

## CRYOGENIC COLLECTION OF PARTICLES BY SOLID XENON SURFACES:

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There has recently been enhanced interest in the study of small particles in the solar system. In the near-earth environment, this interest is centered on the high velocity interplanetary dust particles<sup>1)</sup>, presumably the debris from comets, meteorites, or from their interaction with other solar system bodies. Another interest arises from the desirability of collecting a dust sample on a rendezvous mission to a comet. Important considerations in designing a collection scheme for such missions are freedom from contamination by the spacecraft or by the collecting medium, efficiency of collection, and collection of a sample of adequate size without undue exposure of the spacecraft to the hazards of the cometary environment.

A cold surface such as that of a solid film of xenon would appear to be attractive from the standpoint of these constraints. The noble gas nature would maximize the probability of preserving the pristine nature of the collected dust, specifically avoiding contamination by light chemical elements such as C, N, O and F. The hazards to the spacecraft from the comet environment could be minimized by having a relatively large area of collection and then subsequently concentrating the collected sample on to a small area.

In order to explore the possibilities of this concept, a gas jet accelerator has been constructed (see Fig. 1) to accelerate micron-size dust particles to velocities of  $\sim 300$  m/sec. This is the range of velocities expected for dust particles ejected from a cometary nucleus during passage near the sun.<sup>2)</sup> The accelerator operates on the principle of pumping a gas through a capillary long enough so that the gas emerges at sonic velocities, carrying along the particles.<sup>3)</sup> The gas is separated from the particles by skimmers. The larger momentum of the particles keeps them going forward through the skimmer holes while the higher transverse velocity of the gas molecules acts to remove them from the beam in the regions between the skimmers. Using argon as a carrying gas produces particles of about 300 m/sec; helium accelerates particles to  $\sim 1000$  m/sec. Less energetic particles can be produced by slowing them down by appropriate amounts of stationary gas after acceleration.

In order to study the behavior of micron-size particles conveniently, dust that fluoresces under the influence of near UV light has been used. Both  $\text{CaCO}_3$  impregnated with a dye, and ZnS particles have been accelerated.

The ability of solid xenon at  $-188^\circ\text{C}$  to catch particles at these velocities has been demonstrated (see Fig. 2). Microcrystalline solid xenon,  $\sim 0.1\text{g/cm}^2$  prepared by vapor deposition at low temperatures, has been found to be approximately as effective in collecting accelerated particles as an oil-covered metal plate at room temperature.

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Significant differences in the ability of metal surfaces to catch fast particles have been noted: dry particles appear to bounce off surfaces appreciably more than if they have been produced by evaporation of a carrier solvent. This may be related to the presence of residual solvent on the particles at the time of impact. Also, the sticking probability of particles to metal surfaces appears to be sensitive function of their velocity.

These studies suggest that solid xenon collection of cometary dust on a comet rendezvous mission is feasible. The samples collected would be adequate for examination by instruments onboard the spacecraft and specifically, large enough for accurate and complete chemical analysis by alpha-proton-x-ray methods.<sup>(4)</sup>

## References:

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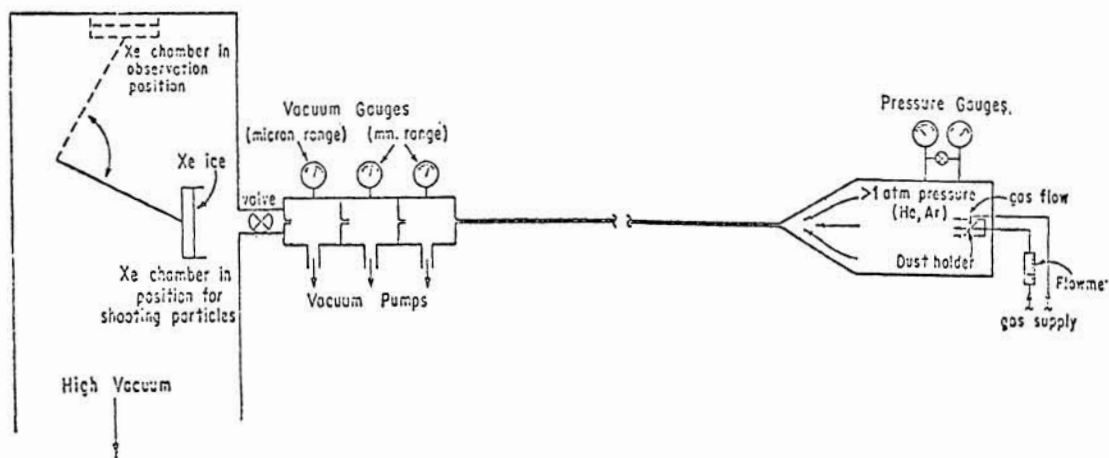
DUST ACCELERATOR USING GAS JETLaboratory for Astrophysics and Space Research  
University of Chicago

Fig. 1 Dust accelerator.



Fig. 2  $\sim 300$  m/sec particles embedded in solid xenon film ( $\sim 0.3$  mm thick) at  $-188$  C. Some of the particles are not in focus because they end up at various depths in the film. The full picture represents an actual area of  $\sim 10$  mm<sup>2</sup>.