A Microchannel Inlet to Reduce High-Velocity Impact Fragmentation of Molecules in Orbital and Fly-by Mass Spectrometers

Anupriya Anupriya, Brandon Turner, Eric T. Sevy, Daniel E. Austin

Department of Chemistry and Biochemistry, Brigham Young University, Provo, UT 84602

Closed source neutral mass spectrometers are often used on flyby missions to characterize the molecular components of planetary exospheres. In a typical closed source, neutrals are thermalized as they deflect off the walls within a spherical antechamber prior to ionization and mass analysis. However, the high kinetic energy of each molecule as it impacts the chamber can lead to fragmentation before the ionization region is reached. Due to this fragmentation, the original composition of the molecule can be altered, leading to ambiguous identification.

Even knowing the fragmentation pathways that occur may not allow deconvolution of data to give the correct composition. Only stable, volatile fragments will be observed in the subsequent mass spectrometer and different organic compounds likely give similar fragmentation products. Simply detecting these products will not lead to unambiguous identification of the precursor molecules. Here, we present a hardware solution to this problem—an inlet that reduces the fragmentation of molecules that impact at high velocities, while retaining the benefits of ram-pressure enhancement on sensitivity.

We present a microchannel inlet that reduces the impact fragmentation by allowing the molecules to dissipate kinetic energy faster than their respective dissociation lifetimes. Preliminary calculations indicate that impact-induced fragmentation will be reduced up to three orders of magnitude compared with conventional closed sources by using this inlet. The benefits of such an inlet apply to any orbital or flyby velocity. The microchannel inlet enables detection of semi-volatile molecules that were previously undetectable due to impact fragmentation.