INVESTIGATING THE TIDAL EVOLUTION OF TRANSNEPTNIAN BINARIES WITH VARIABILITY OBSERVATIONS. S. D. Kern[1] and K. S. Noll[1], [1]Space Telescope Science Institute, 3700 San Martin Dr., Baltimore MD 21218; susank@stsci.edu, noll@stsci.edu.

Introduction: The discovery of an unexpected abundance of binaries among the transneptunian population has enabled the detailed physical study of these objects. About half of the >50 known binaries now have their mutual orbits determined, yielding their mass and supplying understanding about the orbital angular momenta of these systems. Determining the rotational angular momenta is the next step for investigating potential tidal interactions between these objects which might provide constraints for formation models. Some of these models rely on an understanding of the total angular momenta of these systems.

Observations: Lightcurves are among the fundamental measurements that can be made in the study of small solar system bodies. They reveal rotational state and shape. Among the near Earth and main asteroid belt populations their measurement has directly impacted formation models of binary systems. In the near Earth population a significant fraction of the fast rotators are binaries and are described as having been formed through tidal break-up [7]. In the main belt many secondaries are in synchronous rotation with their primaries. It remains to be determined what rotational signature might be found among Transneptunian binaries (TNBs).

For assumed single TNOs the period range for a sample of ~50 TNOs (d≥400km) is between 4-18 hours [3] Sheppard & Jewitt [8] found that 30% are variable by >0.15 magnitudes. Smaller objects show more variability [4,5]. Complete lightcurves for 100-km-class TNOs for only 4 objects [9] exhibit a similar range of amplitudes (0.07-1.09). HST and Magellan measurements made over short time spans (30-180 minutes) for ~100 objects, coupled with Monte Carlo modeling, also suggest that a larger fraction of the smaller-sized TNOs have significant amplitude lightcurves. Below several hundred km diameter, TNOs may be insufficiently massive to force the object into a hydrostatically controlled shape, although this depends on significant unknowns about their internal structure. Targeting TNBs means sampling a smaller size range than has typically been done in the past as well as coupling the rotational characterization (period and amplitude) with additional information about the bodies mass and inferred density to better understand these objects as a whole, both individually and as a class of objects.

Interpretation: Contrary to main belt binaries we do not expect many TNBs to be tidally evolved. Using the orbital periods we have measured and the Goldreich and Soter [2] formulation we calculate that the circularization timescale, $\tau_{tidal} \infty a^5$ for most of our objects is longer than 4.5 Gyr, with spin-locking being a factor of ~100 shorter. However, since Pluto-Charon are tidally evolved it would not be a surprise to find one or more systems in a similar configuration; in fact our calculations find 2 potentially interesting targets. Still, there are many unknowns and direct measurements of an ensemble of objects are needed to test theoretical expectations [6].

We present analysis of sparse variability observations from HST datasets which we are using to help identify which TNBs might provide the most useful information about the tidal evolution of these systems. Figure 1 provides a sample of the coverage and results we have for slightly more than a dozen objects. These objects are worth the investment of large quantities of ≥4-m telescope time (which we are seeking to obtain) to acquire complete lightcurves, and potentially resolved observations of both components.

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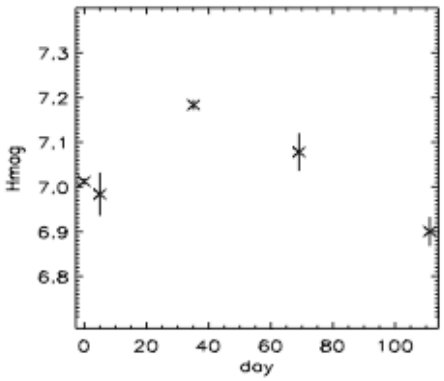

Figure 1. Sample results from HST observations. The data are corrected for observational geometry so they can be plotted together to evaluate variability.