Transactions IAU, Volume XXVIIIA
Reports on Astronomy 2009–2012
Ian Corbett, ed.

doi:10.1017/S1743921312002803

DIVISION IV-V / WORKING GROUP ACTIVE B STARS

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TRIENNIAL REPORT 2009-2012

1. Introduction

The Working Group on Active B Stars (WGABS) was re-established under IAU Commission No. 29 at the IAU General Assembly in Montreal, Quebec, Canada in 1979. Its main goal is to promote and stimulate research and international collaboration in the field of active B stars. Originally known as the Working Group on Be Stars, its name was changed at the 22nd IAU General Assembly in The Hague, Netherlands in 1994 when the research interests of the group were broadened to include activity in all B stars, especially pulsating OB stars, interacting binaries, stellar winds, and magnetic fields.

2. Developments within the past triennium

The *Be Star Newsletter* † has continued to be the main source of information on new discoveries, ideas, manuscripts, and meetings on active B stars. G. Peters, D. Gies, and D. McDavid continue, respectively, as Editor-in-Chief, Technical Editor, and Webmaster. News items and abstracts are published online soon after they are accepted. Since 2000 all contributions have been refereed. When sufficient material is accumulated an issue is formed and a paper version is distributed. Issue No. 39 was published in June 2009, and contains 20 research notes and advertisements of interest to the active B star community and 32 abstracts of papers. The current working issue No. 40 contains 24 research notes and 34 abstracts received by 20 October 2011.

IAUS-272 (Active OB Stars: Structure, Evolution, Mass-Loss, and Critical Limits) was held in Paris, France from 19-23 July 2010. The key topics included the internal structure of active OB stars (pulsations, rotation, magnetism, transport processes), evolution of OB stars (formation, binaries, late evolutionary stages including magnetars and GRBs), the circumstellar environment (disks, magnetospheres, Be phenomenon, and winds), OB stars as extreme condition test beds (critical rotation, mass loss, radiation fields), normal OB stars for calibration purposes (fundamental parameters, astronomical quantities), and populations of OB stars (studies, tracers of galactic structure, cosmic history). The symposium was supported by IAU Divisions IV (Stars) & V (Variable Stars), Commissions 27 (Variable Stars), 36 (Theory of Stellar Atmospheres), and 42 (Close Binary Stars),

† http://http://astsun.astro.virginia.edu/∼dam3ma/benews/

and Working Groups on Active B Stars, Ap and Related Stars, and Massive Stars. There were over 150 participants. The Proceedings, edited by Coralie Neiner, Gregg Wade, Georges Meynet, and Geraldine Peters, were published in July 2011.

High resolution interferometry in the optical and the infrared is continuing to be a valuable probe for circumstellar material surrounding massive stars especially for the disk-like structures that surround Be stars. Improvements in this observational technology now allows angular scales below 1 milli-arcsecond to be reached and in turn has resulted in advances in our understanding of these disk structures (Tycner 2011). For example, interferometry has been used to model individual stars (Štefl *et al.* 2011, Schaefer *et al.* 2011, Delaa *et al.* 2011), compute disk sizes in various wavelength regimes (Millan-Gabet *et al.* 2010, Meilland *et al.* 2008), infer the disk density structure (Tycner *et al.* 2008), find binary systems (Koubský *et al.* 2010, Meilland *et al.* 2008), and estimate disk mass (Kraus *et al.* 2011). New data combined with other observables has led to successful dynamic models that follow disk structure over time to be developed and tested (cf. Carciofi *et al.* 2009). Key to continuing progress will be further development of theoretical models tightly constrained by observations. Interferometric imaging still suffers from sparse (u,v) plane coverage, and theoretical images play a critical role in interpreting the observations. Several groups have developed this modeling capacity (cf. Carciofi *et al.* 2009, Kervella *et al.* 2009, Jones *et al.* 2008, Schaefer *et al.* 2011) and further refinements of these models are expected. Theoreticians and observers from this active area of research will meet in Foz do Iguaçu, Brazil in February 2012 at a European Southern Observatory workshop entitled, *Circumstellar Dynamics at High Resolution.*

