Motivation and presentation of the instrument

Relative abundances and isotope ratios of noble gases in planetary atmospheres can answer fundamental questions:

i) What was the delivery mix (Solar/Chondritic/Cometary) to planetary atmospheres?

ii) To what extent are silicate portions (mantle, crust) of terrestrial planets degassed?

iii) How much of the atmosphere was lost by atmospheric escape and what is the timing of this escape?

Venus is a missing piece of the noble gas puzzle [1]. Compact missions recently suggested to use a noble gas quadrupole ion trap mass spectrometer (QITMS) [2] developed at JPL (Fig. 1) [3] to measure noble gases in the Venus atmosphere.

Main questions

- Is the instrument able to measure small amounts (<10^{-15} mol) of noble gases in static mode & without a cooling gas?
- Does the precision meet requirements for answering questions in planetary sciences?

Sensitivity and signal evolution

Sensitivity depends on the emission current and reaches 1.2x10^{14} cps/torr of gas.

Potential improvements:

i) collecting all ions with a second detector
ii) changing the type of filament to get a more focused electron beam
iii) changing the type of getter for a better purification of the residual gas

Signal decreases faster than predicted by ion trapping theory (Fig. 4). This is likely due to a growing contribution from residual gas (mainly CH4).

Results obtained on samples

Results of the measurement of gases extracted from HF-HCl residue of the Allende meteorite are similar to values reported in the literature [5]. For example, the 40Ar/36Ar ratio is lower than 50. The isotopic composition of Xe (Fig. 8) matches the Q component found in meteorites [5].

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A NEW QUADRUPOLE ION TRAP MASS SPECTROMETER FOR MEASURING NOBLE GASES IN PLANETARY ATMOSPHERES


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Abstract

This paper describes the development of a new quadrupole ion trap mass spectrometer (QITMS) for measuring noble gases in planetary atmospheres. The QITMS is designed to measure noble gases in static mode without a cooling gas, allowing for the measurement of small amounts of noble gases. The instrument is able to measure noble gases in planetary atmospheres for extended periods of time (>10 h) and has a precision that meets requirements for answering questions in planetary sciences. The results obtained on samples extracted from the Allende meteorite show similar values to those reported in the literature. The instrument would be proposed for integration on the Cupid’s Arrow small satellite mission.