EPSC Abstracts
Vol. 8, EPSC2013-140, 2013
European Planetary Science Congress 2013

The dust environment of Main-Belt Comet P/2012 T1 (PANSTARRS)

F. Moreno (1), A. Cabrera-Lavers (2,3,4), O. Vaduvescu (2,5), J. Licandro (2,3), and F. Pozuelos (1)
(1) Instituto de Astrofísica de Andalucía, CSIC, Spain
(2) Instituto de Astrofísica de Canarias, Spain
(3) Universidad de La Laguna, Tenerife, Spain
(4) GTC Project, La Laguna, Tenerife, Spain
(5) Isaac Newton Group of Telescopes, Santa Cruz de La Palma, Spain
(fernando@iaa.es)

Abstract

Main-Belt Comet (MBC) P/2012 T1 (PANSTARRS) has been imaged using the 10.4m Gran Telescopio Canarias (GTC) and the 4.2m William Herschel Telescope (WHT) at six epochs in the period 2012 November through 2013 February. Using our dust tail Monte Carlo model we inferred that the object has experienced a continuous mass loss during an extended period of 4-6 months. The total ejected dust mass is estimated at $\sim$6–25$\times 10^6$ kg, depending on the maximum particle size ejected (1–10 cm). The observed dust tails are best interpreted with an anisotropic ejection model, the emission being concentrated in a high latitude region for an object whose rotation axis is located near the orbital plane pointing approximately to the perihelion point, and whose maximum activity occurs some 30 days post-perihelion. This seasonally-driven ejection behavior, along with the modeled particle ejection velocities, are in remarkable agreement to those we found for P/2010 R2 (La Sagra) [4].

1. Introduction

MBCs are active objects in orbits typical of main-belt asteroids. Bona fide MBCs (i.e., those having likely ice-sublimation as the driver of their activity) amount to seven, including this one. There are, however, three more active objects of this kind, but they seem to be linked to short-duration episodes of activity, in which a collision with another body or a rotational disruption could drive their activity, among other mechanisms [2].

2. Observations and reduction

CCD images of P/PANSTARRS were acquired on several nights from 2012 November 2012, until the end of 2013 February. We used instrumentation attached to the 4.2m William Herschel Telescope, and the 10.4m Gran Telescopio Canarias, both at the Observatorio Roque de los Muchachos on the island of La Palma. The object was imaged on six epochs using red bandpasses (either Johnson-Cousins R band or r' Sloan filters). In all cases the MBC was imaged repeatedly, and a median stack was obtained. The frames were bias subtracted, flat-fielded, and calibrated by standard techniques. Figure 1 shows the reduced images.

3. Results

To perform an interpretation of the dust tails observed, we used our Monte Carlo code described previously, see e.g. [5]. The particle orbital elements are computed from the terminal velocity and the β parameter (the ratio of pressure radiation to solar gravity forces). The geometric albedo is assumed at p_v=0.04, and the particle density at ρ=1000 kg m^{-3}.

Based on the evolution of the dust tail brightness and morphology, we hypothesized a sustained activity pattern for P/PANSTARRS. The persistence of brightness during the period spanned by the observations is in marked contrast with that would be expected from a short-duration event. In addition, there are other arguments against such impulsive ejection scenario based on tail morphology.

In consequence, as in the similar case of P/La Sagra and 2006 VW139 [4, 3], we used an ejection (terminal) velocity as given by $v(\beta) = v_0\beta^\gamma$, where we assume γ=1/2 for hydrodynamic gas drag. The model parameters to fit are the onset time (t_0), the ejection velocity parameters, the power-law size distribution index, the limiting sizes of the particles (r_{min},r_{max}), and the dust loss rate (dM/dt) are the free parameters of the model. We will work under the hypotheses of both isotropic and anisotropic particle ejection scenarios.

