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Near-infrared polarimetric study of near-Earth object 252P/LINEAR: an implication of scattered light from its unexpected brightness enhancement

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Abstract

In this presentation, we report our new near-infrared (NIR; *JHK*s-bands) polarimetric study of near-Earth object 252P/LINEAR over 12 days near perihelion; alongside broadband optical photometric (*g'RcIc* bands) data over four months in 2016 and a subsidiary dynamical simulation over 1000 years backward in time to characterize the sublimation pattern of the comet. We detected two discontinuous brightness enhancements of the comet (by ~13 % at most) with unusual blue polarimetric color, showing similar polarimetric behaviors with fragmenting comets, e.g., D/1999 S4 (LINEAR) [**4**]. We will discuss the most probable scenario of the observed results, together with a trial to search any dynamical characteristics of the comet in the near-Earth orbit contributable to the observed abnormal photo-polarimetric behaviors in the apparition.

1. Introduction

Comets, one of the least-altered leftovers from the early solar system, have probably preserved the primitive inside, whereas their surfaces become different from initial states after repetitive orbital revolutions around the Sun. Resurfacing makes the surface drier and more consolidated than the bulk nuclei, creating inert refractory dust layer (so-called "dust mantle") [**1**][**7**][**9**]. The cometary dust that we observe generally originates from such a near-surface layer or bounded boulders ejected from the last apparition [**2**][**8**]. Conversely, fresh particles tend to be ejected from the interiors of the nuclei in rather erratic ways, such as during a sudden brightness enhancement near perihelion or outbursts (e.g., [**3**]).

The polarimetry of comets is a useful diagnostic for investigating the physical properties of dust particles, such as their sizes and porosities [**5**]. NIR polarimetry is theoretically expected to maximize contrast of the porosity between inner fresh and evolved dust particles, by harboring more dust constituents in the single wavelength than the optical, and thus intensifying electromagnetic interaction in dust agglomerates [**6**]. Despite the advantage, only a few studies have been conducted in this approach at multiple observation epochs at high phase angle (an angle between the Sun—comet—observer) of >70 degrees ([**5**] and references therein).

Herein, we present our new multi-band NIR polarimetric (1.25—2.25 μm) study of near-Earth object 252P/LINEAR (hereafter 252P) over 12 days near perihelion; alongside broadband optical photometric (0.48—0.80 μm) data over four months in 2016 and a subsidiary dynamical simulation over 1000 year backward in time. 252P drew attention due to (i) its close approach to the Earth (~0.036 au on 2016 March 16), (ii) its possible dynamical pairing to a comet P/2016 BA14 (PanSTARRS), and (iii) its very low activity level despite its relatively young dynamical age. In this study, we detected two discontinuous brightness enhancements of 252P, particularly, the former of which accompanied a significant increase of NIR polarization degree of the comet (by ~13 % at most) with unusual blue polarimetric color. We will discuss the most probable scenario of the observed results, together with the orbital evolution of the comet and a dynamical association with its pair.

2. Results

Here we summarized the key results to be discussed in this presentation. In Figure 1, two arrows in panel (a) mark the probable activation points of 252P. Yellow-colored area covers the epoch of our polarimetric observations over ~two weeks.

- Abnormal increase of the polarization degree of the comet upon the 1st activation point only within the change of in δr_H = 0.008 au, similar with the behavior of fragmenting comets, e.g., D/1999 S4 (LINEAR) [**4**]

- Blue polarimetric color (−2.55 % (1000 Å)$^{-1}$ on average) of the comet, different from those of non- and long-periodic comets ever observed which show moderately positive spectral dependence of the polarization degree

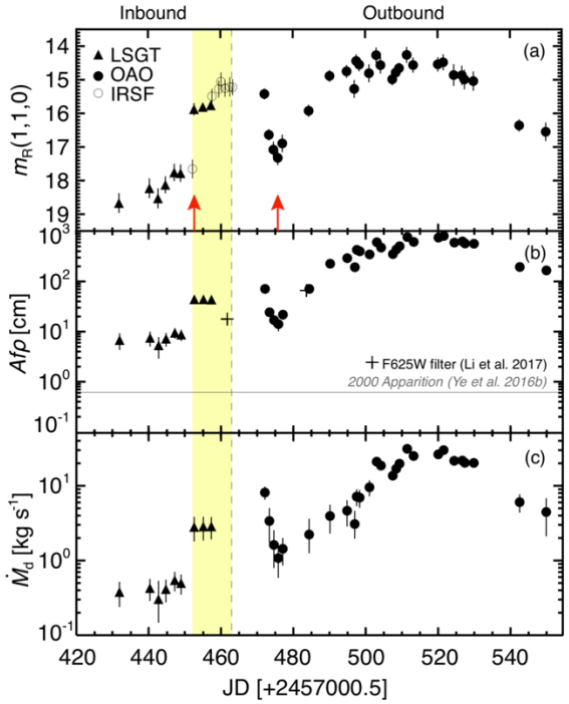

Figure 1: Reduced absolute magnitude (a), a proxy of dust production rate $Af\rho$ (b), dust mass-loss rate (c) as a function of Julian Day. Two red arrows in panel (a) mark presumable locations where 252P presented significant brightness enhancements. Yellow-colored area covers the epoch of our polarimetric observations. The vertical dashed line denotes the perihelion on UT 2016 March 15.28.

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