NEAR-IR MONITORING OBSERVATION OF COMET 9P/TEMPEL 1. Y. Mori[1], T. Sekiguchi[2], S. Sugita[3], N. Matsunaga[4], H. Fukushi[4], N. Kaneyasu[5], T. Kawadu[6], R. Kandori[2], Y. Nakajima[2], M. Tamura[2], [1]. Department of Earth & Planetary Science, Graduate School of Science, The University of Tokyo (moriyuki@impact.k.u-tokyo.ac.jp). [2]National Astronomical Observatory of Japan, [3]Department of Complexity Science and Engineering, Graduate School of Frontier Science, The University of Tokyo, [4]Institute of Astronomy, University of Tokyo, [5]Department of Physics, Meisei University, [6]Department of Astrophysics, Kyoto University

Introduction: On July 4, 2005(UT), NASA's Deep Impact (DI) spacecraft hit on the target comet 9P Tempel 1 with 370 kg cooper-based impactor [1]. Before and after this event, many telescopes were pointed at comet 9P/Tempel 1 [2]. Although many high quality observations were conducted using very large telescopes [3]-[5]. However almost observations were conducted only a few days near the impact ;long-term phenomena that may have been induced by the DI collision is not observed extensively. Thus, we conducted a long-term observation, covering time from 7.5 days before the impact to 24.5 days after. Because there is no strong gas emission in near-IR wavelength, we chose to use this wavelength range. This way, we can observe only the dust component separated from the gas component. Here, we present the observed long-term change of the comet activity and the motion of the dust ejected by the impact.

Observation: We carried out 3-color photometric observations of comet 9P/Tempel 1 in near-infrared wavelengths J (λ=1.25μm), H (λ=1.65μm), K (λ=2.15μm) simultaneously. The observation were performed for 16 nights since June 27 to July 28, using the near-infrared camera SIRIUS (Simultaneous Three-Color Infrared Imager for Unbiased Survey) mounted on the IRSF (Infrared Survey Facility) 1.4 m telescope of Nagoya University at the Sutherland South African Astronomical Observatory (32.38S latitude, 20.81E longitude). At this location, we could observe the comet a half day after the impact. We took two data sets every observing nights. We also observed standard stars 9150 and 9155 in the catalog by Persson et al. [6].

Results: We monitored the variation of brightness of the comet before and after the impact (Fig. 2). After the impact, the comet brightened by 0.3-0.4 magnitude in the three wavelengths. However the high brightness did not continue, it gradually darkened, and returned almost to the pre-impact brightness about three days later. This result suggests that no active region were made by the impact, that is, the excavation couldn't reach the region containing presumable hyper-volatile material might exist. Although the brightness after the impact did not continue, some small increase of brightness were seen in Fig.2. Except for bad data owing to bad weather (with large error bars, June 27, July 3 and 16), the data of July 7 and 11 maight be after small outbursts.

We also obtained the data on color during this observation period. The difference between J and H (i. e., J-H) was ~0.45 and H-K was ~0.15. These values are redder than the Solar color and typical comets [7]. However, the change in color by the impact was not observed.

We estimated the ejecta velocity with an assumption that the ejecta moved at constant velocity since its release. Photometric measurements using various aperture sizes (Fig.3) indicate that, the brightness in apertures smaller than 15000 km decreased 1.5 days after the impact. In contrast, the brightness in apertures larger than 20000 km did not decrease. This suggests that the ejecta had reached 15000 km from nuclei , but hadnot reached 20000 km. Based on this observation, we estimated the ejecta velocity, 115~150 m/s. This value is larger than the result of mid-infrared observation with Subaru Telescope [3] and smaller than optical observation with the Rosetta spacecraft [8].

The time variation of ejecta distribution was also detected. We made angular profiles every 15 around the nuclei on the data of July 1, 4, 5 and 6 (Fig.4). On July 4 (0.5 days after the impact), the profile of inner region (aperture=6000km) differed from outer region (aperture=9000km). The inner one had single peak, but outer one had double peak. This trend that ejecta released earlier had double peak distribution is consistent with the result of observation with the Subaru Telescope [3]. On July 5 and 6, peak of profiles moved to ~90 degree. This angle is near the direction of the Sun ~295 PA. It is probable that ejecta released toward the Sun was slowed down by the effect of radiation pressure[9], so stayed near the nuclei longer than ejecta released toward the other direction. More detailed map of the distribution of ejecta may enable us to estimate the mean size of ejecta.

References: [1] A'Hearn M. F. et al. (2005) *Science, 310, 258-264*. [2] Meech K. J. et al. (2005) *Science, 310, 265-269*. [3] Sugita S. et al. (2005) *Science, 310, 274-278*. [4] Mumma M. J. et al. (2005) *Science, 310, 270-274*. [5] Harker D. E. et al. (2005) *Science, 310, 278-280*. [6] Persson S. E. et al. (1998) *AJ, 116, 2475-2488*. [7] Degewij J. et al. (1980) *Icarus, 44, 541-547*. [8] Keller H. U. et al. (2005) *Science, 310, 281-283*. [9] Finson M. L. et al. (1968) *ApJ, 154, 327-380*.

