Laboratory Analyses of Seven Particles of likely Interstellar Origin Returned by the Stardust Spacecraft

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Stardust was the first spacecraft ever to bring back to Earth extraterrestrial materials from beyond the Moon. Stardust was two missions in one spacecraft. It returned the first samples from a known primitive solar system body, the Jupiter-family comet Wild 2. Stardust also carried a separate collector consisting of aerogel and aluminum foil that was exposed the interstellar dust stream for 200 days before the encounter with the comet.

The Stardust Interstellar Preliminary Examination (ISPE) was the sixth official NASA Preliminary Examination — the first being the PE of the Apollo lunar samples. The goal of the ISPE was to characterize the materials collected by the Stardust Interstellar collector at a level of detail sufficient to enable the scientific community to productively request samples. Among the questions to be answered were these: *What is the size of the collection, and what is the distribution of particle sizes? What fraction of the materials are consistent with an interstellar origin? What fraction are crystalline? Are there organics?* and others. We formed a consortium of scientists to address these questions, using a variety on laboratory instruments, including six infrared and x-ray microprobes at four different synchrotrons. We also developed new techniques for extracting particles from the aerogel capture media, and for identifying impacts in the aerogel and the aluminum foils. We used an unusual and very successful approach for the identification of the impacts in the aerogel collectors: we developed a web-based virtual microscope that enabled >30,000 amateur dust-hunters to search for impacts in images collected by an automated microscope. We conducted a campaign of laboratory hypervelocity capture experiments at the Heidelberg Dust Accelerator to support our interpretation of the track morphology, and also did numerical modelling of interstellar dust propagation through the heliosphere to support interpretation of observations of the trajectories of the tracks. I report on the analyses of seven particles that have a likely interstellar origin, and discuss their implications for our understanding of the the properties of interstellar dust. I also discuss plans for future analyses of these candidates as well as others yet to be identified in the Stardust Interstellar Dust Collector. I will also discuss the implications of these results on the design of future interstellar dust sample return missions.