Chemical and Isotopic Composition Measurements on Atmospheric Probes for Giant Planets

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The ice giants Uranus and Neptune are the least understood class of planets in our solar system but the most frequently observed type of exoplanets. Unfortunately, no designated mission to either of the two ice giants exists so far. Almost all of our gathered information on these planets comes from remote sensing. Whereas information provided by remote sensing is undoubtedly highly valuable, remote sensing of a planet's atmosphere also has limitations. In recent years, NASA and ESA have started planning for future missions to Uranus and Neptune, with both agencies focusing their attention on orbiters and atmospheric probes. A mass spectrometer experiment is a favored science instrument for an atmospheric probe for in situ composition measurements in most of these studies. Mass spectrometric measurements can provide unique scientific data, i.e., sensitive and quantitative measurements of the chemical composition of the atmosphere, including isotopic, elemental, and molecular abundances. Of major interest for the formation and evolution process of our Solar System are the species including the major volatiles CH₄, CO, NH₃, N₂; the noble gases He, Ne, Ar, Kr, Xe; and the isotopic ratios D/H,¹³C/¹²C,¹⁵N/¹⁴N,³⁶Ar/³⁶Ar,³⁸Ar/³⁶Ar, as well as those of Kr and Xe. We will review the state-of-the-art mass spectrometry with respect to an application on such an atmospheric probe.