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Disintegrating asteroid P/2016 G1: a crater in flagrante delicto

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Abstract

We report on deep images of P/2016 G1 (PANSTARRS), obtained over a period of three months after its discovery as an active asteroid in April 2016. In addition to the previously reported central concentration surrounded by an elongated coma, we identified a sharp arc and a linear feature. Their morphology and evolution independently point toward a brief event resulting in the quasi-complete disruption of the object, and can be reproduced by a ring of large particles moving on a cone. We suggest that the asteroid was hit by a small object, the ring corresponding to large fragments tracing the formation of the crater.

P/2016 G1 was discovered on 2016 Apr. 1, as an active object on an asteroidal orbit, suggesting a possible main belt comet [1], and triggering follow-up observations by our and other groups.

In particular, Moreno et al. observed it with the Gran Telescopio Canarias [2] and with the Hubble Space Telescope [3], reporting an expanding elongated coma surrounding a compact feature constituted of 3 main concentrations. The higher-resolution HST data showed no large remaining fragments.

We collected pre-discovery data and deep and wide follow-up observations from the Pan-Starrs 1 Telescope, the Canada France Hawaii Telescope and the Himalayan Chandra Telescope, over 20 epochs until July 2016.

In addition to the already reported characteristics, we identified additional features: a sharp linear feature, and a partial arc, both off-centred with respect to the central condensation.

We measured the evolution of these features taking advantage of the excellent time coverage of the observations. We also characterize the dust features using a Finson-Probstein-based dynamical modelling method [4, 5]. The central condensation, the orientation of the main coma and of the linear feature, and their evolutions, and the growth of the arc all independently point to a short event on 2016 March 16. Furthermore, the arc and the head of the linear features could be reproduced by a ring of large dust grains moving at low velocity on a cone with a 40^{o} half-opening.

We propose a scenario in which P/2016 G1 was hit by a small, high-velocity projectile which caused the quasi-complete disruption of the body, resulting in the central condensation. The dust released by this event spread to form the observed coma, the spread being caused essentially by a distribution of low ejection velocities and radiation pressure. The impact would have caused a crater to be formed on the main body. While most of the small grain, high-velocity ejecta dispersed and left the field of view, the final stage of crater formation would have lifted a ring of very large particles, moving a low velocity, and appearing as the arc and the head of the linear feature.

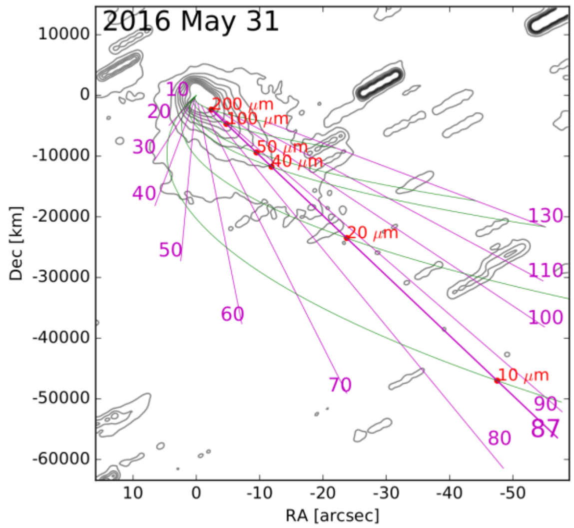

Figure 1: Logarithmically scaled contours of a CFHT image of P/2016 G1 from 2016 May 31. Finson-Probstein syndynes (green) and synchrones (purple) are over-plotted. The ejection epochs of the synchrones are indicated in days prior to the observations. While a large dispersion indicates a range of ejection velocities, the coma is sharply pointing in the direction of synchrone 87. Making simple assumptions, the size of dust grains along that synchrone can be computed, and are indicated in microns.

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