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Laboratory study of hypervelocity impact-driven chemical reactions and surface evolution of icy targets.

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Abstract

Although ice is prevalent in the solar system and the long-term evolution of many airless icy bodies is affected by hypervelocity micrometeoroid bombardment, there has been little experimental investigation into these impact phenomena, especially at the impact speeds encountered in space. For example, there is little direct information about how dust impacts alter the local chemistry, and dust impacts may be an important mechanism for creating complex organic molecules necessary for life. Furthermore, the Cassini mission revealed CO2 deposits in icy satellites of Saturn, which may have been created by dust impacts. With the creation of a cryogenically cooled ice target for the dust accelerator facility at the NASA SSERVI-funded Institute for Modeling Plasma, Atmospheres, and Cosmic Dust (IMPACT), it is now possible to study the effects of micrometeoroid impacts in a controlled environment under conditions and at energies typically encountered in nature. Complex ice-target mixtures are created with a flash-freezing target which allows for homogeneous mixtures to be frozen in place even with salt mixtures that otherwise would form inhomogeneous ice surfaces. Coupled with the distinctive capabilities of the IMPACT dust facility, highly valuable data concerning the evolution of icy bodies under hypervelocity bombardment and the genesis of complex organic chemistry on these icy bodies can be gathered in unique and tightly controlled experiments. Results from recent and ongoing investigations will be presented.