The origin of magnetic fields in B stars and their role in generating short-term activity and controlling the evolution is currently a topic of widespread interest. The MiMeS (Magnetism in Massive Stars) Project (Wade *et al.* 2011) is an international collaborative effort that has been awarded 1230 hours of observing time on the Canada-France-Hawaii Telescope and the Telescope Bernard Lyot from 2008-12 to obtain high resolution spectropolarimetry with the ESPaDOnS and Narval instruments. Data on 25 targeted stars and ∼200 survey stars are being modeled by contemporary codes (e.g. Townsend *et al.* 2007, ud-Doula *et al.* 2008).

The *Kepler*, *CoRoT*, and *MOST* spacecraft continue to produce high-quality photometry of active B stars (especially the β Cep, Be, and SPB stars) over long baselines (Balona *et al.* 2011, De Cat *et al.* 2011, Gutiérrez-Soto *et al.* 2011). Along with spectroscopic information these observations reveal a rich set of pulsational frequencies and modes from which constraints can be placed on the internal rotation, metallicity, and the nature of sub-photospheric convection.

The *Fermi Gamma-ray Space Telescope* is providing a wealth of data on a rare group of Be/X-ray binaries that exhibit very high energy emission in the MeV-TeV range. Ongoing studies are investigating their stellar/compact companion interactions, identify the mechanism for particle acceleration, and determine the nature of the compact companions (e.g. Aragona *et al.* 2009, McSwain *et al.* 2010).

Large surveys are yielding information on the nature of entire classes of active B stars, and the extent of the variability in individual objects. The *Spitzer* SAGE survey of the Magellanic Clouds (Bonanos *et al.* 2011) that includes ∼5000 OB stars from which Be stars can be clearly identified reveals a higher percentage of Be stars in the SMC and frequent transitions from a Be-phase to a non-emission state . The VLT-FLAMES surveys of OB stars in the Galaxy and Magellanic Clouds are providing fundamental parameters for thousands of OB stars (Evans *et al.* 2005, 2006, Lennon *et al.* 2011).

Stellar models and evolutionary tracks for B stars continue to become more representative of actual stars with the inclusion of rotation, magnetic fields, and lower metallicities

https://doi.org/10.1017/S1743921312002803 Published online by Cambridge University Press

(cf. Zahn 2011, Ekström *et al.* 2011a,b, 2008) in their computation. Evolutionary models for rotating stars predict an enhancement in the nitrogen abundance due to meridional circulation and turbulent diffusion of CNO-processed material from the stellar core to the photosphere. The effect becomes more prominent at very high rotational velocities. Several investigations have failed to confirm an elevated N abundance in Be stars in general (Brott *et al.* 2011, Dunstall *et al.* 2011, Peters 2011) and thus do not offer support for the presence of critical rotation in these objects. Substantial progress was made on the computation of evolutionary models for Algol binaries with B-type primaries (Van Rensbergen *et al.* 2011) taking into account mass loss from the system from spin-up of the mass gainer and the creation of an accretion hot spot due to the impacting gas stream. Computations of 561 models (Van Rensbergen *et al.* 2008) are available through the CDS.

3. Closing remarks

The WGABS has seen significant advances in our understanding of the activity and the evolution of B-type stars during the past triennium. Large collaborations have produced substantial databases from ground-based telescopes and spacecraft that reveal information on disk geometry and structure, the nature of magnetic fields, pulsation characteristics, and fundamental stellar parameters. Evolutionary models for single stars and Algol binaries are increasingly representing actual stars, though more attention must be given to predicting the N abundances and distribution of mass ratios for the binaries. Mass-loss, rotation, and accretion in hot stars are important processes that still lack sufficient understanding. They affect the evolution of massive stars and, in turn, these stars govern the evolution of their parent galaxies. Circumstellar disks and winds offer unique laboratories for studying these key phenomena.

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Chair and Co-Chair of the Working Group on Active B Stars

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