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RE-ENTRY OF SPACECRAFT ON HIGHLY ECCENTRIC ORBITS - CLUSTER-II

Abstract

Atmospheric re-entry and break-up of spacecraft on highly eccentric orbits have not been investigated with high fidelity re-entry analysis tools so far. The Cluster-II mission consists of four spin-stabilized spacecraft on highly eccentric orbits. Luni-solar perturbations influence the eccentricities, leading to perigee altitudes low enough for atmospheric re-entries. Before final re-entry the spacecraft pass through the denser atmosphere at high altitudes still above 90 km, without being captured by the atmosphere.

We have analyzed the influence of the perigee altitude and the spacecraft attitude during the last perigee passes on the orbit evolution, using the SCARAB (Spacecraft Atmospheric Re-entry and Aerothermal Break-up) software. After the perigee passes the orbits of the spacecraft and potential escaping fragments were propagated with OrbGen, a numerical propagator of ESOC's Space Debris Office.

Our simulations show that the atmospheric influences on the orbit during the last perigee passes depend on the initial orientation of the spin axis of the spacecraft. This is due to the variation of the effective flow-projected cross section. The spin rate has only a negligible effect on the orbit, but is significant for the break-up of the spacecraft.

For re-entries from highly eccentric orbits the heat load is much higher than from nearly circular orbits. This is due to the much higher re-entry velocities. For Cluster-II this results in a perigee altitude range where the SCARAB simulations show a complete demise of the spacecraft. Perigee altitudes above this range can cause escaping fragments that demise during the following re-entry. Perigee altitudes below this range can cause a ground risk by surviving fragments.