CU Physics Department Colloquium

Monday, March 19, 2012 4:10 PM 428 Pupin Hall

“Orbits and Interiors of Extrasolar Planets”

Long-term orbital evolution of multi-planet systems under tidal dissipation often converges onto a dynamical fixed point. Such stationary states are characterized by apsidal alignment among the orbits and lack of secular variations in the orbital eccentricities. Quantitatively, the nature of the fixed point is dictated by mutual interactions among the planets as well as non-Keplerian effects such as general relativity and gravitational quadrupole fields created by the inner-most planet's tidal and rotational distortions. As a result, the nature of the dynamical attractor, onto which the system settles, encapsulates independent information about the planetary mass and its degree of central concentration. Consequently, in the first half of the talk, I will show how a precise characterization of a planetary systems' orbital state can either resolve the sin(i) degeneracy inherent to non-transiting bodies, or yield meaningful constraints on the interior structure of a transiting giant planet.

Konstantin Batygin, Caltech

In the second half of the talk, I will address the long-standing issue of physics behind close-in giant planet radius anomalies, by presenting a novel magnetohydrodynamic mechanism responsible for inflation. The mechanism largely relies on the electro-magnetic interactions between fast atmospheric flows and the planetary magnetic field in a thermally ionized atmosphere, to induce electrical currents that flow throughout the planet. The resulting Ohmic dissipation acts to maintain the interior entropies, and by extension the radii of hot Jupiters at an enhanced level. Using self-consistent calculations of thermal evolution of hot Jupiters under Ohmic dissipation, we show a clear tendency towards inflated radii for effective temperatures that give rise to significant ionization of K and Na in the atmosphere, a trend fully consistent with the observational data. I will conclude by discussing the possibility of Ohmic evaporation of planets.