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IMAGING POLARIMETRY OF THE DUST COMA OF THE DEEP IMPACT TARGET: COMET TEMPEL 1

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Abstract. We have observed comet 9P/Tempel 1 (the target of the Deep Impact mission) by a polarization imaging technique before and after impact with the 80 cm telescope at Haute-Provence observatory (France). The ejected material is clearly visible on our images and differences in physical properties are characterized.

1 Introduction

The light scattered by dust in a cometary coma is partially linearly polarized. The polarization value depends hon the phase angle and on the wavelength. The overall polarization on the whole coma provides information on the dust particles bulk physical properties. Three classes of comets, comets with a low maximum in polarization, comets with a high maximum in polarization and Hale-Bopp have been defined by their dust optical properties (Levasseur-Regourd et al. 1996; Hadamcik & Levasseur-Regourd 2003a). Average physical properties (size distribution, albedo) can be retrieved by such observational results through numerical and laboratory simulations results (Levasseur-Regourd & Hadamcik 2003a; Hadamcik et al. 2006; Lasue & Levasseur-Regourd 2006). The imaging technique gives access to changes (e.g. size differences, fragmentation of particles) of the properties in the different coma regions, such as jets, and circumnucleus halo (Tozzi et al. 1997; Hadamcik & Levasseur-Regourd 2003b). Comets with important jet activity generally belong to the high polarization class of comets. Comets with restricted dust emissions or without jet activity generally belong to the low polarization class of comets. A correlation between comets with a high polarization and comets with well structured silicate features in the infrared has been noticed (Hanner & Bradley 2004). It provides constraints on the size of the grains.

2 Observational conditions

The observations were conducted at *Observatoire de Haute-Provence* with the 80 cm telescope in a Cassegrain configuration. Four polarized filters are mounted on a rotating wheel with their fast axis at 45^0 from one another. A red filter centered on 650 nm avoids the contamination by gaseous emissions. A CCD camera with a resolution of 0.84 arcseconds/pixel is used. The comet was observed on 2005, July 2.799, July 3.868, July 5.960, 6.875, respectively about −32 hrs, −7 hrs, +43 hrs and +65 hrs from the impact. The Sun-comet distance was about 1.51 AU and the comet-Earth distance about 0.89 AU. The phase angle was about 41°.

3 Results

For each night, intensity and polarization maps are obtained. A rotational shift on the intensity image allows to emphasize the jets and other features. On Fig. 1, maps of intensity, emphasized intensity and polarization are shown for July 3.87 and July 5.96. The coma is always asymmetric and extends on the antisolar direction (close to southeast). Faint jets are present before impact. A large plume extends on more than 15000 km in about the southwest direction after impact. The overall polarization in a 13000 km aperture is about 6.3 %, 32 hrs before impact and 6.7 %, 7 hrs before impact. It is about 7.9 %, 43 hrs after impact and 6.6 %, 65 hrs after impact. The polarization in the plume (about 8 %) is higher than in the neighbourhood coma except in a small region at about 4000 km from the nucleus, in the inner part of the plume, where the polarization is smaller (5.5 %).

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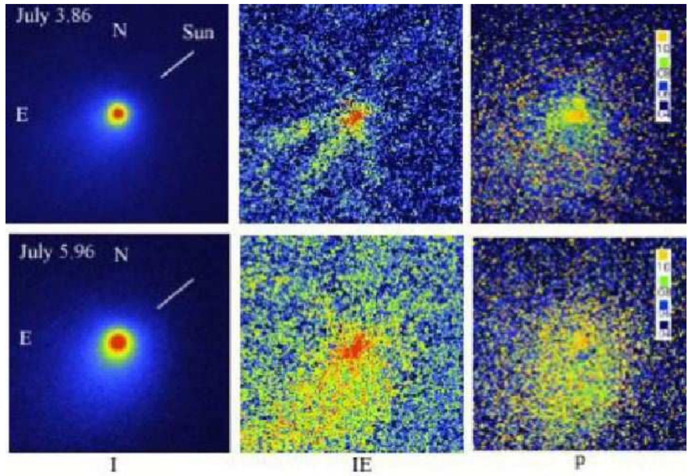

Fig. 1. Maps for July 3.87 (before impact), and July 5.96 (after impact) intensity (I), emphasized intensity (IE) and polarization (P). Field 70000 km x 70000 km

4 Discussion and conclusions

Comet 9P/Tempel 1 seems to belong to the low polarization comets (from its value at 41°), with a limited jet activity. Just after impact, the polarization increases and the overall value reaches a value typical of high polarization comets. A good correlation between the increase in polarization and infrared emissions is noticed after impact (Harker et al. 2005). From comparison with various data (Meech et al. 2005), it is suspected that the grains ejected in the plume (and responsible for the increase in polarization) are smaller than in the surrounding coma. The narrow lower polarization region in our map can be interpreted by a sorting by grains size, the fastest grains having a greater speed (Sugita et al. 2005). The dust ejected from the subsurface seems to be similar to that ejected from more active comets. Particles at the surface may be more processed by the long time in solar vicinity of this short period comet.

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