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Simulating the interaction of micrometeoroids with planetary atmospheres in laboratory conditions

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A laboratory capability has been developed at the Institute for Modeling Plasmas, Atmospheres, and Cosmic Dust (IMPACT), University of Colorado to study the interaction of micrometeoroids with planetary atmospheres. A 3 MV electrostatic dust accelerator is used to generate particles with up to 70 km/s velocity. The ablation process takes place in a gas cell filled to $\sim$100 mTorr pressure. Previous investigations included measuring the ionization efficiency of iron and aluminum dust particles over a 10 – 70 km/s velocity range, and the results are relevant to the interpretation of meteor radar data [DeLuca et al., Planet. Space Sci., in press, 2017]. Two new experimental campaigns have been completed recently. The first is to measure the decelerating drag force the particles experience from collisional interaction with neutral gas. The results show that the drag coefficient is approximately 1.3, i.e. it is larger than the typical range of values used in numerical ablation models (0.5 – 1). This means that dust particles experience a considerably stronger drag force when interacting with planetary atmospheres than previously assumed. It is also independent of the type of the background gas used (air, N2, Ar, CO_2). In the latest experimental campaign, the process of differential ablation is investigated, where the low melting temperature constituents of the dust particle are ablated early while refractory constituents are ablated later in the process. Complex mineral dust samples are used in these experiments and the data is being analyzed.