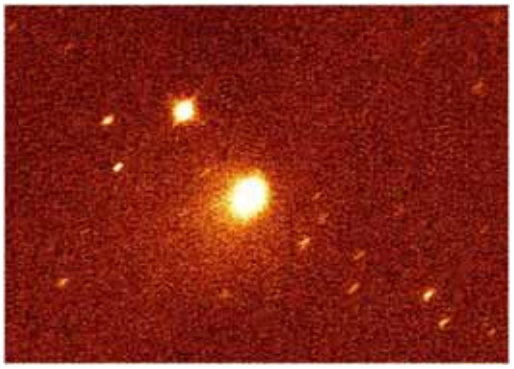

Figure 1. J band image of 9P/Tempel 1 on July 4 : 0.5 days after the impact.

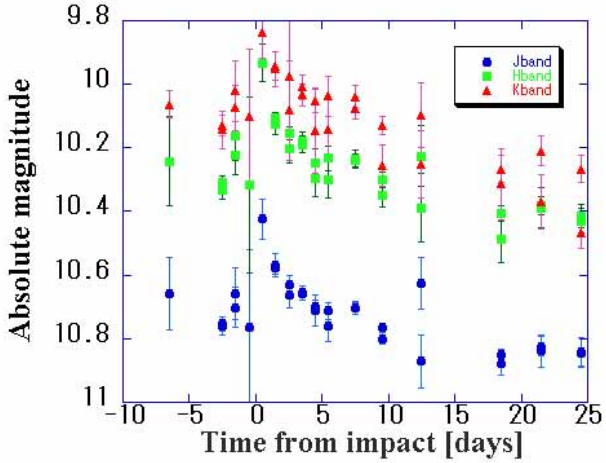

Figure 2. The variation of brightness of the comet before and after the impact.

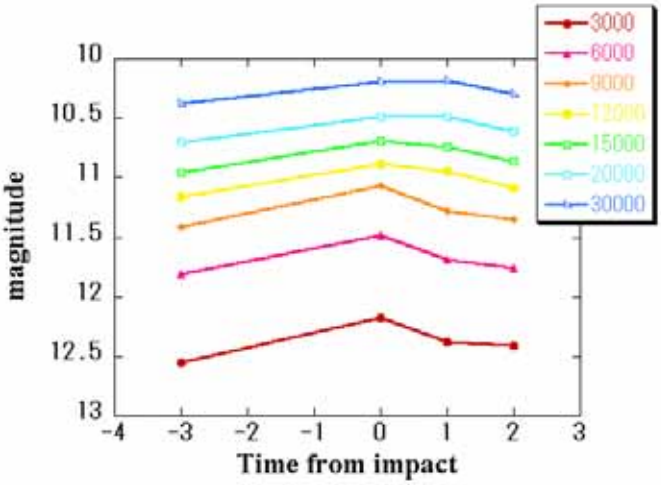

Figure 3. The variation of brightness of the comet mesured with various apertures.

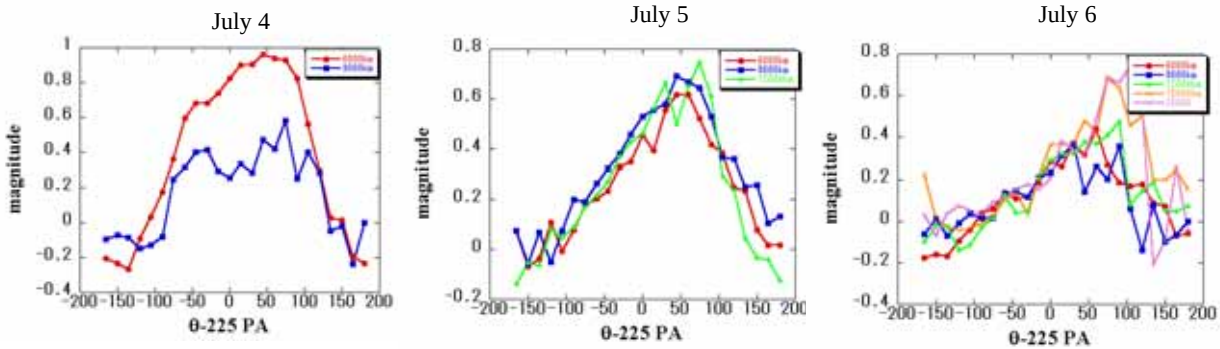

Figure 4. Angular profiles around the nuclei. The origin of the horizontal axis is 225 PA, the center of the ejecta distribution on the data of Subaru Telescope [3].