Optical polarimetry and photometry of comet 17P/Holmes

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ABSTRACT

Comet 17P/Holmes was observed for linear polarization using the optical polarimeter mounted on the 1.2-m telescope atop Gurushikhar peak near Mt. Abu during the period 2007 November–December. Observations were conducted through the International Halley Watch narrow-band (continuum) filters. During the observing run, the phase angle was near 13° at which the comet showed negative polarization. On the basis of the observed polarization data, we find comet 17P/Holmes to be a typical comet with usual dust characteristics. We note that radial rate of change of brightness in coma in red band is higher than that in blue band; it has decreased by a factor of 3.6 and 2.5, respectively, in red and blue bands during the November–December run, indicating relative increase in the abundance of smaller dust particles outward. Radial brightness variation seen near the nucleus on November 6 is indicative of the presence of a blob or shocked region beyond 10 arcsec from the nucleus which has gradually smoothened by December 13. The brightness distribution is found steeper during November 5–7 as compared to that on December 13.

Key words: methods: observational – techniques: polarimetric – comets: general – comets: individual: comet 17P/Holmes.

1 INTRODUCTION

Physical properties of cometary dust can be obtained from the solar radiation scattered by the cometary dust which, in the process, gets polarized. The degree of polarization and its direction mainly depend on the size distribution, composition of the particles, phase angle and the wavelength of the incident solar radiation. However, the real situation is not that straightforward. In an attempt to study the detailed behaviour of polarization with phase, Dollfus et al. (1988) synthesized the polarization observation data on 1P/Halley by various researchers and derived curves of polarization as a function of the phase angle. Phase curve below about 20° shows negative polarization while it is positive at higher phase angles. They find slight modification in the polarization phase curve as one moves away from the nucleus indicating the change in the nature of the dust particles. Also, an anomalously high transient polarization was noted between 1985 October 17 and 30, at the phase angle of 25°, attributed to sudden release of large number of smaller particles. On the basis of this work on 1P/Halley, Dollfus (1989) derived the physical properties of the dust grains indicating the presence of large particles – aggregates comprising of sub-micron-sized grains, very rough and dark. These rather large grains are mixed with the clouds of small particles and they are usually responsible for almost all the polarization effects in visible light, except during temporary specific dust release events (as seen in the case of 1P/Halley during 1985 October 17–30) by the nucleus (Dollfus 1989). The complex behaviour of the dust is also seen in comet C/1995 (Hale-Bopp), especially the region around the nucleus shows complex structure (Hadamcik & Levasseur-Regourd 2003). Though the comets, in general, show similar polarization behaviour with phase angle, they are divided into three classes based on the maximum in polarization (Levasseur-Regourd 1999). Varying polarization observed in the coma or in the features (jets, shells, etc.) indicates a diversity of dust particles. Issues related to the dust characteristics are adequately reviewed by Kolokolova et al. (2004).

One of the main objective behind the study of comets is to understand the origin of the Solar system. Since comets spend substantial part of their life away from the Sun, their subsurface material is considered pristine. Space mission Deep Impact was launched on 2005 January 12 to study the composition of the interior of the comet 9P/Tempel 1 by colliding a part of the spacecraft with the comet (Meech et al. 2000; A’Hearn et al. 2005b). At 5:52 UTC on 2005 July 4, the impactor of the Deep Impact probe successfully collided with the comet’s nucleus, excavating huge amount of debris from the interior of the nucleus (A’Hearn et al. 2005a,b).

On 2007 October 24, nature itself provided a similar opportunity, albeit at a much grander scale. Comet 17P/Holmes underwent unprecedented outburst on 2007 October 24, after about 5 months of perihelion passage (Santana 2007). The comet brightenings are well documented in the literature and in general are associated with an evident fragmentation of cometary nucleus (e.g. Sekanina 2002a,b, and the references therein). But, the magnitude and the characteristics of the outburst occurred in comet 17P/Holmes has dwarfed all the events seen earlier.