemical composition and feedback processes. There is large room for synergies between the dwarf galaxy community and ours.

This session will bring researchers from both community together, to foster interaction and future collaborations.

Symposium Scientific Rationale:

Dwarf galaxies are key tools for understanding structure formation and galaxy evolution across cosmic time. These low-mass systems allow us to not only gain a detailed understanding of stellar, chemical, and dynamical properties in the nearby universe, they also provide a unique window into the complex physics of the early universe. We are in an era where increasingly powerful observing facilities and simulations are inspiring new studies of the building blocks of structure at all epochs of the universe. This timely Symposium will bring together the broad dwarf galaxy community, with expertise ranging from local dwarf galaxies to massive star formation in low-metallicity environments, from simulations of feedback in a cosmological context to observations of the faint-end of the luminosity function at high redshift.

Symposium Topics will cover:

- Local Group Dwarf Galaxies

- The Interstellar Medium and Star Formation in Dwarfs

- Metallicity, Massive Stars, and Chemical Evolution

- The Dwarf Galaxy - Environment Connection

- Low-Mass Galaxies at High Redshift

- Dwarfs as Cosmological Probes

- The Future in Dwarf Galaxy Research

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