EPSC Abstracts
Vol. 6, EPSC-DPS2011-1513, 2011
EPSC-DPS Joint Meeting 2011

The Reactivation of Main-Belt Comet 238P/Read

H. H. Hsieh (1,2), K. J. Meech (1) and J. Pittichová (1)
(1) Institute for Astronomy, University of Hawaii, USA, (2) Hubble Fellow (hsieh@ifa.hawaii.edu)

Abstract

We present observations of the reactivation of main-belt comet (MBC) 238P/Read. Using July and August 2010 data when 238P appeared inactive, we find best-fit IAU phase function parameters of H=19.05±0.05 mag, corresponding to a nucleus radius of r_n≈0.4 km (assuming an albedo of p_R=0.05), and G=−0.03±0.05. Data from September 2010 onward show a clear rise in activity, causing both a change in visible morphology and increasing photometric excesses. By December 2010, the coma dust mass showed indications of reaching a level comparable to 2005, but further observations are needed once 238P again becomes observable in mid-2011 to confirm whether the comet does reach 2005 activity levels, or if a notable decrease in activity strength can be detected. Comet 238P is now the second MBC, after 133P/Elst-Pizarro, observed to exhibit recurrent activity, providing strong corroboration for the conclusion that it is a true comet whose activity is driven by sublimation of volatile ice.

1. Introduction

MBCs exhibit cometary activity but are dynamically indistinguishable from main-belt asteroids [1]. Discovered on UT 2005 October 24, 238P/Read was the second MBC to be discovered. A physical study following its discovery found that 238P's activity was consistent with being sublimation-driven, and inconsistent with being impact-driven [2], meaning that 238P was likely to be a true comet (possessing sublimating ice), and not a disrupted asteroid (e.g., [3]). That study further found a mass loss rate an order of magnitude larger than that calculated for 133P. This higher emission rate may indicate that 238P's activity was triggered more recently than that of 133P [2].

2. Observations

Observations made between July and December 2010 (Fig. 1) using the 4.2 m SOAR telescope at Cerro Pachon, the 3.54 m NTT at La Silla, and the 10 m Keck I and 2.2 m University of Hawaii (UH) telescopes on Mauna Kea chronicle a rise in activity for 238P over this period. There is a clear transition from a nucleus-dominated morphology prior to October 2010 to a coma-dominated morphology afterwards.

3. Analysis

We derive a best-fit IAU phase function for 238P using inactive July and August 2010 data, where later data show steadily increasing photometric excesses (Fig. 2). To analyze these excesses, we employ a thermal sublimation model to derive the photometric enhancement expected from a sublimating surface. We find that our data fit a model in which activity turns on at ν=295°, peaks at ν=35°, and ceases at ν=120°. The delay in peak activity until ∼35° past perihelion may be due either to (1) the delay required for the thermal wave from solar radiation to reach the subsurface ice reservoir driving 238P's activity, or (2) seasonal modulation of solar radiation reaching an isolated active site that is the source of activity. If (1) is correct, we would expect all MBCs to exhibit peak activity post-perihelion. If (2) is correct, we would expect some MBCs to exhibit peak activity pre-perihelion as well. All known MBCs primarily exhibit post-perihelion activity, though a larger sample of MBCs is required to definitively determine whether (1) or (2) is the primary mechanism for MBC activity modulation.

We find a likely active area equivalent to ∼1% of 238P's total surface area, or an active area of $\sim 2\times10^4$ m^2, about an order of magnitude larger than the active area estimated for 133P. Along with 238P's smaller size and therefore lower escape velocity for emitted dust particles, the larger physical size of its active area is consistent with its dramatically more vigorous activity compared to 133P.

4. Summary and Conclusions

Our finding of renewed dust production is strong confirmation that 238P is exhibiting genuine cometary ac-

