

The Potentially Hazardous Asteroid 2007 PA8: a fresh L chondrite analogue

S. Fornasier (1,2), I.N. Belskaya (3), D. Perna (1)

(1) LESIA, Observatoire de Paris, CNRS, UPMC Univ Paris 06, Univ. Paris Diderot, 5 Place J. Janssen, 92195 Meudon
Principale Cedex, France, (2) Univ. Paris Diderot, Sorbonne Paris Cité, 4 rue Elsa Morante, 75205 Paris Cedex 13, (3)
Astronomical Observatory of Kharkiv National University, 35 Sumska str., 61022 Kharkiv, Ukraine

Abstract

We present in this work the results on the polarimetric and spectroscopic observations of the Potentially Hazardous Asteroid (PHA) 2007 PA8 obtained during its favourable apparition of October-November 2012, when it approached the Earth at the minimal distance of 0.043 AU. Our data allow to constrain the surface composition of this PHA, to obtain the first estimation of its albedo and to determine its size.

1. Introduction

Asteroid 214869 2007 PA8 is a Potentially Hazardous Asteroid discovered on 2007 August 09 by the LINEAR sky survey. It is an Apollo Earth-crossing Near Earth Asteroid (NEA) with a Minimum Orbit Intersection Distance (MOID) of 3.63 millions of km (0.0214 AU). 2007 PA8 has a Tisserand invariant $T_J=2.95$, and its orbit resembles that of Jupiter-family comets. Extensive radar observing campaigns were performed at Goldstone, when the target was 0.043 AU far away from the Earth. Radar images reveal possible craters, boulders, an irregular, asymmetric shape (with rough dimensions of $1.9 \times 1.4 \times 1.3$ km), and a very slow rotation (102 ± 2 hr) in retrograde spin state [1]. Photometric investigations also indicate a long rotational period [2].

In this work we present the results on the polarimetric and spectroscopic observations of the PHA 2007 PA8 obtained during its favourable apparition of October-November 2012.

2. Polarimetric properties and size

Polarimetric observations were carried out at the 2.5 m Nordic Optical Telescope (NOT) of the European Northern Observatory (ENO) in La Palma, Spain, in 4 runs between 13 October and 14 November 2012. The

observations were done in the Bessel B, V, R and I filters covering both low phase angles (12-23 deg) and large phase angles (88-99 deg), and using the Wedged Double Wollaston prism mounted on the ALFOSC instrument.

The measured polarisation phase curve is shown in Fig. 1. We found a strong dependence of polarisation degree on wavelength. We have used the measured polarimetric slope and the value of P_{max} to calculate polarimetric albedo of the asteroid, using well known empirical relationships. Albedos defined from the polarimetric slope and P_{max} are very well consistent and point versus a 0.21 value in the V band. To be compared with radiometric albedos which are determined using the H value we need to take into account the opposition effect. For a moderate-albedo asteroid the mean increase in brightness from the phase angle of ~ 5 deg to zero phase angle is about 1.4 which gives an albedo in the V band of 0.29 ± 0.04 . Using this value of albedo and an absolute magnitude $H_v=16.2$ mag [2], we determine a diameter of 1.42 ± 0.10 km for this PHA.

The NEA 2007 PA8 is the fourth moderate albedo asteroid and the first Q-type asteroid (see section 3) for which the value of polarisation maximum is determined. The value of P_{max} for 2007 PA8 is the lowest one compared to three other silicate rich asteroids measured at a large phase angle of about 100 deg. The polarisation properties of 2007 PA8 are very similar to those measured for Near-Earth asteroids Icarus and Itokawa, suggesting similar surface properties.

