ORIGINAL IMPACTOR MODELING FROM WHOLE STARDUST TRACK DATA

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Introduction: The Stardust mission to comet Wild 2 returned numerous extraterrestrial particles trapped in 'tracks' of melted silica aerogel [1]. Ingrained in the structure of each track is the history of one hypervelocity capture event. We have collected some of the highest resolution 3D morphological and 2D chemical abundance data on whole tracks, solely using non-invasive methods [2,3]. Combining our data with existing and evolving microphysical models of track capture dynamics, we are able to estimate the properties of original impactors of several tracks.

Methods and Data: For three years we have been collecting 3D morphological data on whole tracks using 3D Laser Scanning Confocal Microscopy (LSCM). Unlike other imaging techniques, LCSM is capable of rapidly imaging at resolutions <100nm/pxl with 12 bit depth, and quantifying with high precision, important track parameters such as maximum track width, entrance hole diameter, depth of entrance hole depressed from the aerogel surface, and paths of multiple styli [2,4]. We have also collected complementary high resolution synchrotron X-Ray Fluorescence (SR-XRF) maps on whole tracks, allowing calculation of integrated whole track chemical abundances and extraction of a value for total mass captured per track. A mass deposition profile as a function of track depth can then be calculated. Calculated parameters are then applied to our model, or those of others.

Results and Discussion: Tracks formed on the cometary side of the Stardust collector have an initial kinetic energy dependent solely on velocity and mass. This quantifiable parameter, combined with any energy of volatilization, is partitioned and partially thermally transferred to the aerogel medium upon excavation of the track cavity [5]. Our approach to modeling of each impact involves the division of each track into a series of segments, each frustum-shaped and corresponding to a certain regime of track formation. The base of each frustum corresponds to a cross sectional area measured at each division, and may be non-circular. These divisions are made by visual inspection, in lieu of full thresholded 3D data. The appropriate microphysical model of hypervelocity capture and track formation is then applied to each segment of track. Energetic parameters are calculated for each segment, accounting for mass deposition and fragmentation, if necessary [5,6,7]. This method, in concert with accurate modeling efforts, provides an accurate estimation of the effects of capture processes on a per track basis.

The combination of multiple high spatial resolution data sets on whole Stardust tracks enables the best whole-impactor size and composition estimation available. Refinements to our modeling approach in the future will include finer scale modeling of energy constraints via a semiautomatic track thresholding application. Additionally we will investigate an apparent correlation between entry hole depression depth and original impactor mass.

References: [1] Burchell M.J. *et al.* (2006) *Ann. Rev. Earth Planet. Sci*. 34: 385-418. [2] Ebel D.S. *et al.* (2009) *MaPS.* 44: 1445-1463. [3] Greenberg M. *et al.* (2010) *Geosphere.* In press. [4] Tsuchiyama A. *et al.* (2009) *MaPS.* 44: 1203-1224. [5] Dominguez G. (2009) *MaPS.*44: 1431-1443. [6] Coulson S.G. (2009) *Int. Journal of Astrobiology.* 8: 9-17. [7] Trigo-Rodríguez J.M. (2008) *MaPS*. 43: 75-88.