PHYSICAL CHARACTERISTICS OF ASTEROID-LIKE COMET NUCLEUS C/2001 OG108 (LONEOS).
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Introduction: For many years several investigators have suggested that some portion of the near-Earth asteroid population may actually be extinct cometary nuclei. Evidence used to support these hypotheses was based on: observations of asteroid orbits and associated meteor showers (e.g. 3200 Phaethon and the Geminid meteor shower); low activity of short period comet nuclei, which implied nonvolatile surface crusts (e.g. Neujmin 1, Arend-Rigaux); and detections of transient cometary activity in some near-Earth asteroids (e.g. 4015 Wilson-Harrington) [1,2]. Recent investigations have suggested that approximately 5-10% of the near-Earth asteroid population may be extinct comets [3,4].

However if members of the near-Earth asteroid population are extinct cometary nuclei, then there should be some objects within this population that are near their final stages of evolution and so should demonstrate only low levels of activity. The recent detections of coma from near-Earth object 2001 OG108 have renewed interest in this possible comet-asteroid connection. This paper presents the first high quality ground-based near-infrared reflectance spectrum of a comet nucleus combined with detailed lightcurve and albedo measurements.

Background: M. E. Van Ness discovered 2001 OG108 on July 28, 2001 with the LONEOS telescope at the Lowell Observatory [5]. The object was classified as an Apollo near-Earth asteroid based on its preliminary observations. However, further data revealed that its orbital parameters, (semi-major axis of 13.3 AU, eccentricity of 0.92, inclination of ~80°, perihelion of 0.99 AU, and aphelion of 25.6 AU) were similar to the Damocloid group of asteroids [5]. Named after asteroid 5335 Damocles, the Damocloids have been studied as possible extinct cometary candidates due to the similarity of their orbital parameters (i.e. high inclinations and large semi-major axes) with those of Halley Family comets [6,7].

Initial discovery observations and those obtained several months later showed no indications of coma [8], but observations taken in January and February 2002 by several groups showed that the object had developed a small amount of cometary activity as it approached perihelion [9]. It was subsequently reclassified and designated as comet C/LONEOS 2001 OG108.

Visual Lightcurve Photometry: Observations in R filter, with several additional points in B, V, and I filters (Johnson-Cousins system, calibrated using standards from Landolt [10]), were collected by several observers. The data have been corrected to account for viewing geometry and light travel time. A rotation period of the nucleus of 2.38 ± 0.02 days has been derived. This value is on the long-period tail of the spin rate distribution of the asteroid population, but is not unusual for members of the comet nuclei population [11]. The composite lightcurve (Fig. 1) appears strictly periodic, hence there is not yet any indication of possible tumbling motion of the nucleus. The phase slope parameter G is –0.01 ± 0.1 and the colour indices are: V-R = 0.46 ± 0.02; B-V = 0.76 ± 0.03; V-I = 0.90 ± 0.02. The values of V-R obtained in this study are almost identical to those determined for extinct comets (0.44 ± 0.02) and comet nuclei (0.45 ± 0.02) [12]. They are also consistent with values for P-type, but not C-type asteroids [13]. The mean absolute R magnitude is H_R = 12.59 ± 0.09 and the mean absolute V magnitude is H = 13.05 ± 0.10.

Thermal Infrared Observations: Simultaneous optical and thermal observations at 0.43 rotation phase give an albedo in V band of 0.030 ± 0.005, and an effective radius at the midrange of the lightcurve of 8.9 ± 0.7 km (Fig. 1). Combining this value for the radius with the axial ratio (and assuming the nucleus is an ellipsoid with axes a > b =c) gives 10.1 x 7.9 km for its dimensions.

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Near-Infrared Observations: 2001 OG108 was observed for two nights in October 2001 using the low-resolution or asteroid-mode of the SpeX [14] instrument at the NASA Infrared Telescope Facility on Mauna Kea, Hawai'i. The object had an estimated visual magnitude of ~17, and was at a phase angle of ~8° for the duration of the observing session. 26 two-minute near-IR spectra were taken of this object between 1.00 and 1.02 airmass on October 9 and 10 Universal Time. Note that these near-IR spectra were obtained when no coma was detected emanating from the surface of 2001 OG108 [8]. Thus only the surface of the nucleus was observed rather than the dust coma that is typically seen in most cometary observations.

An average spectrum for the two nights was produced and is shown below (Fig. 2). The spectrum spans the near-IR interval from ~0.73 to 2.46 microns and is very nearly linear. There is also no indication of the presence of weak 0.8 – 1.0 micron features such as are seen in the spectra of carbonaceous chondrites and many low albedo asteroids [15]. This would be consistent with the presence of anhydrous rather than hydrous silicates, similar to the results of measurements of dust from comet Halley made by the Giotto spacecraft and results from observations made by Deep Space 1 of comet Borrelly [16,17]. The spectrum seems to be similar to taxonomic C and P-type asteroids.

Conclusions: The recent cometary activity of near-Earth object 2001 OG108 would seem to suggest that in fact some near-Earth asteroids could be extinct comet nuclei. This comet probably represents the transition between typical highly active Halley Family/long period comets and extinct comets. The V-R colours and albedo measured of this comet agree well with those obtained from other near-Earth asteroids that are good extinct comet candidates. These colours are also consistent with those obtained of P-type asteroids. The low albedo of 0.03 and featureless near-IR spectrum are similar to those for the C and P-type taxonomic class asteroids, but the visual colour data precludes that 2001 OG108 is similar to a C-type asteroid.

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Fig. 1:

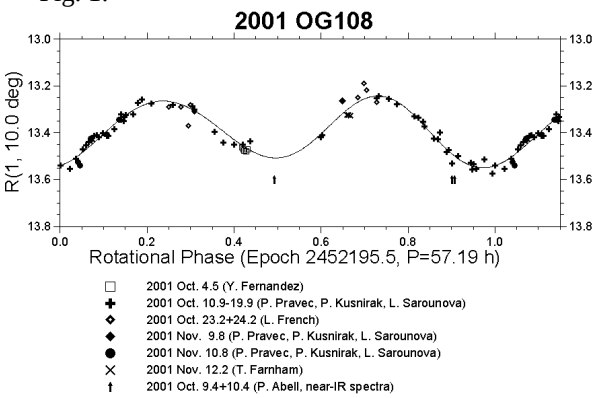

Fig. 2: