EPSC Abstracts
Vol. 6, EPSC-DPS2011-69-1, 2011
EPSC-DPS Joint Meeting 2011
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Comet 169P/NEAT(=2002 EX_{12}): More Dead Than Alive

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Abstract

The Jupiter family comet 169P/NEAT (previously known as asteroid 2002 EX_{12}) has a dynamical association with the α-Capriconid meteoroid stream. In this paper, we present photometric observations of comet 169P/NEAT to further investigate the physical characters of its disintegration state related to the stream. The comet shows a point-like surface brightness profile limiting contamination due to coma emission at $\sim 4\%$ at most, indicating no evidence of outgassing. An upper limit on the fraction of the surface that could be sublimating water ice of $<10^{-4}$ is obtained with an upper limit to the mass loss of $\sim 10^{-2}\,\mathrm{kg\,s^{-1}}$. The effective radius of nucleus is found to be 2.3$\pm$0.4 km. Red filter photometry yields a rotational period of 8.4096$\pm$0.0012 hr, and the range of the amplitude 0.29$\pm$0.02 mag is indicative of a moderately spherical shape having a projected axis ratio $\sim$1.3. The comet shows a redder colors than the Sun, being compatible with other dead comets candidates. The calculated lost mass per revolution is $\sim 10^9$ kg. If it has sustained this mass loss over the estimated 5000 yr age of the α-Capriconid meteoroid stream, the total mass loss from 169P/NEAT ($\sim 10^{13}$ kg) is consistent with the reported stream mass ($\sim 10^{13}$ – 10^{15} kg), suggesting that the stream is the product of steady disintegration of the parent at every return.

This work is published in *The Astronomical Journal*, Vol. 140, Issue 6, pp. 1806-1813 (2010).

1. Overview

Comet 169P/NEAT, the former name was asteroid 2002 EX_{12}, has been identified as the parent body of the α-Capriconid meteoroid stream [1, 2]. The semi-major axis, eccentricity and inclination of 169P/NEAT are 2.604 AU, 0.767, and 11°.31 respectively (NASA JPL HORIZON), corresponding to a Tisserand parameter T_J = 2.89, and it is classified as a member of the Jupiter-family comets (JFCs). The perihelion distance $q\sim$0.61 AU and the short orbital period $P_{\rm orb}\sim$4.2 yr suggest the rapid sublimation of volatiles from the surface. The other example of nearly-dead JFC is D/1819 W1(Blanpain) (recovered as asteroid 2003 WY_{25}), considered to be related to the Phoenicids meteoroid stream [3, 4, 5]. It shows extremely weak coma activity in one of the smallest cometary nuclei ever (effective radius is 160 m) and has too small a mass loss rate to supply the stream mass over the dynamical age of the stream [6].

Judged by the observations for 169P/NEAT in the last 5 years [7, 8] and the orbital association with the α-Capriconid meteoroid shower, this object is apparently a dying comet just before the extinction. We present physical observational results of 169P/NEAT, including limits to the coma activity, mass loss rate, fractional active area on the nucleus, size, rotational period and colors.

2. Summary

Optical observations of comet 169P/NEAT lead to the following results.

1. The surface brightness shows star-like profile, setting a limit to the fractional light scattered by the steady state coma of 0 – 4%.

2. The absolute red magnitude of the nucleus is $R_c(1,1,0)$= 15.80$\pm$0.11 (using an assumed value of linear phase coefficient β=0.04). The geometric albedo of the 169P/NEAT (p_R=0.03$\pm$0.01) provides the effective radius r_e=2.3$\pm$0.4 km.

3. No evidence of lasting mass loss was found from the surface brightness profiles in imaging data. The maximum mass loss rate is $\sim 10^{-2}\,\mathrm{kg\,s^{-1}}$ which corresponds to the fractional active area $f < 10^{-4}$.

4. 169P/NEAT might be in non-principal axis rotation with the period of $P_{\rm rot}$=8.4096$\pm$0.0012 hr if the light curve has two maxima per period. The

photometric range of ΔR_c=0.29±0.02 mag corresponds to an axis ratio of 1.31±0.03 with the critical density $\geq$200 kg m^{-3} (Fig. 1).

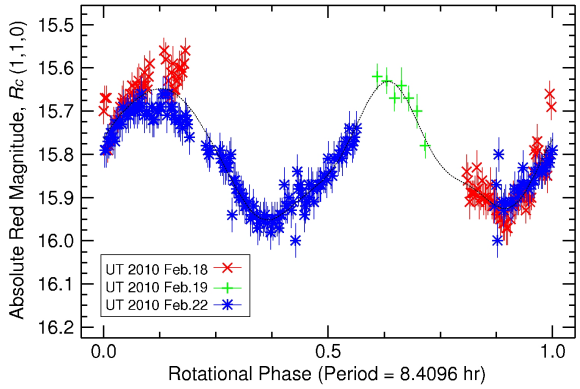

Figure 1: Red photometry of 169P/NEAT observed on UT 2010 February 18, 19 and 22, phased to the double-peak period $P_{\rm rot}$=8.4096±0.0012 hr. Dotted curve displays fitting result having the amplitude ΔR_c(1,1,0)=0.29±0.02.

5. The α-Capricornid meteoroid stream is probably formed by the steady mass loss from the parent because the calculated lost mass per revolution $\Delta M \sim 10^9$ kg is in agreement with the total mass of the stream for about a 5000 yr dynamical lifetime.

6. Colors measured for 169P/NEAT are less red than usual cometary nuclei and Trojans, but similar to those of dead comet candidates (Fig. 2).

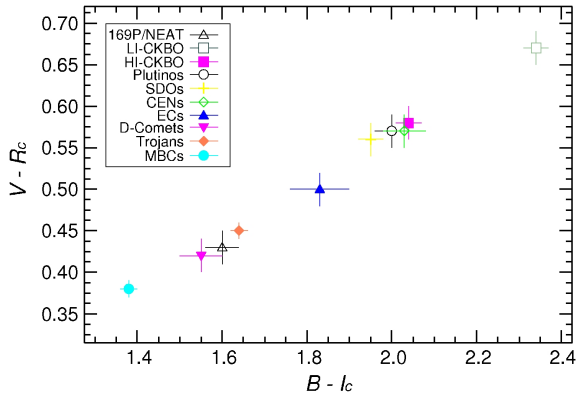

Figure 2: Color distributions $B-I_c$ vs. $V-R_c$ for 169P/NEAT and various types of minor bodies in the Solar System; LI-CKBO, HI-CKBO, Plutinos, SDOs, CENs, D-Comets, Trojan [9] and MBCs

Acknowledgements

T.K. thanks to Margaret Campbell-Brown, Reto Musci and Peter Brown for encouragements in this research at the University of Western Ontario. We are grateful to David Jewitt for comment on this study. Support for this work is provided by the Natural Sciences and Engineering Research Council of Canada.

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