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Impact-Induced Mission Effects and Risk Assessments (3)

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ADVANCES IN THE CHARACTERISATION OF COLLISION BREAK-UPS BY MEANS OF NUMERICAL MODELLING

Abstract

A new statistical model for the characterisation of collision breakups in orbit is under development, as object of an ESA project entitled "Exploiting numerical modelling for the characterisation of collision break-ups". The new model will be based on a large database of collision simulations, performed using a semi-empirical numerical tool, namely an improved version of the Collision Simulation Tool solver (CSTS), created by Centro di Ateneo di Studi e Attività Spaziali "Giuseppe Colombo" of the University of Padova (CISAS - Italy). The CSTS is used to reproduce the consequences of a collision between two orbiting structures, simulating their physical response at component level. The shape and model of the involved satellites/debris are taken into account, as well as the geometry of the impact. Small scale hypervelocity impact tests at component level are also performed to support the numerical tool validation and improvement, before the construction of the collision database. Exploiting the database of simulated collisions generated with the CSTS, the new statistical model aims to provide a fast and reliable tool for the prediction of the effects of a collision in orbit, taking into account the structure of the involved objects, their materials, as well as the collision geometry, thus overcoming some of the limitations of the currently available empirical and semi-empirical breakup models, like the de facto standard NASA breakup model (Johnson et al., 2001). As an example, these tools do not consider the objects' material and detailed design and do not take into account the effect of the impact point. On the basis of the input provided,

the new model shall be able to work in basic mode, which only accounts for speed and masses, like the NASA model, or in advanced mode, taking into account also design details and collision geometry. A validation and comparison campaign is foreseen, also against the NASA model, on past in-orbit collisional events. In conclusion, the new tool shall be able to produce accurate information for many hypothetical collision scenarios in a relatively short CPU time. The final goal is to have a reliable computational tool that should be suitable to complement the standard NASA's breakup model for the predictions of the environmental consequences of a fragmentation in orbit. The content of the ongoing project activities and the partial results achieved at the time of the conference will be presented.