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Exploring the nature of new MBCs using the 10.4m GTC telescope.

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Abstract

We present observations of two recently discovered Main Belt Comets, (300163) 2006 VW_{139} and P/2012 F5 (Gibbs), obtained with the Spanish 10.4m telescope GTC at "El Roque de los Muchachos" observatory (La Palma, Spain). The observations were done in the framework of a ToO program started mid 2011. Images and spectra in the visible of (300163) 2006 VW_{139} and images of P/2012 F5 (Gibbs) were obtained with the OSIRIS camera-spectrograph.

Images are analyzed using a Monte Carlo scattering dust model that allows us to determine the mass loss rate and ejection velocity of the dust particles as a function of time. We also determine a lower limit of the absolute magnitude of both asteroids. The reflectance spectrum of 2006 VW_{139}, typical of a C-type asteroid, is finally compared with the spectra of other MBCs and comet nuclei as we did in [7]. This comparison shows that the surface of 2006 VW_{139} is very similar to that of other MBCs and suggest that this object is unlikely a "normal" comet.

1. Introduction

Two objects with orbits typical of main belt asteroids were observed with cometary-like coma and tail in the last months: (300163) 2006 VW_{139} (hereafter VW139) [4] and P/2012 F5 (Gibbs) [2]. Both objects fit into the category of "main belt comets" (MBCs) following the pure phenomenogical definition of MBCs by [3].

Dynamical simulations show that MBCs are extremely unlikely to originate in the place were comets came from: the trans-neptunian belt (TNB) and the Oort Cloud (e.g., Fernández et al. [1]). They likely formed in situ.

Understanding the origin of MBCs is crucial. If they are formed "in situ" and if their activity is due to water ice sublimation, there should be water ice in many asteroids and they must have formed in the Main Belt region, presumably at a time when the Snow Line was at ∼3AU, during the first Myr of the Solar System. If they are captured trans-neptunian objects or Oort cloud comets, the mechanisms that drove them to their present orbits need to be understood. The existence of ice in main-belt objects is surprising given their proximity to the Sun, and presents intriguing opportunities for constraining the temperature, composition and structure of primitive asteroids and our protoplanetary disk. This it is critical for understanding the physical conditions and the mechanisms of planetary formation, and also addresses the question of the origin of Earth's water. If the outer main belt has a large population of asteroids with ice, they could have contributed to the water on Earth.

2. Observations and Analysis

Broad band images and low resolution spectroscopy of VW139 were done in service mode on November 29, 2011. Broad band images of P/2012 F5 were obtained on May 18, 2012. Images were obtained using Sloan g and r filters. Spectra of VW139 were obtained using the R300B and R300R grisms, with dispersions of 2.48 and 3.87 Å/pixel, respectively.

Examples of the images obtained of both MBCs are shown in Fig. 1. VW139 presents a narrow almost linear tail that extends up to 40.000 km in the antisolar direction (position angle PA∼ 63°) and more than 80.000 km in the direction of the orbit's plane (PA∼ 250°). This image is typical of comets when observed with the observer very close to the comet orbit plane. P/2012 F5 presents a linear tail in PA=282°, that extends more than 3 arcmin.

We have performed an analysis of the MBCs images using a direct Monte Carlo dust tail model, which is based on previous works of cometary dust tail analysis e.g. [8, 9, 10]. We determine the mass loss rate and ejection velocity of the dust particles as a function of time, which help us to discriminate between a long or short lasted ejection event, and then obtain information of the activation mechanism and nature of the objects.

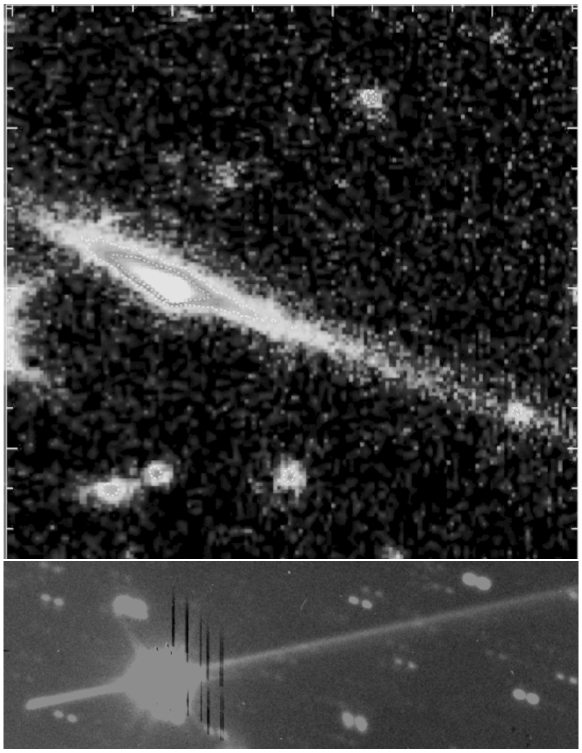

Figure 1: *Upper image*: Combined r band image of (300163) 2006 VW_{139} obtained on November 29, 2011; *Lower image*: combined r band image of P/2012 F5 (Gibbs) obtained on May 18, 2012.

The obtained reflectance spectrum of VW139 is shown in Fig. 2. The spectrum of VW139 is typical of a C-type, almost neutral in the 0.5 – 0.9 μm region (with a spectral slope S'_V=0.5±1.0%/1000 Åin this region), and a UV drop below 0.55 μm. It is also very similar to the spectra of other well known MBCs, 133P/Elst-Pizarro and 176P/LINEAR [7] An almost neutral slope in the spectra is atypical on active comets [5] and cometary nuclei [6].

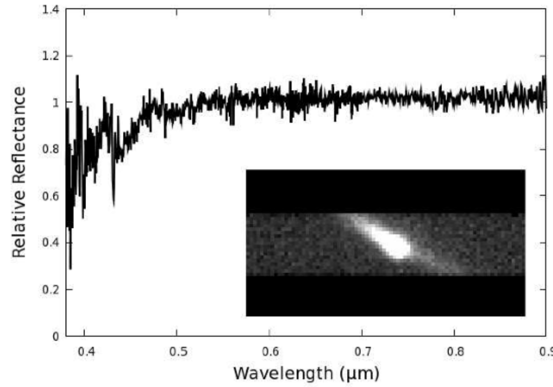

Figure 2: Relative reflectance spectrum of (300163) 2006 VW_{139} obtained on November 29, 2011. Inside the plot is an image of the asteroid in the slit.

Acknowledgements

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