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Thermal lightcurve observations of TNOs with Herschel*

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Abstract

We present results of the thermal lightcurve observations of TNOs Haumea, 2003VS2, 2003AZ84 and Varuna using the PACS [1] and SPIRE [2] instruments on the Herschel Space Observatory. These data were acquired as a part of the "TNOs are Cool" key programme [3], [4].

1. Introduction

Thermal lightcurves of airless bodies are only available for a few objects, mainly near-Earth asteroids [5], [6]. These thermal lightcurves provide, in combination with the optical ones, a mean to distinguish between the effects of shape and surface markings and permit infer thermal properties of the body surface. For transneptunian objects, only Haumea's thermal lightcurve observed with Spitzer at 70 μm [7], and with Herschel at 100 μm [8] has been reported.

2. Observations and results

Haumea was observed on December 23 and 25, 2009, and June 20-21, 2010 with the PACS photometer at 100 and 160 μm. Assigning a rotational phase for each one of these observational dates (rotational period= 3.915341 h), we obtain a clear thermal lightcurve at 100 μm, and only a marginal one at 160 μm. This thermal lightcurve is correlated with the visible lightcurve, confirming that both are due to shape effects [8]. The resulting lightcurve from the combined 2009 and 2010 data has an amplitude of 50%, slightly larger than the 30% the visible lightcurve amplitude. The dark red spot seen in optical data [9] does not produce a measurable effect on our 100 μm thermal lightcurve, probably because of the moderate signal-to-noise of our thermal observations. SPIRE observations of Haumea at 250, 350 and 500 μm were acquired on January 7 and 9, 2011, resulting in a marginal detection of the thermal lightcurve at 250 μm. To first order, our results give albedos and diameters consistent with those found from previous studies [10], [11].

We used PACS to observe 2003VS2 on August 10, 2010 at 70 and 160 μm, and 2003AZ84 on September 26-27, 2010 at 100 and 160 μm. Neither data set reveals a clear thermal lightcurve, but, using differential photometry, we discuss the possible marginal detection of flux variation with rotational phase.

Varuna was observed on September 26-27, October 25, 2010, and April 17 and 19, 2011 with PACS at 70, 100 and 160 μm. The September and October 2010 observations of this object point to a nice detection with a clear and high amplitude on the thermal lightcurve. As for Haumea, Varuna's lightcurve appears to be correlated with the optical one, indicating that both are due to shape effects. More recent observations from April 2011 covering a

complete lightcurve period are actually under analysis. The results of these analysis will be presented.

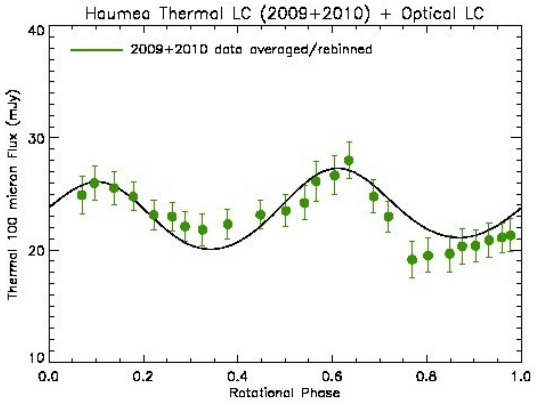

Figure 1: Haumea thermal lightcurve at 100 μm. The green points are the result of the average/rebinned data from 2009 and 2010 observations with PACS detector. The black curve is the optical lightcurve. The correlation between the optical and thermal lightcurve imply an optical lightcurve due mainly to shape effects.

4. Discusion

We will discuss about the detection or no-detection of thermal lightcurves for these transneptunian objects. Also we will present and discuss the obtained fluxes, the albedos, diameters, beaming-parameters, and possible thermal inertia resulting for the radiometric fits for these 4 objects.

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