DETECTING AND CHARACTERIZING PLANETARY SYSTEMS WITH TRANSIT TIMING VARIATIONS

Jason Steffen
Fermilab

Each transiting planet discovered by Kepler provides an opportunity to discover additional nontransiting planets in the same system, determine their masses and orbital elements, and characterize the interactions among the various objects. This is done by observing and analyzing the deviations from a constant period that arise from mutual gravitational perturbations (transit timing variations or TTVs). This method was first developed by myself, my advisor, and my present collaborator (Agol et al. 2005, Holman & Murray 2005) and I have contributed to many of the first analyses and planet discoveries using TTVs (e.g., Steffen & Agol 2006, Agol & Steffen 2007, Holman et al. 2010). TTVs are also important probes of planet formation and evolution theories as some models predict an abundance of systems in or near mean motion resonances where a TTV signal would be the largest. I propose to continue my work for the Kepler mission, where I currently chair the TTV working group, in analyzing the transit times of Kepler systems to detect and characterize the planets discovered in those systems. In particular, using my existing software I will identify additional, nontransiting planets in Kepler systems including possibly nontransiting planets in the habitable zone of the host star, measure the orbital elements of planets in multi and singly transiting systems, eliminate potential false positive signals based upon the observation or non-observation of TTVs, and constrain planet formation and evolution theories using the observed orbital architectures of planetary systems (e.g., proximity to resonance or large eccentricities where the TTV signal is particularly strong).