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Stardust: An overview of the craters in aluminium foils (calibration, classification and particle size distribution)

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The NASA Stardust mission (1) to comet 81P/Wild-2 returned to Earth in January 2006 carrying a cargo of dust captured intact in aerogel and as residue rich craters in aluminium foils (2). Although the aerogel (and its content of dust grains) has gathered most attention, the foils have also been subject to extensive analysis. Many groups contributed to the dimensional characterization of representative populations of foil-craters in the Preliminary Examination and combined with a laboratory calibration

this yielded a particle size distribution of the dust encountered during the fly by of the comet (3).

The calibration experiments will be described in this paper in detail. They involved using the two stage light gas gun at the University of Kent (4) to impact Stardust grade aluminium foils (from the same batch as used on Stardust) with projectiles at 6.1 km/s (the cometary encounter speed). A variety of projectiles were used to simulate possible cometary dust grain composition, morphology and structure. Prior to the return of Stardust, glass beads were used to provide the initial calibration (5) which was used to obtain the size distribution reported in (3). A range of projectiles of differing density were then used (6) to determine the sensitivity of the results to impactor density (also allowed for in (5)). Subsequently this work has been significantly extended (7) to allow for a greater range of projectile densities and strengths. The work has now been extended further to allow for aggregate impactors which have a high individual grain density, but a low overall bulk density. In addition, the results have been extended down in impactor size from the previous lower limit of 10 microns to 1.5 micron impactor diameter.

The application of these new calibration results to the measurement of the cometary dust size distribution will be discussed. It will be shown that the changes are within the range originally presented in (3). The results will be compared to the dust size distribution obtained from the tracks in the aerogel and the combined results contrasted to those obtained with active impact detectors in real time during the cometary encounter (8, 9). At small dust grain sizes (a few microns and below) a significant discrepancy is seen which is still unexplained.

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