SPACE DEBRIS: ORBITAL MICROPARTICULATES IMPACTING LDEF EXPERIMENTS FAVOUR A NATURAL EXTRATERRESTRIAL ORIGIN. **J.A.M.McDonnell**, Unit for Space Sciences, University of Kent at Canterbury, Canterbury, Kent CT2 7NR.

THE LDEF OPPORTUNITY. Opportunity for study of the space environment following return of NASA's Long Duration Exposure Facility (LDEF) in January 1990 is manifold. In the field of space particulates, it is the stabilisation of the orbit relative to the velocity vector and Earth radius which can now be seen to have provided the unique opportunity to collate and compare flux data on such diverse experiments and space hardware; many such surfaces were not designed to be host surfaces for impacts. The area-time product of $2.2.10^{10} m^2 s$ exceeds all previously returned space hardware; with only minimal assumptions regarding calibration, data on impact crater statistics can now be readily intercompared. Spacecraft experiment data has been published for the Microabrasion Package (MAP) by McDonnell et al (1,2,3), for the Frecopa Experiment by Mandeville (4) and Singer et al (5). Results from modelling have also been published by Zook (6), Kessler (7) and Steel and McDonnell (8). Survey data of the entire spacecraft has also been published by the LDEF "A-Team" led by M. Zolensky (9). Presentation of the 5 MAP experiment penetration data (N,S,E,W and Sp faces) can now be set within a larger data set (Figure 1). First analyses (10) had indicated size dependent "excess" of orbitals above the natural unbound component on the leading (E) face. This conclusion is now seen to be supported by in the wider context of other data, but is a feature only of the smaller particulates.

DYNAMIC MODELLING AND FLUX ANISOTROPY. Our computer modelling of impact rates on the various LDEF pointing directions incorporate two separate populations, namely orbital and unbound particulates (3); we take an average 'single particle' characterisation for the interplanetary component in the sense of it having a single mean velocity rather than a velocity distribution. LDEF's exposure averages out many of the features of the interplanetary component, but differing impact velocities do result from the pointing direction. Modelling by by McDonnell et al (3) demonstrates how the impact flux size distributions may be transformed between two experiment pointing directions without recourse to absolute calibration in terms of particulate mass although velocity differences *are* incorporated. Of especial interest is the application of modelling to enable the separation of these two components from the data.

The space and West (trailing) faces are seen to be accessed only by unbound particulates, and the average velocity of impacts on these two faces is directly related to the geocentric particle velocity. Hence, the average natural flux component can be determined and also its velocity (we find that $V_{geocentric} = 16$ kms^{-1}; $V_\infty = 12$ kms^{-1}); the leading (East) face (which is accessible to both bound and unbound components can hence be decomposed to yield an estimate of the orbital component (Figure 2). Is it the much heralded space micro-debris component or not?

EVIDENCE FOR THE ORIGIN OF SPACE PARTICULATES. Chemical data of SEM EDS analysis will be presented for several sample impact sites on the East, West and Space faces. Whilst a full separation of such populations must await the analysis of a vast body of such data, flux anisotropies via modelling currently remain the main tool for decoding. Although the application of our modelling points to an increasing orbital population at smaller dimensions (below a few microns particulate diameter), considerable difficulties arise in accepting that the population is artificial space debris associated with the space age era. A time plot of relevant foil perforation data from Ariel II (11), Explorers 16 and 23 (12), Solar Max (13), MFE (14) and LDEF (Figure 3) shows little evidence for a sympathetic temporal increase in an epoch of near-exponential growth of the space population and its impact comminution products! It should be noted that the Solar Max data (13) refers to the source crater statistics (transformed from thick to thin targets) and not the *mass distribution* deduced; the latter is now open to considerable doubt due to the incorporation of two quite differing penetration formulae (15 and 16). We are thus faced again with the possibility of an orbital particulate component which may be of natural origin - the Earth's Dust Belt (18). To maintain this we require low Earth-approach velocities, namely of low ecliptic inclination (i) and low eccentricity (e). Candidate sources comprise asteroids (of low i and e) and comets (low e (after PR drag circularisation) but distributed i values).

