Paper ID: 52864
oral

17th IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Impact-Induced Mission Effects and Risk Assessments (3)

Author: Prof. Alessandro Francesconi
University of Padova - DII/CISAS, Italy

Dr. Lorenzo Olivieri
CISAS "G. Colombo" - University of Padova, Italy
Dr. Giulia Sarego
University of Padova, CISAS – "G. Colombo" Center of Studies and Activities for Space, Italy
Dr. Cinzia Giacomuzzo
Italy
Dr. Andrea Valmorbida
CISAS – "G. Colombo" Center of Studies and Activities for Space, University of Padova, Italy
Dr. Darren McKnight
Integrity Applications Incorporated (IAI), United States

EXAMINATION OF SATELLITE COLLISION SCENARIOS SPANNING LOW TO HYPERVELOCITY ENCOUNTERS USING SEMI-EMPIRICAL MODELS

Abstract

This paper reports a parametric study of the consequence of spacecraft collisions, with focus on satellite damage (sub-catastrophic or catastrophic) and fragment generation at different impact velocities and mass involvement. In particular, the transition from non-hypervelocity to hypervelocity regime is considered (with low velocity being of primary importance for GEO collisions), as well as the influence of structural properties to possibly dissipate impact energy when the two objects' appendages interact first. Nine collision scenarios are examined involving two satellites similar to GEO telecom payloads of different size, i.e. two spacecraft with solid parallelepipedal body, multiple dishes, and deployed solar panel wings. The two satellites are 500 kg and 2000 kg. Three impact velocities are considered (0.1, 1 and 10 km/s) and for each of them three encounter configurations are analysed: (1) body-to-body, (2) body-to-solar-panel with velocity vector pointing on the target centre of mass, and (3) solar-panel-to-solar-panel with velocity vector as in the second case. Numerical simulations are performed with a software called Collision Simulation Tool (CST), that is a brand new semi-empirical tool developed in the framework of ESA contract "Numerical simulations for spacecraft catastrophic disruption analysis", led by CISAS-UniPD with etamax GmbH as subcontractor. CST results are compared with those obtained by the semi-empirical breakup model FAST and the NASA SBM, and are finally used to highlight fragments distributions dependencies on impact velocity, collision configuration, and structural dissipation.