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Mid-Infrared Observation of Dust Plume Induced by Deep Impact Collision With Comet 9P/Tempel 1

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The projectile of NASA's Deep Impact (DI) spacecraft successfully collided with a Jupiter-family comet (JFC), 9/P Tempel 1 on July 4, 2005 (UT). We observed the comet before and after the Subaru telescope and its mid-infrared detector, COMICS [1]. Mid-infrared (mid-IR) observations are important because this wavelength range is not covered by the DI spacecraft instruments [2] but can allow us to see what is happening deep inside the coma around the comet. Both imaging observations with seven band filters and N-band low-resolution (R∼250) spectroscopic observations were conducted from July 3 to 5 (UT). This observation was as a part of Subaru-Gemini collaboration, in which Subaru was focused primarily on N-band imaging and Gemini was on N-band spectroscopy [1, 3]. The observation revealed several very important results.1) A large (several km across) dust plume was formed in 225 degree position angle, which is consistent with the surface normal at the impact site on the comet.2) The total ejecta mass is estimated to be on the order of 10^6 kg and is consistent with gravity-controlled cratering.3) The size distribution of the silicate grains found in the dust plume is surprisingly similar to that in the comas around Oort-cloud comets (OCC) and very different from that in the comas around JFC's.4) The crystal/amorphous ratio of the silicate grains found in the dust plume was much higher than that found for the coma of JFC's and very similar to typical OCC coma observation results. Here, it is noted that the observed high crystallinity ratio is intrinsic and not significantly increased by impact-induced devitrification of amorphous grains, because the entire DI impact energy can devitrify only 1/10 of the estimated mass of ejecta. These observation results strongly suggest the apparent difference between OCC's and JFC's are rather superficial but very close inside. Then, the origin of the two families of comets may be much closer than previously thought. [1] Sugita, S. et al. (2005) Science, 310, 274-278. [2] Hampton, D. L. et al. (2005) Space Sci. Rev., 117, 43-93. [3] Harker, D. E. et al. (2005), Science, 310, 278-280.