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Physical Properties of Asteroid (1917) Cuyo

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Abstract

Asteroid (1917) Cuyo is a Near-Earth Asteroid (NEA) from the Amor group. It is orbitting the Sun on a highly elongated orbit with semimajor axis 2.15 AU and eccentricity 0.504. At a low delta-V (8.6 $km\,s^{-1}$) it could be a potential target for future spacecraft missions. Radar observations indicated a slight elongation of the object with a "breadth ratio" of the asteroid's mean cross section estimated to be 1.14 [7]. Further studies showed its rotation period to be 2.6905 ± 0.0007h [11], and it was classified as 'Sr' type in the Bus-DeMeo taxonomy [8].

Cuyo was observed as part of our ESO Large Programme. The programme includes ongoing optical photometric monitoring of selected NEAs, thermal-IR observations, and optical-NIR spectroscopy. Among the principal aims of the programme are the physical characterisation of NEAs, shape modelling, and search for YORP-induced changes in rotation periods. Here we present our latest results and analysis from our observational monitoring of (1917) Cuyo. We are conducting a broad study of this asteroid, including optical photometry and spectroscopy, and thermal-IR observations. This work is ongoing and we shall present our latest results at the meeting.

1. Observational data

Asteroid (1917) Cuyo was subject to an extensive observing campaign between April 2010 and April 2013. During this time the asteroid passed through a wide range of observational geometries, conducive to producing a robust shape model and spin state solution (see Fig. 1). We obtained photometric imaging data for rotational lightcurves (in V or R broadband filters), optical spectra for surface composition, and thermal-IR imaging data to study the surface thermal properties of the asteroid. The lightcurve data were obtained using the ESO 3.6m New Technology Telescope (NTT) at La Silla (Chile) on 12 nights during seven observing runs with geometries shown in Fig. 1. Additional lightcurve data was available from the ESO 2.2 telescope at La Silla, JPL's Table Mountain Observatory 0.6m telescope (California) and the 2m Faulkes Telescope South (Australia).

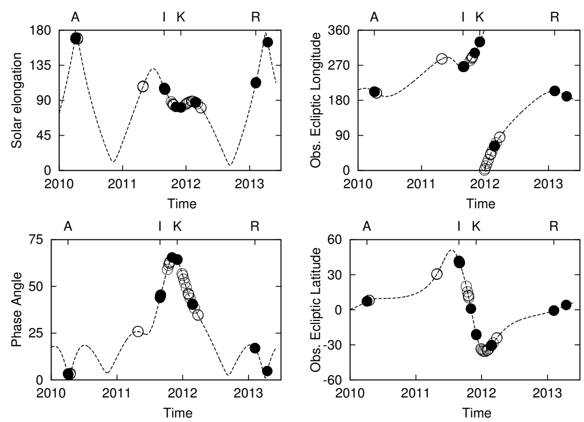

Figure 1: Asteroid (1917) Cuyo has been observed at a range of geometries. Closed circles indicate the NTT runs (labeled on secondary x-axis), open symbols - other available data.

Table 1: The thermal data gathered for 1917 Cuyo.

Date	ESO period	hrs obs.	wavelength range [μm]	$\alpha°$
04/09/11	P87	2.2	6, 8.2-13.0	47
16/12/11	P88	3.0	6, 8.2-13.0	61
18/12/11	P88	1.1	5, 8.3-19.6	60

We observed Cuyo on three occasions at the European Southern Observatory (ESO) VLT Unit 3 'Melipal' at Paranal, Chile, using the VISIR instrument (VLT Imager and Spectrometer for mid-IR [6]) in imaging mode. The dates and wavelength ranges are listed in Table 1.

2. Preliminary results

2.1. Shape modelling

We extracted the rotational lightcurves for a subset of our overall dataset (NTT runs A, I, K and R as marked on Fig. 1). We then applied lightcurve inversion techniques to the photometry data, using the methods of Kaasalainen et al. [3, 4] and our customized version of the software described by Ďurech et al. [1]. The ecliptic longitude and latitude space (λ, β) was divided into a $5° \times 5°$ grid and each point was considered a possible rotation pole. The asteroid shape and sidereal period were iterated for each provisional pole and artificial lightcurves were generated. The best solution for each point was chosen by minimizing the residuals between observational data and the fitted lightcurves.

The resulting shape model indicates a nearly spherical shape for the asteroid (Fig. 2). We estimate the rotation pole to have ecliptic longitude $\lambda_p = 0° \pm 30°$ and latitude $\beta_p = -55° \pm 15°$. The sidereal rotation period was measured to be 2.689787 $(\pm 1 \times 10^{-6})$ hours.

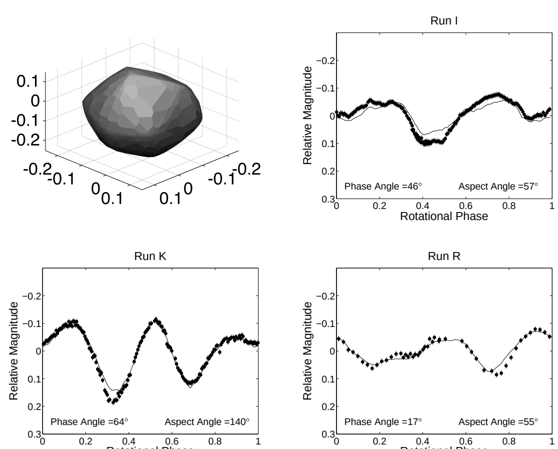

Figure 2: A preliminary shape model from lightcurve inversion of a subset of our observations (top left panel). The panels around the shape model represent the fit of synthetic lightcurves (lines) to the observational data (points).

2.2. Thermal analysis

The Near-Earth Asteroid thermal model [2, 12] has been fitted to the measured VISIR thermal fluxes to derive geometric visual albedos, effective diameters, and beaming parameters (Table 2). The values for each of these parameters are quite similar. Once all photometric data has been factored in, we will perform a more rigorous linkage with the thermal data, as well as a detailed thermophysical analysis [9, 10, 5] with the refined shape model and spin-state solution. The full analysis will be presented at the meeting.

Table 2: The results of NEATM thermal analysis.

Date	D_{eff}	σ	p_v	σ	η	σ
04/09/11	3.81	$^{+0.12}_{-0.12}$	0.16	$^{+0.05}_{-0.03}$	1.27	$^{+0.08}_{-0.08}$
16/12/11	4.18	$^{+0.16}_{-0.14}$	0.13	$^{+0.05}_{-0.03}$	1.25	$^{+0.10}_{-0.09}$
18/12/11	3.80	$^{+0.35}_{-0.37}$	0.16	$^{+0.07}_{-0.04}$	0.97	$^{+0.20}_{-0.21}$

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