GEO DEBRIS AND INTERPLANETARY DUST: FLUXES AND CHARGING BEHAVIOR.

A. L. Graps[1], S. F. Green[2], N. M. McBride[2], J. A. M. McDonnell[3], G. Drolshagen[4], H. Svedhem[4], K. D. Bunte[5]
[1]Institute of the Physics of Interplanetary Space (IFSI), CNR-ARTOV, Via del Fosso del Cavaliere 100, 00133 Rome, Italy. Amara.Graps@ifsi.rm.cnr.it, [2]The Open University, UK, [3]Unispace Kent, UK, [4]ESTEC, The Netherlands, [5] eta_max space, Germany

Introduction: A population of cosmic dust mixed with a population of man-made debris exists within the Earth's magnetosphere. Measurements of these provide the data samples for studies of the interplanetary dust particles that travel through our magnetosphere from the outside, and for studies of the local byproducts of our space endeavours. Even though instruments to detect natural meteoroids and space debris particles have been flown in Low Earth Orbits (LEO) and on interplanetary missions, very little information on the particle environment for Earth orbits above about 600 km altitude have been available. In particular, knowledge about particles smaller than 1 m in the geostationary (GEO) region was largely unknown before GORID [1]. In September 1996, a dust/debris detector: GORID, was launched into GEO as a piggyback instrument on the Russian Express-2 telecommunications spacecraft. The instrument began its normal operation in April 1997 and ended its mission in July 2002. The goal of this work was to use GORID's particle data to identify and separate the space debris from the interplanetary dust particles (IDPs) in GEO, to more finely determine the instrument's measurement characteristics and to derive impact fluxes. Here we present results of that study.

Clustering: Very large variations in daily event rates led to the identification of clusters of events, some of which re-occurred on consecutive days at the same local time [1,2]. They were interpreted as clouds of aluminium oxide debris resulting from the firing of solid rocket motors. Clustering of events is therefore indicative of a debris source and provides a selection criteria for statistical separation of the debris and IP populations. The mean rate for science events is 1.83 day^{-1} corresponding to an interval of 0.55 d. The distribution of times between events shows a bimodal distribution with one component peaking at about the expected “random” rate and the other with very much shorter times, indicating clustering. The limit of cluster membership is consequently defined at 0.05 days.

The temporal and charge distributions: Debris are concentrated near midnight local time except during summer. In early summer, clustered events are concentrated near 5 am, just at the time when beta-meteoroids may be expected to be detected. The GORID pointing geometry implies preferential detection of debris after recent crossing of the equatorial plane in the magnetotail. This may be because debris are physically constrained to this region or because some process in the magnetosphere, such as a charging mechanism, makes them more detectable. One possible mechanism leading to the clustered events is electrostatic fragmentation of the slag particles, after passing through the current sheet.

The detection rate and fluxes: The detection rate of interplanetary events is 0.54 d^{-1} and debris events is 2.46 d^{-1}. The fluxes of interplanetary particles are reasonably close to the well-defined model prediction, allowing for the impact speed uncertainty. The mean fluxes are 1.35 x 10^{-4} m^{-2} s^{-1} for IP and 6.1 x 10^{-4} m^{-2} s^{-1} for debris at the detection threshold of Qi = 1.3 x 10^{-13} C. The flux of space debris detected by GORID appears to be higher than in LEO although the results are sensitive to the assumed speeds.

References:

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