COLLECTION IN SPACE OF COMETARY MATERIAL BY THE KMP-COMET EXPERIMENT

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Introduction. Based on a cooperation with the Soviet Union, a french experiment will fly on board the "Saliout" Station. Its purpose is to collect and recover samples of cometary material by exposing capture cells during the encounter by the Earth of cometary tails or meteor streams. The first collecting period will take place in october 1985, when Earth crosses the meteor stream associated with comet Giacobini-Zinnner.

The collectors. Following the design previously published (1), the system is constituted of 4 identical boxes containing 144 modules, each 2 cm^2 in area. Each module is made of high purity metal, and is divided into 200 cells (1 mm^2 each). The module is covered either by a thin metallic film or a coated plastic film. Figure 1 represents a unit consituted of 12 such modules and Figure 2 represents the four boxes in the process of being opened for the collecting period. The modules will be placed within the boxes in a class 100 clean room, at Orsay. The boxes will then be hermetically sealed, set and maintained under vacuum during all stages of their transportation to the Station, reached by a "Progress" probe. Astronauts will take the system out of Saliout and fix it to the external body of the Station. Then, an automatic program will process the opening of the boxes during the collecting period, then their closing and locking. The Astronauts will exit the Station a second time to take the system back to the Station, and send it back to Earth, through a Soyouz spacecraft. Finally, the boxes will be received at Orsay, opened in the clean room and the samples prepared for analysis. The boxes will then be refurnished with new modules and transferred to Soviet Union from where they will be launched for a second collecting period, during the encounter with the meteor stream associated with comet Halley (may 86).

Analytical techniques. The prime objective of the analyses will be to determine the composition of the grains having impacted the collectors. Three basic techniques have now been selected, tested and calibrated : Auger microscopy, PIXE and SIMS. The latter is the most sensitive, and allows the determination of isotopic ratios. However, as this technique is destructive, we may use one of the two other techniques when analysing large grains (> 5 μm). Calibrations have been performed by implanting rare isotopes of easily identified elements (Si, Ca, Co, Cr) in capture cells and films. These surfaces where then analysed using either Auger, PIXE or SIMS. One of the problems we face is to determine the individual cells which have actually been impacted by grains during the exposure in space : the expected numbers of such grains range between one hundred and several thousands for each collecting period, distributed among ~ 120,000 individual capture cells. Moreover, the films covering the modules contain pinholes inherent to their preparation (typically a few pinholes per mm^2). Consequently, we have develo ped an automatic system which scans the covering films with a CCD camera mounted on an optical microscope. These images are processed by a microcomputer so as to determine for each film the position and size of all holes larger than ~ 1 μm. This procedure will take place both before and after the exposures of the samples in space, so that a new hole will be associated with each micrometeoritic impact.

Expected numbers of collected grains. This estimation has been performed for the encounter by the Earth of either a cometary tail or a cometary stream. We first evaluate the total dust emission of a given comet from its absolute optical magnitude, with the dust model developed for Temple 2 considered as a standard case. In the case of a tail encounter, we directly compute the trajectories of the individual grains as a function of the time of ejection, the velocity relative to the nucleus and the size of the grain which modifies the ratio between radiation pressure and solar gravity. For cometary stream encounters, we first note that, for the very small grains considered (< 5 μm), the radiation pressure induces large increases of the orbital period. Therefore, small grains emitted at a given perihelion passage spread over the entire stream within a few periods. We thus compute the contribution to the stream of all past orbits with perihelia smaller than (or close to) one A.U. so as to obtain an average number of expected impacts. Whenever the Earth crosses the stream soon after the comet, this estimate is pessimistic, as grains ejected during the previous orbit have not yet spread over the whole orbit, and trail the comet by a small fraction of the orbital period. This is in particular the case for the october 85 encounter with the Giacobini-Zinner stream, as the Earth crosses the stream less than one month after the comet passage.

Schedule. Tests of the apparatus and cosmonaut training are under way in the Soviet Union since the delivery of the two qualifying models in december 1984. The first flight models will be delivered in June 85, for a launch in early July. Installement on the outside of the Saliout station will occur at the end of september 85. The boxes will be opened for the first collecting period in october 85, to ensure the sampling of grains from the comet Giacobini-Zinner. They will finally be sent back to the laboratory by the end of 85.

Reference. Bibring J-P. et al., XIV LPSC, 37-38

Figure captions. Down : a set of 12 modules exhibiting their individual cells, at scale 0.9. Right : one of the two qualifying models, with its 4 boxes while opening. In this model, the boxes did not contain the collecting modules.