Could the excess orbital population be a new (slimmer) version of the "Earth's Dust Belt"? If confirmed, it would be (1) at smaller dimensions of particle, (2) considerably weaker in magnitude and (3) possibly favouring asteroid comminution products rather than comets, although also compatible with cometary fragments if expelled at larger heliocentric distances. We await the chemical evidence of their origin from LDEF's rich collection of impact residues.

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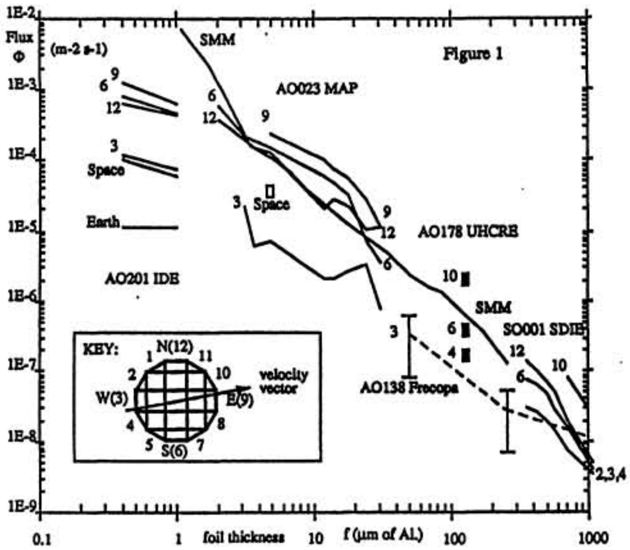

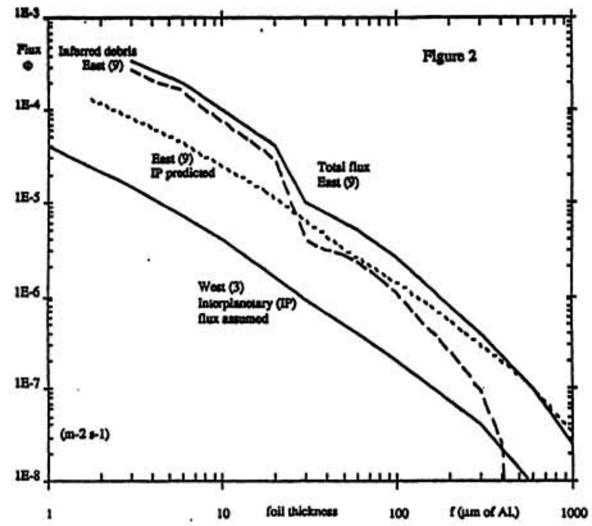

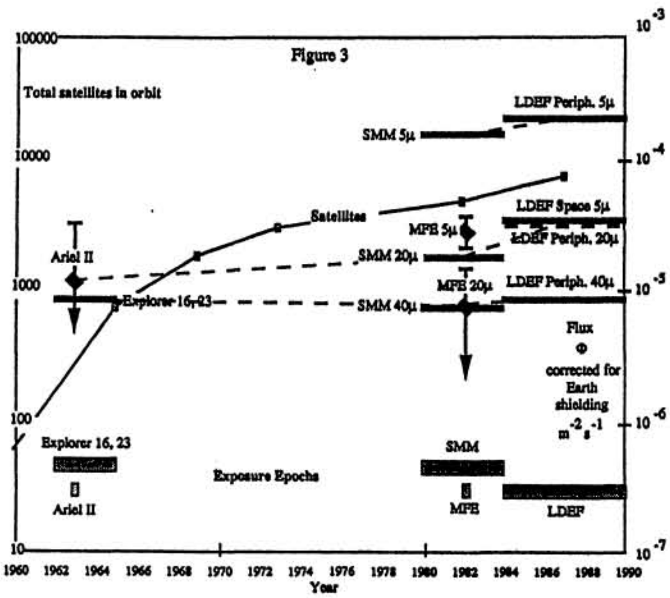

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