Wind clumping in O stars

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Astroseismology of O stars- O stars are rare, but play a dominant role in determining the physical conditions of galaxies, and the interstellar medium. They drive the evolution of galaxies chiefly through chemical enrichment by recycling elements produced in their cores (Kudritzki & Puls 2000). The winds of O stars input significant amount of energy and momentum into the surrounding interstellar medium ionising it, and probably either triggering star formation by collapsing molecular clouds, or inhibiting it by photoevaporating pre-main seqeunce discs thereby influencing planet formation. Overall, O stars and their stellar winds play a crucial role in determining the conditions of their immediate environment, and the galaxy in which they reside.

Although O stars and their stellar winds have been well studied across the wavelength spectrum, they are poorly studied in the time domain. Recent attempts using the space missions focussed on massive stars have shown the potential discoveries about the interior structure of O stars that can be made using information in this domain (Blomme et al. 2011; Buysschaert et al., 2015). The large convective cores of O stars drive oscillations in the pressure and gravity modes. Frequency spectra of O stars can thus be used to understand their interior structure using astroseismology, although current theoretical predictions cannot replicate observations, and there is a considerable amount of red noise (Blomme et al. 2011). Importantly, the winds of O stars are in-homogeneous on small scales, and are termed 'clumped'. Understanding the origin of clumping in the winds of O stars is a matter of grave importance to studies of massive stars, as measures of their mass loss rates, and evolutionary scenarios are affected by clumping which is currently accounted for empirically under a simple optically thin model. Recently, Cantiello et al. (2009) proposed that clumping in O stars, and surface hotspots are induced by a subsurface convective zone, and this may result in unique frequency spectra dominated by red noise. *Using K2, it is for the first time really possible to test whether O stars winds are clumped due to subsurface convection.*

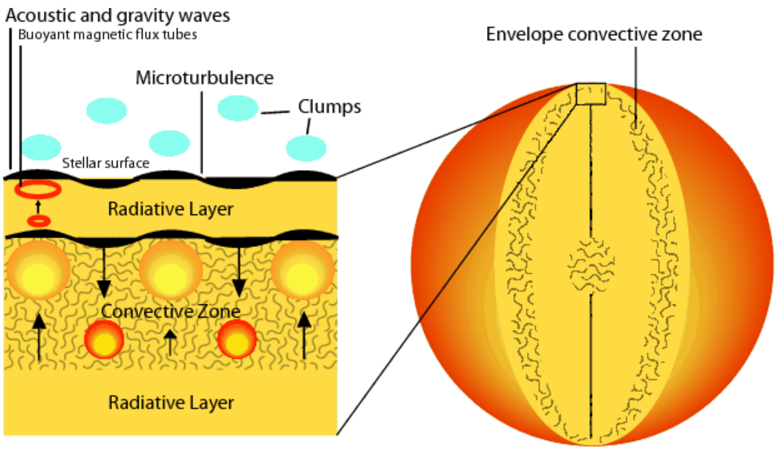

Figure 1: Schematic of the physical processes in sub-surface convection. Acoustic and gravity waves emitted (which can be observed in frequency spectra) travel through the radiative layer and reach the surface, inducing fluctuations, leading to clumping in the wind (from Cantiello et al. 2009).

Planned observations- We plan long cadence monitoring of 20 O stars in K2 falling on silicon in K2 campaign field 9. These are O stars located in the W33, and M8 regions, whose spectral types have been classified previously. They span a range from O3–O9 spectral types, and include both dwarf and giant stars. The extinction and distance to these stars means that they fall within the K2 saturation limit of $K_P > 11$mag, and therefore do not require additional pixels and larger apertures to observe.

Immediate objective– We aim to combine the K2 frequency spectra of the 20 O stars, with high-resolution contemporaneous spectra taken using guaranteed time at the SALT telescope. This will ensure precise spectral classification, measurement of wind terminal velocity, clumping and mass loss rates for the O stars (Bouret et al. 2015). Using the frequency spectra, the data can be used to probe their interior structures (Aerts & Rogers 2015) and understand the clumping mechanisms and test whether a subsurface convective zone really causes clumping and hotspots in O stars.

References- Aerts, C., & Rogers, T. M. 2015, ApJL, 806, L33; Blomme, R., Mahy, L., Catala, C., et al. 2011, A&A, 533, A4; Bouret, J.-C., Lanz, T., Hillier, D. J., et al. 2015, MNRAS, 449, 1545; Buysschaert, B., Aerts, C., Bloemen, S., et al. 2015, MNRAS, 453, 89; Cantiello, M., Langer, N., Brott, I., et al. 2009, A&A, 499, 279 ; Kudritzki, R.-P., & Puls, J. 2000, ARA&A, 38, 613;