AN IMPACT MASS-SPECTROMETER FOR THE HALLEY-PROBE

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The relative speed between Comet Halley and the presently planned Halley Probe will be approx. 55 km/s. At such a speed the method of impact ionization mass-spectrometry is perfectly suited to analysing cometary dust particles with masses from 10^{-16}g to 10^{-10}g. First results are reported by Dalmann et al. If a micrometeoroid hits the sensitive target, ions from both particle and target material are produced. The total number of ions is registered with a charge-sensitive amplifier and this signal Q allows the determination of the particle mass m ($Q \sim m$). By an electric potential difference of 3 kV, ions are drawn into a field-free drift-tube. The ions are separated in time in the TOF-Spectrometer due to their different masses. The mass spectrum is registered as output current of the particle multiplier at the end of the TOF-tube. It gives information about the chemical composition of the detected particle. Characteristics of such spectra recorded with the Impact-Spectrometer currently used in the laboratory are the following: a) mass resolution $m/\Delta m > 100$ at 23 amu, b) flight-time $t \sim \sqrt{m}$ ($t \sim 14$ µs at 100 amu; the corresponding $\Delta t \sim 70$ ns between 99 and 100 amu).

At present a new concept of a TOF-Spectrometer is under development. The expected improvements are longer flight-times at the same mass resolution $m/\Delta m > 100$. With these improvements the requirements upon the speed of the signal conditioning electronics can be relaxed by at least a factor of three. Gold proved to be the most suitable target material for reducing the number of ions originating from the target itself. First tests showed silver as an acceptable alternative with the advantage of having two calibration points (107 and 109 amu) for the exact determination of the mass scale. Here also no perturbations from other elements are expected. The mass range of interest for the mission is below 100 amu. Simulation experiments are being made to study the transformation of the particles' chemistry into the measured mass spectrum using various combinations of projectile- and target-materials. The goal is to get the relative ion yield for the most important elements. Also, the yield of molecular ions is being investigated. Because of the high mass resolution of the instrument, isotopic abundances of elements can be measured. The problem of masking of isotopic ratios by doubly

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ionized elements and/or molecular ions is being studied at the present time.

REFERENCE

Dalmann B.-K., Grün E., and Kissel J.: 1977, Planetary Space Sci. *25*, pp. 135-147.

DISCUSSION

Hanner: Does the high impact velocity of 57 km/s cause a problem in the time resolution of the measurement?
Kissel: The ion speed depends mostly on the potential of the time-of-flight tube and not much on the impact speed. For larger particles, say > 10 μm, the large amount of charge released at this high impact speed may decrease the resolution for that one spectrum.

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