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A Magnitude Limited Survey of the Rotational Properties of Kuiper Belt Objects

R. Kokotanekova (1,2), P. Lacerda (1), C. Snodgrass (2), M. Lockhart (3), S. Lorek (1), N. Peixinho (4), A. Thirouin (5), B. Carry (6), B. Davidsson (3), S. Fornasier (6), M. Wyatt (7), O. Hainaut (8)
(1) Max Planck Institut für Sonnensystemforschung, Göttingen, Germany (2) The Open University, Milton Keynes, UK (3) Uppsala University, Department of Physics and Astronomy, Sweden (4) Unidad de Astronomia, Facultad de Ciencias Basicas, Universidad de Antofagasta, Chile (5) Lowell Observatory, Flagstaff, Arizona, USA (6) Observatoire de Paris, Site de Meudon, France (7) Institute of Astronomy, University of Cambridge, UK (8) ESO Headquarters Garching, ESO, Germany; (kokotanekova@mps.mpg.de)

Abstract

We will present the first results from a magnitude-limited survey of over 60 Kuiper belt objects (KBOs) observed within a Large Program at the 3.6-m ESO New Technology Telescope (NTT). The multi-band observations are used to obtain lightcurves for targets from all KBO dynamical classes. We are aiming to derive the individual targets' physical and rotational characteristics as well as to use the bulk properties of the different KBO populations as sources of information for their formation mechanisms and collisional history.

1. Introduction

After the discovery of the Kuiper belt [1], more than 1700 objects have been identified and classified into dynamical classes (Resonant KBOs, Hot and Cold Classical KBOs, Scattered Disc Objects and Centaurs) according to their orbital characteristics.

Despite the substantial progress in KBO studies from the past two decades, many questions remain open (e.g. the position at the time of formation; the accretion mechanisms which formed them; the sequence of gravitational interactions which lead to their migrations and the collisional interactions during the different evolutionary stages).

These questions can be addressed by studying the spin properties of the different KBO classes. Ligthcurves with sufficient S/N can be used to derive the object's lightcurve period and peak-to-peak range, Δm, which can constrain the KBOs spin state and shape. Lightcurves are therefore powerful tools in comparing different populations [2, 3] and in the detailed study of individual objects [4, 5, 6].

Previous lightcurve observations have been reported for roughly 100 KBOs [7, 8, 9]. The majority of them have been obtained with smaller 1-m or 2-m class telescopes and do not have rotation period solutions, nor useful upper limits to the variability. Furthermore, the available sample of known rotation properties may be biased towards elliptical KBOs [10] as authors tend to report lightcurve detections, while publications of cases with no detected variability are less frequent.

2. Program Description

In order to enable studies of the statistical properties of the different KBO dynamical classes, as well as to characterize the individual objects, we are performing a magnitude-limited study using the 3.6-m ESO NTT at La Silla, Chile. The program (PI P. Lacerda) was awarded 48 nights. The combination of the large aperture and the observing strategy will allow us to analyse the rotational and colour properties of $\sim$ 60 targets. The complete list of possible objects includes 85 KBOs in the main dynamical classes, which are detectable at S/N $\geq$ 50 (Table. 1). The specific targets to be observed are selected based on visibility, while priority is given to KBOs from the less-represented classes (Outer Resonants, Hot Clasicals and Cold Classicals) in order to ensure enough objects in each group. The sample includes several targets with known surface properties and 34 objects for which no rotational properties have ever been reported (Table. 2).

To avoid the possible biases of the previously available data, the observations are being analysed in a consistent way, and all results will be published, including the cases in which no periodic variations are detected.

Table 1: Distribution of the selected targets among the different dynamical classes.

Dynamical Classes	
Inner Resonants	14
Outer Resonants	9
Cold Classicals	7
Hot Classicals	7
Centaurs	20
Sacttered Objects	28
Total Sample	**85**

Table 2: Known properties of the selected targets.

Lightcurve Properties		**Surface Properties**	
No Lightcurve	34	Albedo known	55
Upper limit Δm	23	Colour known	49
Uncertain Period	21	Both (A,C) known	44
Lightcurve known	7	Haumea-type	5

3. Objectives

The use of a 4-metre class telescope allows us to obtain high S/N lightcurves for the selected objects. They are used to study both the characteristics of particular objects and the bulk properties of the different dynamical classes. In particular we are aiming to:

- Measure spin periods, and ranges of magnitude variations in order to constrain shapes and bulk densities;
- Identify contact binaries or objects with extreme shapes or spins;
- Study surface colour variations, including the presence of surface spots;
- Obtain a sample of absolute magnitudes and optical colours protected from lightcurve variability;
- Search for variations in the Δm of KBOs with known lightcurves and attempt to constrain spin obliquity;
- Use the observed Δm distribution to determine the sphericity of the different populations and try to determine the radius at which gravity dominates over material strength [11];
- Use the derived rotational properties of the different dynamical classes as constraints to their formation mechanisms and collisional history;
- Compare the derived properties of the KBO dynamical classes to those of main-belt asteroids and Trojans.

At the time when this abstract is being prepared we have observed and advanced in the analysis of 23 KBOs from all dynamic classes. At the meeting we will present the results from the first half of the survey.

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