

K2 Proposal on behalf of KASC WG 3

Asteroseismology of Delta Scuti Stars

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Delta Scuti stars are important astrophysical laboratories, as they allow us to investigate stellar structures under the influence of different physical phenomena. This is possible because the transition from very deep and vigorous to shallow convective envelopes takes place in the region of the Hertzsprung -Russel Diagram where these stars are located. The existence of convection in the outer layers is of great importance to many aspects of astrophysics; for example, it is believed that the observed alignment of planets around their host stars is strongly related to the depth of the convective zone (so far only approximated; e.g. Lai 2012, MNRAS, 423, 486), but determining the stellar structure is not straight-forward and requires the help of asteroseismology.

While the puzzle of delta Sct stars is not entirely solved yet, observations from the *Kepler* space telescope, revolutionised the field of A and F type stars significantly. Thanks to the unprecedented high quality and long data sets we can now conclude that the mechanism triggering pulsations in δ Sct stars is not (well) understood. Not only do we find *constant* stars inside the δ Sct instability strip (e.g. Uytterhoeven et al. 2011, A&A, 534, 125), which cannot be explained yet, but current models predict, in many cases, a far smaller frequency region of oscillation modes to be excited than observed (e.g. Balona & Dziembowski 2011, MNRAS, 417, 591; Smalley et al. 2011, A&A 535, A3; Antoci et al. 2012, Nature, 477, 570). This suggests either missing physics in the current models and/or additional excitation mechanisms.

The K2 mission offers the unique opportunity to measure known δ Sct stars at ultra-high precision, combining with available ground-based and space data (e.g. SuperWasp) as well as parallaxes and well determined effective temperature and gravities, covering different evolutionary stages. For example, Field 2 contains several known chemically peculiar Am δ Sct stars, but also young pre-main-sequence stars, which not only give us an insight on how the stellar structure changes as the stars evolve toward the Zero Age Main Sequence, where they start burning H to He in their cores. But it is also to be expected that some of these (young) objects host planetary systems, making these perfect targets to meet the primary and secondary mission of K2. Their oscillatory behaviour as well as available parallaxes can help to characterise these systems in case of a positive detection.

Observing A and early F type stars with K2 will also allow to shed light on an additional puzzle for these type of stars: from the ‘first’ *Kepler* mission, there were some A type stars discovered to show flare-like structures (Balona 2012, MNRAS, 423, 3420; Balona 2013, MNRAS, 43, 2240). The flaring phenomenon is directly linked to magnetic fields induced by the dynamo effect, which can only operate if a substantial convective envelope is present. This is not expected for such hot stars. The alternative explanation is that very active low-mass companions are responsible for the flares. New data, in combination with known physical parameters will allow to distinguish between the two scenarios.

There are 9 known δ Scuti stars in Field 2 and 3 in Field 3, most of which were discovered using SuperWasp data (Smalley et al. 2011; Holdsworth, D. et al. 2014, MNRAS, 439, 2078). Eight of these stars show oscillations higher than the Nyquist frequency defined by the long cadence mode. The higher frequency modes imply that higher radial orders are excited giving rise to the possibility of measuring the spacing between consecutive radial orders of modes with the same degree l , a measure for the mean density of the star. We realise that SC slots are in high demand, so in the attached table, stars have been ordered according to perceived priority. We recommend that as many of these stars be observed in short cadence mode, but failing this, it would be important that long-cadence observations be made.

To summarise, with the targets proposed here we plan to investigate: (1) δ Scuti stars at different ages and therefore different stellar structures; (2) pulsation mechanism(s); (3) the possible presence of flares; (4) planetary systems, if found around these stars.