SAMPLE-RETURN MISSIONS FROM COMETS AND PRIMITIVE BODIES: A FUTURE LANDMARK IN SPACE EXPLORATION

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ABSTRACT

The successful Stardust mission to comet 81P/Wild 2 provided the second direct samples of a solar system body after the recovery of lunar rocks by Apollo, and Luna missions. Recovering cometary materials by using an aerogel collector, while the spacecraft was overflying this Jupiter Family Comet at a speed of 6.1 km/s, was a huge technological challenge [1]. This significant achievement was obtained in the framework of the multidisciplinary Stardust science team [2]. Recovered 81P/Wild 2 materials suffered significant heating during deceleration in the Stardust aerogel collectors that have partially altered some of the carbonaceous compounds during track excavation [3, 4]. To study low-melting temperature organic and mineral phases, future sample return missions to primitive bodies will require new techniques to collect essentially unaltered materials. An interesting step ahead has been proposed with the Comet Coma Rendezvous Sample Return (CCRSR) mission concept [5] in which the spacecraft is designed to rendezvous with a comet, making extended observations within the cometary coma, and gently collect coma samples at much lower relative velocities than Stardust mission did. Landing on a cometary surface is another critical issue that requires the effort of the Planetary Probe community. This technological challenge is remarkable because remote measurements, and laboratory evidence suggest that most of these primitive objects are formed by poorly-consolidated pristine materials [6]. Deep Impact mission to comet 9P/Tempel 1 demonstrated the extreme fragility and tiny size of cometary materials, and provided information on the gravity-dominated regime that dominates the late phases of crater excavation. Below the surface most comets seem to have ice deposits that may have explosive behaviour when exposed to solar radiation. Planetary scientists and engineers need to work together to find solutions on these important issues. New techniques to return safely pristine samples from these primitive bodies are urgently required to get significant progress in our understanding of the physicochemical environment present in the outer regions of the protoplanetary disk. The prize of a sample-return mission for the scientific community would be having direct access to unprocessed solar system materials, particularly true if we use penetrators to obtain samples in depth [7]. We expect that such pristine materials provide new clues to better understand the processes that took place during the early stages of solar system formation.

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