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Session 6) Isotopes in Mars and Venus

The Planetary Isotopologue Frontier: Recent Discoveries from Laboratory, Rover, and Telescopic Observations from across the Solar System

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The stable isotopic compositions of extraterrestrial materials provide vital information on the origins and evolution of planetary bodies. Often, this information is complementary to —but not accessible by— other types of geochemical or geophysical analyses. The isotopic data thus enable a more nuanced understanding of, e.g., the provenances of meteoritic organic compounds or the sources and sinks of planetary volatiles over geologic timescales. Our first forays into this realm occurred in the laboratory and from ground-based telescopes but rapidly expanded to include in-orbit remote sensing and in-situ analytical measurements of extraterrestrial solids and gases during planetary probe descents and surface rover operations. The planetary isotopologue frontier continues to push forward with innovative sample return missions and new measurement techniques that enable us to quantify the isotopic compositions of smaller and smaller quantities of material —in some cases down to the intramolecular scale— and the advent of increasingly powerful ground- and space-based telescopes that enable us to probe the isotopic compositions of gas-phase molecules in exoplanetary systems as well as make higher-precision measurements of volatiles in and on planetary bodies closer to home. In this keynote presentation, I will highlight recent advances in our understanding of meteoritic organics, the martian hydrosphere, and Io's sulfur cycle with insights based on ultrahigh resolution measurements of the intramolecular isotopic compositions of PAHs from the Murchison meteorite, in situ isotopic analyses of CO_2 and H_2O thermally evolved from minerals sampled at Gale crater by SAM-TLS on the Curiosity rover, and spectroscopic observations of SO_2 isotopologues in the exosphere of Jupiter's moon Io as made by the Atacama Large Millimeter/submillimeter Array. I will close with a prospectus for the coming decade and the ever-advancing planetary isotopologue frontier.