LABORATORY MEASUREMENTS OF HYPERVELOCITY MICROMETEOROID IMPACTS INTO FROZEN WATER AND ARGININE TARGETS.

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Introduction: Ice is prevalent throughout the solar system and beyond. Though the evolution of many of these icy surfaces is highly dependent on associated micrometeoroid impact phenomena, and detection of impact-ejected ice particles can be a valuable tool for sampling surface material, experimental investigation of these impacts has been extremely limited, especially at the impactor speeds encountered in space. The dust accelerator facility at the Institute for Modeling Plasmas, Atmospheres, and Cosmic Dust (IMPACT) of NASA's Solar System Exploration Research Virtual Institute has developed a novel cryogenic system that will facilitate study of hypervelocity impacts into ice and icy regolith.

Of particular interest for understanding icy moons such as Europa are the products from impacts into water ice with trace minerals or organics embedded into the ice matrix. For example, the chemical composition of this ice would contain information about the geological activities on and below a moon's surface, in particular about the material exchange between the interior and the surface.

Laboratory experiments using a water-beam ionization technique [1] have previously shown that even trace amounts of complex organic molecules can be identified in mass spectra, and such experiments have been used as an analogue to hypervelocity impact phenomena. For example, the amino acid arginine ($C_6H_{14}N_4O_2$) was detected at a concentration of 10 ppm in H_2O. In addition to $ArgH^+$, arginine forms cluster ions of the type $(H_2O)_nArgH^+$, which allows further identification in the mass spectra. The next step in such studies is to compare hypervelocity laboratory experiments to the water-beam ionization experiments, which will then inform the expectations for future dust-detection instruments such as SUDA on the Europa mission.

Hypervelocity Experiments: The experiments are performed in the University of Colorado dust accelerator, which consists of a 3 MV Pelletron generator with a dust source, image charge pickup detectors, and interchangeable target chambers [2]. The accelerator is a source of hypervelocity dust particles with radii in the range of 20 nm < a < 2 μm (Fe), and speed range in excess of 100 km/s. For each experiment, the particle population reaching the target is downselected to a specific user-defined range of velocities and masses.

Cryogenic Target Capability: The accelerator facility has recently implemented a cryogenic target system consisting of a LN_2 cooling loop connected to an interchangeable target surface [3]. The target options include both a vapor deposition system and a movable freezer/holder for a pre-mixed liquid cartridge, for use in single-component ices or salty/multi-component mixtures, respectively. The target temperature is adjustable from a baseline of 96.5° K using integrated heaters.

Impact products and chemistry are assessed with an integrated time-of-flight mass spectrometer. The target surface is biased up to 4 kV, and ions from the impact plasma are sent through a grounded grid to a 1m drift tube.

We present the early results from studies of hypervelocity Fe particle impacts into mixtures of frozen H_2O+arginine.

References: [1] F. Stolz, et al., (2013) *EGU General Assembly*, Vienna. [2] Shu, A., et al., (2012) *Rev. Sci. Instr.*, 83, 075108. [3] Nelson, A.O., et al., (2016) *Rev. Sci. Instr.*, 87, 024502.