Description for the general public

Statistical studies of extrasolar planetary systems show that planets similar to Jupiter in mass and radius and with orbital periods shorter than 10 days - so called hot Jupiters - constitute a relatively small group of planetary systems. An interesting aspect of hot Jupiter-class planets is that they are not observed in compact planetary systems and other nearby planets do not accompany them. Interestingly, there are hot Jupiters on non-circular orbits. One explanation is that the orbit has not circularized so far. The efficiency of the circularization process depends on the tidal dissipation constant, which is in general poorly constrained for exoplanets. Calculations show, however, that the circularization timescale is much shorter than the system age in most such cases. Another explanation is that the orbital eccentricity might be pumped up by gravitational interactions with unseen planetary companions. Dynamical models show that even very small (Earth-mass or less) companions in certain orbits can provide significant eccentricity excitation.

In this project, we attempt to find the answer on the question about the nature of the non-zero orbital eccentricity in a carefully selected sample of hot Jupiters, which are available for observations from the ground. In particular, we are interested in scenarios, in which the non-circular planetary orbit could be sustained by gravitational perturbations from an additional nearby planet hidden in a system. We plan to use the transit timing technique to identify hot Jupiters, which could be perturbed by planetary companions. For planets, for which such signal is detected, we will conduct high-precision photometric and spectroscopic observations to get to know the system architecture better. If perturbative origin of eccentric orbits can be eliminated, then the tidal dissipation constant could be constrained tighter. This, in turn, could help construct more precise models of the planetary internal structure. We will also search for any sign of long-timescale variations in orbital parameters.

Hot Jupiters with nearby planetary companions would be unprecedented outliers, challenging for theories of formation and evolution of planetary systems. The question whether hot Jupiters are accompanied by nearly planets or not, and what is the occurrence rate of such planetary configurations remains opened.