K2 Proposal on behalf of KASC WG3 (field 4 & 5)

Unveiling B-type star mysteries with K2

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Even nowadays, the interior structure of main sequence stars and their temporal evolution is still not satisfactorily understood. With respect to massive stars, such as the β Cephei stars (variability periods between $2-7$ hr, masses between $9-17$ $M_\odot$; Stankov & Handler, 2005, ApJS 158, 193) and the Slowly Pulsating B (SPB) stars (variability periods between $0.3-3$ d, masses between $9-17$ $M_\odot$; De Cat, 2002, ASPC 203, 436), essential uncertainties comprise:

• *Rotation and angular momentum evolution.* Rotation is believed to influence the evolution of massive stars as strongly as mass and metallicity (e.g., see Maeder, 2009, Springer Berlin Heidelberg, ISBN 978-3-540-76948-4). Rotation leads to a reduction of the stellar luminosity and to an increase of its central density and a reduced central temperature, i.e. they have a reduced effective mass. Angular momentum transport from the core to the envelope in massive stars is needed to avoid that their iron cores in later evolutionary stages reach critical rotation.

• *Internal mixing and main sequence lifetime.* Rotation also induces internal mixing which causes surface abundance changes during stellar evolution (e.g., Maeder, 1987,ASPC 374, 13). Mixing of material into the hydrogen-burning stellar core (”convective overshooting”) considerably affects the main sequence lifetimes of massive stars (e.g., Mowlavi & Forestini, 1994, A&A 282, 843). Different methods to determine the amount of convective core overshooting are still rather inaccurate and results contradictory (e.g., Briquet et al. 2012, MNRAS 427, 483).

• *Opacities.* With the ”new” solar abundances (Asplund et al., 2004, A&A 417, 751) an increase in the heavy-element opacities in the Sun is required (e.g., Villante, 2011, NuPhS 217, 115) to match helioseismic data. The same conclusion holds for pulsational mode excitation in massive stars (e.g., Lenz, 2012, arXiv:1206.2147). Using the new method of ”complex asteroseismology”, Walczak & Daszyńska-Daszkiewicz (2010, AN 331, 1057) showed that it is even not clear which of the presently available opacity tables are preferable.

• *Convection.* In massive stars, gravity modes could be stochastically excited by turbulent convection (Cantiello et al. 2009, A&A, 499, 279; Samadi et al. 2010, Ap&SS, 328, 253; Shiode et al. 2013, MNRAS 430, 1736). The He II ionisation zone is the only subsurface convective layer present in SPB stars, but it is shallow and inefficient (Cantiello et al. 2009). No solar-like oscillations driven by the convection in the envelope are expected in SPB stars. If there would be any, these would be excited by the convection in the core but none were observed so far.

These essential questions can be addressed, and likely solved, using asteroseismology. The prerequisite for such studies are suitable observations of the pulsations. These must be precise, and have a sufficient time span (at least one stellar rotation period) to assure the detection of a suitable number of pulsation modes. For massive pulsating stars, this strategy has been demonstrably applicable. E.g., using photometric and spectroscopic results, Pamyatnykh, Handler & Dziembowski (2004, MNRAS 350, 1022) constrained the convective core size and heavy element abundance of the star ν Eri, and found an increase of the rotation rate towards the core. Degroote et al. (2010, Nature 464, 259) applied the theory of deviations from regular period spacings predicted for gravity modes in the asymptotic regime (Miglio et al., 2008, MNRAS 386, 1487) to the SPB star HD50230 to estimate the extent of the convective core and to constrain the location of the chemical transition zone. However, to arrive at a consistent picture for all massive stars, more objects, over a large range of parameter space, must be seismically sounded.

In the nominal Kepler mission, the β Cep stars were poorly represented because of the rather high Galactic latitude of the observed field. As a result, none these stars could be seismically studied. We are carefully selecting a sample of B-type stars as targets for K2 in long cadence mode. As the K2 photometric data should most likely be complemented with time-series of high-resolution spectroscopy to allow an indepth asteroseismic investigation, we give priority to relatively bright objects with known parallax.