**LOW-TEMPERATURE MASS SPECTROMETRY OF AMINO ACIDS EXPOSED TO ELECTRON AND ULTRAVIOLET RADIATION.** Bryana L. Henderson and Murthy S. Gudipati; Science Division, Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Blvd, Pasadena, CA 91109 (bryana.l.henderson@jpl.nasa.gov; gudipati@jpl.nasa.gov).

**Introduction:** Amino acids, essential for terrestrial biology, have been detected in a variety of extra-terrestrial sources such as meteorites, comets, and even tentatively in the interstellar medium [1-5], and transport of this and other exogenic biological precursors through impacts may have contributed valuable material for life on early Earth [6]. Although amino acid destruction has been extensively studied under non-cryogenic conditions, so far very few studies have examined these processes in ice at temperatures relevant to space. Formation and survivability of complex organics in these environments must also be considered when evaluating habitability and the emergence of complex chemistry and life in the universe. Further, understanding the stability and reaction pathways of important biological precursors at temperatures and environments relevant for potential habitable bodies such as Europa and Mars is critical to constrain future studies of these bodies in search of life.

Recently, we employed a new mass spectrometry technique to find that degradation and recombination reactions occur at temperatures as low as 5 K in simple water, ammonia, and methanol ices exposed to energetic processing from UV photons and 2 keV electrons [7]. Using the same instrument, an earlier study involving irradiation of polycyclic aromatic hydrocarbons revealed extensive hydrogenation and oxidation [8]. Several of the observed reaction products from these studies also corroborated results from prior low-temperature IR experiments. Here, we use this unique *in situ* technique to evaluate the low-temperature chemistry of amino acids in ice, and extend existing low-temperature IR studies of amino acid radiolysis to the mass spectrometry regime.

**Methods:** Mixtures of amino acids and water were vapor deposited in desired ratios onto a cold copper substrate (5 - 150 K). The substrate was exposed to energetic radiation consisting of either electrons (2000 eV, 5 μA) or Lyman-alpha photons (~121.6 nm with broadband UV emission >165 nm) from a hydrogen microwave-discharge lamp.

The samples were then analyzed with a two-step laser ablation and ionization mass spectrometry (2S-LAIMS) method whereby an infrared laser ejects a large volume of sample from the surface and a second ultraviolet laser intersects and ionizes this material for analysis via time-of-flight mass spectrometry. This method enables accurate compositional analysis of the products *in situ* and under vacuum, without a need for heating or further sample preparation. To further evaluate the volatility of specific components, substrate temperatures were varied.

**Discussion:** Here, we report on the interactions between water and selected amino acid species in irradiated samples, and compare the findings with previous experiments [9,10] involving low-temperature spectroscopy, which reported formation of $CO_2$ and amines as reaction products.

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