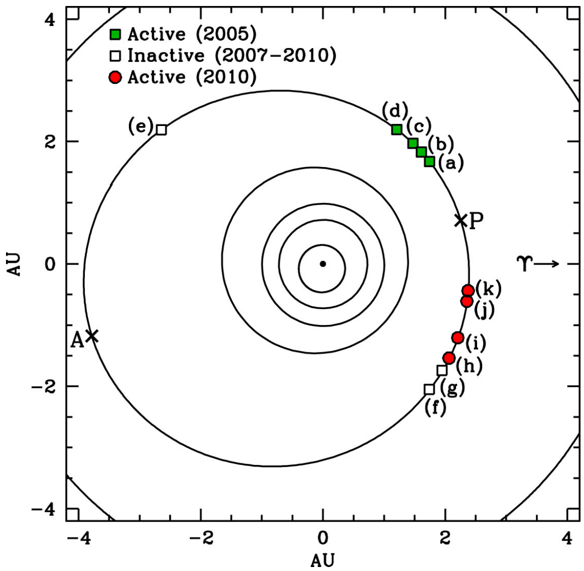

Figure 1: Orbital position plot for 238P observations from (a) 2005 October 24, (b) 2005 Nov 10, (c) 2005 Nov 19-22, (d) 2005 Dec 24-25, (e) 2007 Jan 27, (f) 2010 Jul 07-20, (g) 2010 Aug 15, (h) 2010 Sep 03-05, (i) 2010 Oct 05, (j) 2010 Nov 25, and (k) 2010 Dec 09.

tivity driven by the sublimation of ice. Repeated activity is unexpected if 238P were a disrupted asteroid, as it would require two separate collisions to occur within less than 5 years. Observations in 2010 are thus far insufficient to evaluate the suggestion made by [2] that we had perhaps witnessed the immediate aftermath of a collisional activation of the MBC in 2005 and that subsequent outbursts may be much weaker. Observations reported here were made at a different portion of its orbit than in 2005 and it is unclear what will happen to 238P's activity strength as it progresses to that later portion of its orbit again. Further observations of 238P are highly encouraged when it again becomes observable in mid-2011.

Acknowledgements

HHH is supported by NASA through Hubble Fellowship grant HF-51274.01 awarded by STScI, operated by AURA for NASA, under contract NAS 5-26555, and by the UK's STFC through STFC fellowship grant ST/F011016/1. Support for some work presented here was also provided by NASA through the NASA Astrobiology Institute under Cooperative Agreement No. NNA09DA77A issued through the Office of Space Science, and NASA grant NNX07AF79G.

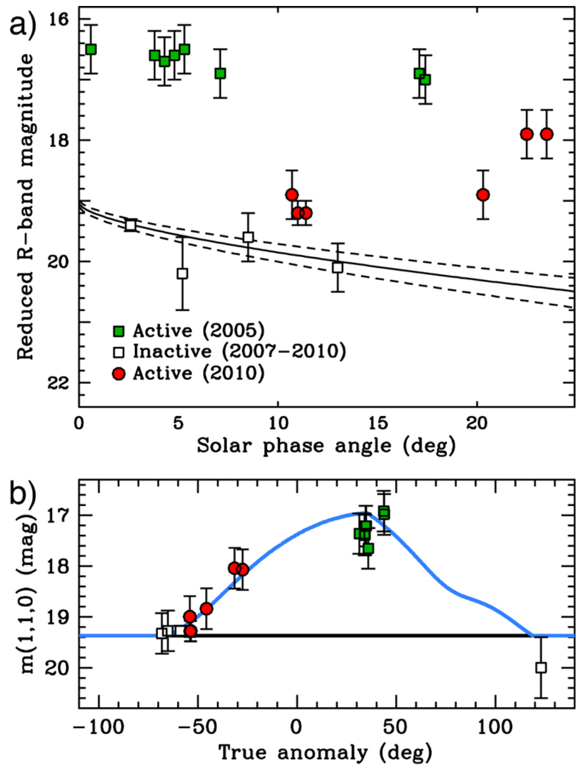

Figure 2: (a) Best-fit phase function from inactive Jul-Aug 2010 data. Active Nov-Dec 2005 and Sep-Dec 2010 data are overplotted. (b) Sublimation modeling results where the nucleus's baseline magnitude is marked by a black line, and the brightness predicted by our model is marked by a blue line.

Observing travel support was provided by the STFC's Panel for the Allocation of Telescope Time, and the European Southern Observatory. This work is in press in ApJ Letters.

References

[1] Hsieh, H. H., & Jewitt, D.: A Population of Comets in the Main Asteroid Belt, Science, Vol. 312, pp. 561-563, 2006.

[2] Hsieh, H. H., Jewitt, D., & Ishiguro, M.: Physical Properties of Main-Belt Comet P/2005 U1 (Read), AJ, Vol. 137, pp. 157-168, 2009.

[3] Jewitt, D., Weaver, H., Agarwal, J., Mutchler, M., & Drahus, M.: A recent disruption of the main-belt asteroid P/2010 A2, Nature, Vol. 467, pp. 817-819, 2010.