A small multiple-pass time-of-flight mass spectrometer (MR-TOF-MS) for in-situ investigations

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To increase the mass resolving power of an energy- isochronous time-of-flight mass spectrometer one can increase the overall flight time of the ions, if the length of the ion pulse is kept constant. On the other hand only small and light-weight instruments of low power requirements can be accepted for mass spectrometers that are used in situ. For such investigations we therefore have built a small time-of-flight mass spectrometer in which the ions are repeatedly reflected between two grid-free ion mirrors [1,2,3,4], thus achieving a mass resolving power that depends on the number of passes of the ions through the system.

The Multi-Pass Time-of-Flight Mass Spectrometer (MTOF-MS) was constructed and optimized for in-situ investigations in space missions that required a high performance mass spectrometer of very low weight and very small power consumption.

In the linear mode, i.e. without reflections, the 420 mm long system achieves a basic mass resolving power of m/Dm = 350 with an electron impact gas ion source operated at a repetition frequency of 1 kHz. In the multi-pass mode the spectrometer achieves a mass resolving power $m/\Delta m \approx 4000$ after 15 passes, i.e. after an overall flight path of ≈6.5m, which can be increased to a mass resolving power of $m/\Delta m \approx 15000$, after 101 passes, i.e. after an overall flight path of ≈30m. The finally registered ion intensity is about 50% of the ion intensity obtained with the MTOF-MS in the linear mode and does not depend noticeably on the number of passes.

The built MTOF-MS will be placed on board of the Lander module of the ROSETTA Mission of the European Space Agency (ESA), to be launched in January 2003 to perform in-situ investigations on the head of the comet P/Wirtanen. It also is planned to use this MTOF-MS to investigate the gases of the comet atmosphere but also the effluent of a gas chromatograph.

References:

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