# Sampling Systems That Support Atmospheric Probe Mass Spectrometry Objectives

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**Abstract**

One of the most fundamental measurements that an atmospheric probe can make is the noble gas composition of the well-mixed atmosphere. The relatively inert chemical nature of noble gases makes them excellent tracers of the original reservoirs of material that formed the planet. Three types of measurements are important in this context: 1) abundance relative to the background H2 atmosphere; 2) relative abundances of He, Ne, Ar, Kr, and Xe; and 3) isotopic abundance patterns within individual noble gases. In the latter context, comparison of the Xe isotopic abundances with those from comet 67P by ROSINA/Rosetta provides constraints on the origin of Earth's volatiles (Marty et al., 2017).
The Galileo Probe mass spectrometer made measurements of the noble gases at Jupiter that indicated a factor of 2-3 increase relative to protosolar values. Likewise the noble gas enrichment system, a subsystem of the Galileo Probe mass spectrometer that is based on a SAES-171 getter, provided measurements of He, Ne, and Ar, but did not provide adequate signal-to-noise measurements for Kr and Xe. This task fell to the hydrocarbon enrichment system that used a carbon sieve trapping system (Mahaffy et al., 2000). The criticality of these measurements to the atmospheric probe mission makes it imperative to understand potential issues involved in the Galileo Probe measurements, and indicates the need to use this information to design a more robust gas enrichment system for future probes.

Another relevant point concerns the recent observations of ammonia from Juno (Bolton et al., 2017), which suggest that the phase transitions of condensable volatiles as a function of pressure are highly complex at Jupiter and latitude-dependent as a result of dynamical effects. Therefore, of equal importance when considering the sampling systems for the probe mass spectrometer is the need to measure both gaseous and aerosol phases of important condensable compounds such as CH4, NH3, H2S, NH4SH, and H2O that will allow an adequate characterization of the bulk elemental abundances as a function of pressure/altitude. The effects of condensation will be magnified at Saturn and the ice giants owing to greater volatile enrichments and lower atmospheric temperatures. Based on the preceding considerations, the measurement types listed above should have increasing robustness against possible observational artifacts.

References

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