The best fit model corresponds to an anisotropic ejection model where an active area poleward of 45° latitude on a rotating spherical nucleus with high obliquity (I=80°), i.e. the rotation axis located near the orbital plane, and oriented approximately toward the Sun at the time of maximum activity, mimicked the observed isophote field quite accurately (Figure 2). The size distribution power law index was –3.5, with a minimum particle size of 5 μm, and a maximum particle size of 1–10 cm, with a total ejected mass of 6–25$\times 10^6$ kg. The activity starts some 50 days before perihelion, peaks at 30 days after perihelion passage, and lasted about 4–6 months.

The significance of results of the anisotropic model is that, in a remarkably similar way to MBCs P/La Sagra and 176P [1], the ejection pattern of P/PANSTARRS is compatible with emission from a single high latitude region of a nucleus whose rotation axis is near the orbital plane. Also the latitudes of the subsolar point at perihelion (where the outgassing is nearly maximum) are similar (–60° for P/La Sagra and –70° for P/PANSTARRS).

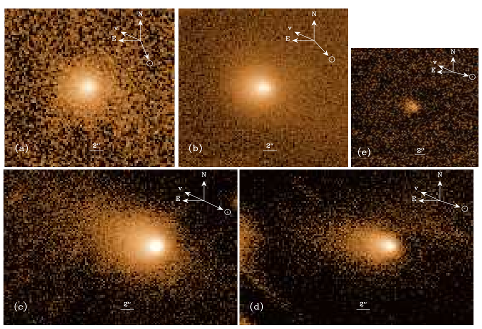

Figure 1: Median stack images of P/2012 T1 (PANSTARRS) obtained with PFIP on the 4.2m William Herschel Telescope (a), and OSIRIS on the 10.4m Gran Telescopio Canarias (b-e). Observing dates: (a) 2012/11/13; (b) 2012/11/20; (c) 2012/12/14; (d) 2013/01/18; (e) 2013/02/18.

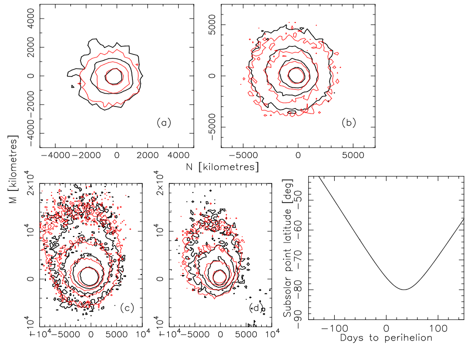

Figure 2: Anisotropic model with MBC activation at 50 days before perihelion time. Panels (a) to (d) correspond to the observations shown in Figure 1. The black thick solid lines at panels (a) to (d) indicate the observed isophotes, while the red thin lines correspond to the model. The lower rightmost panel displays the latitude of the subsolar point as a function of time to perihelion.

Acknowledgements

This article is based on observations made with the Gran Telescopio Canarias (GTC), installed in the Spanish Observatorio del Roque de los Muchachos of the Instituto de Astrofísica de Canarias, in the island of La Palma, and on observations made with the William Herschel Telescope (WHT) operated on the island of La Palma by the Isaac Newton Group in the Spanish Observatorio del Roque de los Muchachos of the Instituto de Astrofísica de Canarias.

We are indebted to Pedro J. Gutiérrez for fruitful discussions. This work was supported by contracts AYA2011-30613-C02-01, AYA2012-39691-C02-01 and FQM-4555 (Junta de Andalucía). J. Licandro gratefully acknowledges support from the Spanish “Ministerio de Ciencia e Innovación” projects AYA2011-29489-C03-02 and AYA2012-39115-C03-03.

References

[1] Hsieh, H.H., Meech, K., & Pittichova, J. 2011, ApJ, 736, L18

[2] Jewitt, D. 2012 AJ, 143, 21

[3] Licandro, J., de León, J., Moreno, F., et al. 2013 A&A 550, A17

[4] Moreno, F., Lara, L.M., Licandro, J., et al. 2011, ApJ, 738 L16

[5] Moreno, F., Pozuelos, F., Aceituno, F., et al. 2012, ApJ, 752, 136