Noble gases from the interstellar medium trapped on the MIR space station and analyzed by in vacuo etching

Conference or Workshop Item

NOBLE GASES FROM THE INTERSTELLAR MEDIUM TRAPPED ON THE MIR SPACE STATION AND ANALYZED BY IN VACUO ETCHING.

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Introduction: The composition of the present interstellar medium (ISM) provides an important benchmark in cosmochemistry. It serves as a reference for galactic chemical evolution (GCE) models, solar mixing predictions and provides information for understanding Big Bang nucleosynthesis. The present-day ISM ^{3}He abundance allows, combined with the protosolar ^{3}He, deduced from the Jovian atmosphere or meteorites [1,2], tracing the GCE over the past 4.56 Ga. ^{3}He/^{4}He = (2.5 0.6) x 10^{-4} has been determined for the local ISM [3]. However, the uncertainty is too large to better constrain GCE models and - in combination with the present-day solar wind value - the protosolar D/H [4].

Experiment: The COLLISA experiment [*Coll*ection of *I*nter-*S*tellar *A*toms, 5,6] sampled interstellar gas in Cu-Be foils covered with BeO and exposed to the flux of neutrals from the ISM on board the MIR space station. Stepwise heating extraction allowed the detection of interstellar ^{4}He [6] and yielded $(^3\text{He}/^4\text{He})_{\text{ISM}}$ = (1.7 0.8) x 10^{-4} [7], in agreement with the value for pickup ions observed with SWICS/Ulysses [3].

Further foils are currently analyzed by closed system stepwise etching at ETH Zurich [8]. This technique allows to efficiently separate implanted interstellar He and terrestrial tritiogenic ^{3}He, probably residing in the Cu-Be substrate, which had to be taken into account for the determination of interstellar ^{3}He during stepwise heating [7].

Results: Offline tests suggest that HF acid vapor efficiently and uniformly etches BeO. The system blank (in 10^{-14} cm^3 STP, ^{3}He ~3, ^{4}He ~300, ^{20}Ne ~90) is now sufficiently low to measure the exposed foils. Two unexposed foils (31 and 50 cm^2) were etched online and yielded no significantly increased values relative to these blanks, implying that the tritiogenic ^{3}He (0.5-1 10^{-14} cm^3/cm^2 foil) indeed resides in deeper foil layers that are not affected by superficial etching. The analysis of a foil artificially irradiated with ^{3}He and ^{20}Ne at energies comparable to those of the ISM neutrals (25 eV/amu) showed that our protocol (10 steps 1-30 min, HF vapor at 20 °C) releases all trapped noble gases. Results of the ongoing etching experiment on foils exposed to the ISM (including a witness foil doped with terrestrial ^{3}He) will be presented. The expected concentrations of interstellar gas [3,6,7] in 50 cm^2 of exposed foil are (in 10^{-14} cm^3 STP) ^{3}He ~25, ^{4}He ~200000, ^{20}Ne ~375).

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