



A New NOAO Survey Program: Mutual Orbits and Masses of Kuiper Belt Binaries

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Abstract

We will report progress from our multi-year campaign to determine the orbits and masses of transneptunian binaries (TNBs). Binary systems are abundant in the Kuiper belt, and especially among the “Cold Classical” disk of objects on low-eccentricity, low-inclination, non-resonant orbits about the Sun [1]. These binaries offer an opportunity to learn the masses and densities of an intriguing population of small, distant objects. Additionally, the statistics of their mutual orbital parameters offer clues to conditions where they formed in the protoplanetary nebula, as well as to subsequent dynamical evolution of the outer solar system.

Historically, NASA/ESA’s Hubble Space Telescope (HST) has been the premier facility for spatially resolving the components of TNBs, benefiting from its exceptionally stable optics and from diffraction-limited imaging unimpeded by the Earth’s atmosphere. More recently, laser guide star adaptive optics (LGS AO) technology has enabled large ground-based telescopes to begin contributing valuable data as well [2]. LGS AO observations of faint TNBs (the components of which have typical V magnitudes $\sim 24^{\text{th}}$) are only feasible when the target passes near an appulse star suitable for use as a tip-tilt correction reference. We have been using LGS AO data from Keck in combination with HST data to constrain TNB orbits [e.g., 3].

In 2011 we began a new 3-year NOAO Survey program to use LGS AO on the 8 m Gemini North telescope. We will discuss how Gemini and other telescopes complement one another, show examples of data from Gemini, Keck, and HST, and describe how we are using these facilities to improve orbital knowledge for as many of the tighter TNBs as we can. Optimal scheduling techniques enable us to make the most efficient possible use of the very limited avail-

ability of time on telescopes capable of resolving these objects [4]. Our progress is documented online at <http://www.lowell.edu/~grundy/tnbs>.

We will discuss systems of particular interest such as those likely to undergo mutual events in the near future. These include 2003 QW₁₁₁ (events probably beginning in a few years) and 79360 1997 CS₂₉ (events probably happening right now). Also of interest are systems for which sizes can be independently determined from thermal or other observations. For these systems, the dynamical masses from binary orbits enable computation of bulk densities.

We will also explore statistical patterns beginning to emerge from the growing ensemble of known TNB orbits. Observed distributions of orbital characteristics, including inclinations, eccentricities, and separations have important implications for formation scenarios as well as subsequent evolution [5], although accounting for observational biases remains an open issue. For instance, there appears to be a shortage of loose binaries among TNOs on excited heliocentric orbits. While there seems to be an excess of prograde systems among the tighter binaries, there is little evidence for preferentially low inclinations.

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