K2 Proposal on behalf of KASC WG3

Asteroseismology of SPB stars

Prepared by Peter De Cat, Gerald Handler, Louis Balona, Victoria Antoci & Jan Cuypers

---

Slowly pulsating B (SPB) stars are mid-to-late B-type stars in the main sequence oscillating in high-order gravity (g-)modes with periods from 0.3 to 3 days. These oscillations are driven by the κ mechanism acting in the iron opacity bump at around 200,000 K (e.g. Dziembowski, Moskalik & Pamyatnykh, 1993, MNRAS 265, 588). Since most SPB stars are multi-periodic, the observed variations have long beat periods and are generally complex. The large observational efforts required for in-depth asteroseismic studies are hard to achieve with ground-based observations. Only complementary long-term space-based observations can lead to asteroseismic discoveries:

- The first in-depth asteroseismic study for an SPB star has been performed for HD50230 based on observation of the CoRoT mission (Degroote et al. 2010, Nature 464, 259). Applying the theory of deviations from regular period spacings predicted for g-modes in the asymptotic regime (A. Miglio et al., 2008, MNRAS 386, 1487) allowed to estimate the extent of the convective core (from the mean period spacing) and to constrain the location of the chemical transition zone (from the deviation of the mean).

- The detection of frequency multiplets induced by stellar rotation and/or magnetic fields has the potential to reveal information about the deep interior of these massive stars.

- There have been speculations about the possible occurance of stochastically excited g-modes in massive stars by the 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). According to Cantiello et al. (2009), the only subsurface convective layer present in SPB stars is in the He II ionisation zone, but it is shallow and inefficient. 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.

Unfortunately, the SPB stars were poorly represented in the nominal *Kepler* mission because of the rather high Galactic latitude of the observed field, so seismic results are still lacking. Balona et al. (2011, MNRAS 413, 2403) studied the *Kepler* lightcurves of a sample of 48 candidate B-type stars, revealing different types of frequency spectra:
− SPB stars only showing long period variations,
− Hybrid pulsators exhibiting both SPB- and β Cephei-type oscillations (both the central and outer internal layers can be probed simultaneously),
− Stars showing (more or less) equally spaced frequency groupings (typical for Be stars) for which it is not clear yet if these frequency groups are caused by rotational modulation and/or stellar pulsations in combination of fast rotation,
− Stars for which there is evidence for (additional) variations originating from migrating spots,
− Constant stars (which are a challenge for theory).
K2 has better prospects for a statistical study of the morphology of the variability and for asteroseismic studies of *candidate* SPB stars because it observes closer to the Galactic plane. Eventhough there is only one known SPB in Field 0 (first object in WG3_SPB_Field00.csv), we can identify many mid-to-late B-type stars, and hence candidate SPB stars within a 12 degree radius of the centre of the field. We request to observe them in LC mode. Priority is given to bright targets with known parallax as follow-up spectroscopy is needed for stellar parameter determination (and mode-identification) (#152 targets before blank line in WG3_SPB_Field00.csv).