Characterising surface stellar variability utilising transiting planets of solar-type stars with ESPRESSO

Lauren Doyle
University of Warwick

Characterising a star in great detail is a vital tool for understanding exoplanets. This is because stellar physics can impact important exoplanet parameters such as radii, mass, and planet atmosphere determinations. Additionally, understanding stellar physics can be crucial when searching for low mass, long period planets (Earth-twins) due to signals being lost within stellar ‘noise’. In this talk, I will present my most recent results on two transiting planets orbiting bright (V~10) host stars; (i) WASP-166 b, a transiting super-Neptune within the Neptune desert and (ii) WASP-131 b, a bloated Saturn mass planet. Utilising high-resolution spectroscopic transit observations from ESPRESSO of both targets, we apply the Reloaded Rossiter McLaughlin (RRM) technique to spatially resolve the stellar surface, characterise the centre-to-limb convection-induced variations, and refine the star-planet obliquity. The net convective velocity shift caused by granules changes as a function of limb angle (i.e. from the centre to the limb of the star) due to line-of-sight changes. Since WASP-166 is an F-type main sequence star (Teff = 6050 K), we were able to characterise centre-to-limb convective variations (CLV) as a result of granulation on the surface of the star on the order of a few km/s and explore differential rotation (DR). By accounting for CLV in our RM models, there was a difference in the star-planet obliquity of 10 degrees, which is in agreement when comparing to simulations. WASP-131 has an effective temperature of 5950 K and a misaligned star-planet obliquity of ~160 degrees, meaning the planet occults multiple latitudes allowing us to detect DR with a shear of 0.6. We also have a potential spot occultation during the ESPRESSO transit observations where we explore the impact this has on the radial velocities of the isolated starlight behind the planet through the RRM technique.