3. Spectroscopy and composition

Spectroscopic observations in the visible and near infrared range of 2007 PA8 were made at the 3.56 m Italian Telescopio Nazionale Galileo of the European Northern Observatory in La Palma, Spain, on 12-13 October 2012. For visible spectroscopy we used the Dolores instrument equipped with the low resolu-

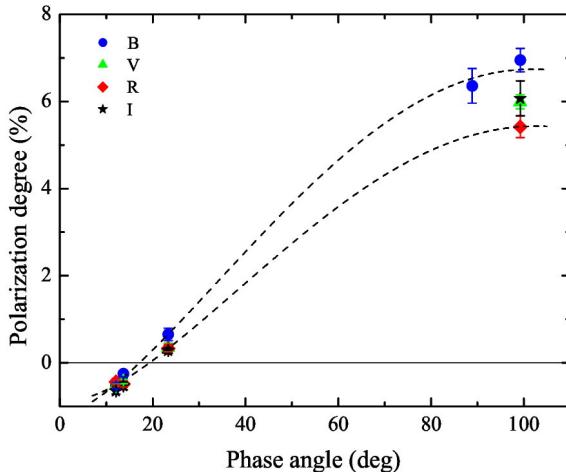


Figure 1: Polarisation phase angle dependence measured in the BVRI filters for the NEA 214869 (2007 PA8). Enlarged small phase angle range is shown in the upper left corner.

tion red (LRR) and blue (LRB) grisms. For the infrared spectroscopic investigation we used the NICS equipped with an Amici prism disperser (0.85–2.4 μm range). The combined visible and infrared spectra of 2007 PA8 (Fig. 2) clearly show a flat spectral slope with silicate bands at 0.95 and 2 microns consistent with a Q-type asteroid classification, following the Bus & Demeo classification scheme. We determined the mineralogical abundances of fayalite and ferrosilite that are fully consistent with the values of ordinary chondrites, and, more specifically, with those of L chondrites.

To constrain the possible mineralogy of 2007 PA8 we conducted a search for meteorite spectral analogues using the RELAB spectrum library. The two best spectral matches are represented in Fig. 2: both meteorites are L type chondrites, in agreement with the spectral analysis of 2007 PA8 that already pointed versus these kind of chondrites.

Nedelcu et al. [3] perform some dynamical simulations showing that 2007 PA8 probably originated from the Koronis or Gefion S-type families close to the 5:2 resonance in the outer belt, and that it rapidly enters (< 200000 years) in the NEO space. The results based on our visible and near infrared spectral investigation confirm that 2007 PA8 has a young surface almost unweathered. The fact that 2007 PA8 may be originated from the Gefion family and that it is spectrally similar to the L chondrites reinforce the Nesvorný et al. [4] hypothesis that the Gefion family, located at 2.7–2.82

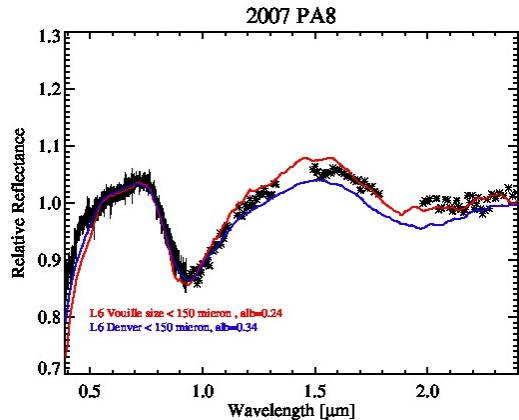


Figure 2:

AU in the outer belt, can be the source of these meteorites.

Acknowledgements

The research leading to these results has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement No. 312430 (OPTICON). This project was supported by the French Planetology National Programme (INSU-PNP), and by the COST Action MP1104 *Polarization as a tool to study the Solar System and beyond*.

References

- [1] Brozovic M., Benner L., Busch M., Giorgini J., Magri C., 2013. Goldstone radar imaging and shape modeling of near-Earth Asteroid (214869) 2007 PA8. American Astronomical Society, DPS meeting 45, #101.09
- [2] Hicks M., Brewer M., Somers J., 2012. Broadband Photometry of 214869 (2007 PA8): A Slowly Rotating Potentially Hazardous Asteroid. The Astronomer's Telegram, #4625
- [3] Nesvorný et al., 2009. Asteroidal source of L chondrite meteorites. Icarus 200, 698–701
- [4] Nedelcu D. A., et al., 2014. Evidence for a second parent body of H-chondrite A&A submitted.