Miniaturized Inductively Coupled Plasma Mass Spectrometer (ICPMS) for Trace Element Analysis

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**Targets:** Primarily low-pressure (≤ 10³ Pa) or airless planetary bodies, such as comets, the Moon, Phobos/Deimos, and many ocean world destinations

**Science:**
- Quantify planetary depletions in volatile element inventories (e.g., Na, K, Zn, and Pb)
- Analyze redox-sensitive agents (e.g., V³⁺,⁴⁺,⁵⁺) to track the evolution in fO₂ through space & time
- Measure concentrations of fluid-mobile elements (e.g., Li and U) and identify alteration signatures
- Investigate potential biominalization via chemical proxies (e.g., Sr/Ca and Se/S ratios)
- Identify signatures of deep mantle processes (e.g., local temperatures via Ni behavior)

**Objectives:**
1) Develop a self-sustaining Ar plasma source capable of atomization/ionization of laser ablation aerosols in low pressure environments
2) Refurbish a legacy Nozomi/ARES mass analyzer and retrofit with ion optics for ICPMS ops
3) Demonstrate an interface region that unites the low pressure plasma and heritage analyzer

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**Key Milestones by Program Year (PY):**
- (PY1) Development of RF tuning circuit for plasma source
- (PY1) Definition of mechanical/ion optical interface region
- (PY2) Refurbishment of Nozomi/ARES flight hardware
- (PY2) Validation of low-pressure plasma source performance
- (PY3) End-to-end demonstration of integrated ICPMS instrument
- (PY3) Verification of science objectives / functional requirements

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The miniaturized ICPMS proposed here will unite a low-power Ar plasma source capable of operation in low pressure environments (≤ 10³ Pa), and a legacy Nozomi/ARES quadrupole mass analyzer to enable efficient atomization/ionization of solid planetary samples, and the quantitative measurement of trace elements down to ppmw level concentrations.