New developments in high-resolution gas source isotope ratio mass spectrometers

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Gas source isotope ratio mass spectrometry (IRMS) is one of the main tools for the study of the isotopic compositions of light elements, extended in the last 10 years to the measurements of molecules bearing several rare isotopes (e.g., clumped isotopes of CO₂) as well as position-specific isotopic substitutions in a few choice analytes (e.g., in N₂O). Measuring those low-abundance species creates several technical challenges, with the main one being the presence of numerous isobaric interferences. Those can come either from contaminants (background gases present in the source of the instrument or impurities introduced with the analyte), or unwanted beams created by the analyte itself during the ionization process (for example adducts and fragments).

In order to avoid those isobaric species, new high-resolution, double-focusing IRMS have been developed. We present here the capabilities of the production series version of the ThermoFisher Scientific 253 Ultra, which was installed at SUERC in July 2015. The instrument is capable of reaching high mass resolving power (above 40,000).

The instrument is similar in design to the Caltech 253 Ultra prototype. The collector array has 9 detector positions, 8 of which are movable. Faraday cups at each detector can be linked to amplifiers with gains ranging from 3.10⁸ to 10¹² Ohm (and 10¹³ Ohm amplifiers being currently developed). There are also 4 ion counters, one of which located behind a retardation lens (RPQ) to limit background noise and improve abundance sensitivity.

Additionally, one of the Faraday cup in the new instrument has a very narrow entrance slit, allowing high mass resolving power and high resolution, with a complete separation of the ion beams instead of complex peak shapes corresponding to overlapping ion beams. This will potentially remove the need for adduct lines or peak stripping schemes for analytes like CH₄.