Planetary transits and stellar variability

Suzanne Aigrain

Most of the 130 or so exo-planets (planets orbiting a star other than the Sun) known to date, were detected via the radial velocity (RV) method, which relies on the spectroscopic detection of changes in the parent star's radial velocity as it orbits the star-planet system's centre of mass. Another promising method relies on the detection, in stellar photometric time series, of the periodic dips caused by planets as they cross the disk of their parent star: planetary transits.

Many ground-based transit search projects have been operating for several years and are expected to come to fruition soon – a handful of planets detected via their transits have been confirmed already. From the ground, both transit and RV methods are limited to giant planets. Several space-based transit search missions are thus planned to probe the terrestrial and habitable planet regimes. The preparation of data analysis tools for these missions, in particular COROT and *Eddington*, has been the focus of my PhD, with potential application to ground-based data as a secondary objective.

I first developed and tested an algorithm for the automated detection of transits in white noise, a challenge due to the rare, brief and shallow nature of the transits. One of the most important noise sources for future space-based missions is the intrinsic low-amplitude variability of the parent star on timescales of tens of minutes to weeks. I constructed an empirical model of this 'stellar micro-variability' to simulate realistic light curves for a variety of stars, and developed filters to remove micro-variability. Monte Carlo simulations were used to test the performance of these tools alone and in combination, and to identify which types of stars make the most promising targets for *Eddington* & COROT.

The algorithms' performance was tested against that of others by participating in the COROT transit detection blind exercise, in which a number of groups from across Europe applied their algorithms to a set of simulated light curves of content known only to a game master. A transit search was also performed in 5 nights of data obtained in 2003 by the UNSW transit search team using the 0.5m APT telescope in Siding Springs Observatory in the field of open cluster NGC 6633, and a handful of transit candidates with depths below 50 mmag were identified.