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A new Approach to Lab Simulation of High Speed Dust Impacts on Aerogel and Foils

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Abstract

The goal of our work is the laboratory simulation of high speed [3 - 40km/s] cometary, interplanetary or interstellar dust impacts onto collector material (e.g. aerogel or foils used for the Stardust Mission). This enables an investigation into both the morphology of impact tracks as well as any structural and chemical modification of projectile and collector material which may occur.

Laboratory analogue shots on Stardust collectors [1] requires complete control of particle size and speed over a wide dynamic range. A complete range of speeds up to 50 km/sec can only be achieved by a Van de Graaff accelerator such as, for example, operated at the MPI für Kernphysik (Heidelberg) [2]. Using an improved version of the Particle Selection Unit, individual shots with defined speed and particle size can be performed. The experiments can be carried out using a variety of cosmochemically relevant materials (silicates, sulfides, oxides, carbides) and can provide clear advantages over shots with a light gas gun. For use in the electrostatic accelerator these mineral grains [~ 0.1 – 5µm in size] are coated by a thin conductive layer of either platinum [3] or polypyrrole [4].

After preliminary shots into STARDUST flight spare tiles and subsequent extraction in picokeystones the suitability of this method was demonstrated in 2009 [5]. A major campaign started in spring 2010 with the goal to characterize impacts of interstellar grains. Different materials are shot within several narrow speed and size windows (e.g. 14 - 16 km/s, 0.37 – 0.43µm). For each set of parameters about 50 particles are collected. Subsequently the aerogel tiles are investigated with appropriate analytical methods (e.g. Scanning Transmission X-ray Microscopy [6]) to obtain information on track morphology and the chemical alteration of grains and collector material. At a later stage the experiments will be repeated with Stardust and Genesis collector foils.

Furthermore, impact signals and impact ionisation Time of Flight (TOF) mass spectra were evaluated using the Large Area Mass Analyser (LAMA) lab model [7]. These spectra provide a mass resolution of about 200 and allow the identification of mineral compounds and isotopes in individual grains [8]. This type of in-situ space instrument is complementary to the collector technique and has already proven its value with the TOF - dust mass spectrometer (CDA) onboard the Cassini spacecraft [9].

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