

SAMPLE COLLECTION ON COMET FLYBYS

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Comet sample return can provide detailed data information on the nature of cometary material by the sensitivity, precision and flexibility of modern laboratory analytical techniques. Sample return from most solar system bodies is complex and costly and is usually attempted after a sequence of reconnaissance missions. For comets, however, sample return should be considered for an early mission since highly simplified collection of coma materials is possible without the complex and costly landing and surface operations. Cometary dusts & gases can be collected by high speed flyby in suitable free return trajectory. The collected samples can be fitted into a small atmospheric entry capsule for earth entry then retrieved by either air or sea recovery.

This flyby sample return concept+ is suitable for encounter velocity ranging from 10-70 km/s. The dust sample collection approach allows particles to impact thin diaphragms to vaporize the particles and small areas in the diaphragms. The resulting vapor is then captured by condensation on compartmentalized collector cells. The condensed dust vapor and individual particles can be either analyzed in place using surface techniques such as the ion microprobe or they can be dissolved off the cell walls and analyzed by solid source mass spectrometry and focused beam X-ray fluorescence. Cometary gas samples can be captured by physisorption or chemisorption with getter material deposited on collector surfaces.

This dust sample return concept has been simulated in the laboratory with good success. Two-stage light gas gun has been used to evaluate 1-3 mm size particle impacts. To compensate for the low speed (6.5 km/s), we have utilized Cd, Zn, and Pb, higher density and low vaporization temperature metals for both particles and diaphragms to simulate encounter impacts. Since vaporization of chondritic material can not be produced by low velocity impacts, we have simulated this by ultra-high power pulsed focused electron beam gun (2×10^{13} watt/cm²). In cooperation with H. Fechtig of Max Planck Institute, very small particle impacts in realistic velocities of 10-30 km/s is simulated with electrostatic accelerator with submicron Fe particles. This basic dust collection concept has been validated in the laboratory.

Initial experiments indicate that 50% to 70% of the particle can be trapped in the collection cell. Recovery efficiency was tested by SEM analysis and bulk weight analysis after chemical etching. Metallic and teflon diaphragms show distinct different collection efficiencies. The recovered material is not fractionated; it has the chemical composition of the original particle. Quantitative data on hypervelocity impact parameters (impact sequence, released radiative energy, plasma plume angle, particle to diaphragm thickness ratio, and condensed particle size distribution) are obtained. These permit us to refine analytical models for particle impacts, and, we believe, a collector for a given flyby velocity and comet dust model can be designed.

+ Shown in enclosed figure.

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