K2 Proposal on behalf of KASC WG3

The causes of variability of O-type stars: pulsation and rotation

Prepared by Luis Balona and Gerald Handler

O-type stars exhibit a plethora of temporal variability. Unfortunately, they have always been poorly studied due to their rarity; none were visible in the original *Kepler* field. In these stars, several mechanisms may lead to observable variations.

For instance, the intense radiation pressure leads to a stellar wind which is observed as migrating discrete absorption components (DACs) in the P Cygni line profiles of far UV spectral lines. DACs are ubiquitous in O star winds (Howarth & Prinja 1989, ApJS 69, 527), and some of these objects show strictly periodic UV line modulations (Fullerton et al. 1997, A&A 327, 699). However, the origin of DACs is not known: one common hypothesis is that they are caused by co-rotating interactive regions (Owocki 2007, ASP Conf. Ser. 361, 3), i.e. variability related to the stellar rotation period is expected. The ubiquity of DACs requires an ubiquitous trigger mechanism which must be rooted on or near the stellar surface. The usual suspects for such a mechanism are nonradial stellar pulsation and magnetic fields. Periodic light variations possibly linked to the rotation period of O stars are observed (Balona 1992, MNRAS 254, 404). However, is very difficult to determine the periods in most cases owing to the limited coverage that can be obtained from the ground.

Many O stars have line profile variations, indicative of pulsation. Models indicate that pulsations of the β Cep and SPB types should extend into the O stars (Pamyatnykh 1999, Acta Astr. 49, 119), but none are found in stars earlier than O9 (Pigulski & Pojmanski 2008, A&A 477, 917; Briquet et al. 2011, A&A 527, A112) However, very few stars have been observed, so no definite conclusions can be made at this time. Of great interest is a report of stochastically driven oscillations in one star, HD 46149 (Degroote et al. 2010, A&A 519, A38). It would be of astrophysical importance if such oscillations were present in (other) O stars.

Besides stellar pulsation and rotation, other possible reasons stated for O star variability are sub-surface convection zones and granulation. The observational consequences thereof, and of structured stellar winds, would be incoherent light variations, giving rise to red noise in periodograms (Blomme et al. 2011, A&A 533, A4). Aside from being interesting to be studied on its own sake, such red noise can mask underlying periodic signals, emphasizing the need for high-quality long-time baseline observations of a larger sample of O stars than available to date.

There are 73 known O stars within 12° of the centre of Field 0. A list of these stars is given in file `wg3_ostars_f00.coomag`. It would be important to take this rare opportunity to observe as many of these stars as possible. The main aims are to look for pulsations and rotational modulation and to separate between different possible causes of O star variability. Long cadence observations are adequate.