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Impact-Induced Mission Effects and Risk Assessments (3)

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A SIMPLE MODEL FOR SHAPE EFFECTS IN HVI

Abstract

Hypervelocity impacts with space debris already represent a threat to operational satellites, and they could further increase in the next years due to a possible collisional cascade, that might follow satellite impacts in crowded orbits. Investigation on spacecraft collisions is currently performed with observations and tracking of fragmentation debris and with ground experiments to reproduce high-energy impacts in the laboratory. On the other hand, the response of spacecraft components and protections is evaluated with hypervelocity impact tests, that usually employ spherical or cylindrical projectiles to represent the debris environment. Such impactors are adequate for most of the small meteoroids and for part of the artificial debris population, but could be inadequate for many fragmentation debris of irregular shape, The space community is showing interest on this topic, as current damage models could lead to highly inaccurate predictions if impactors significantly deviate from the spherical shape.
In this context, this paper describes a simple model for shape effects in hypervelocity impacts. The model is based on sensible geometric assumptions which describe the shape of craters excavated on semi-infinite targets after impact with projectiles having spherical, oblate or prolate shapes. The crater model parameters are tuned using dedicated hydrocode simulations and the model is then extended to different impact configurations (target thickness, impact angle). The collision response, in terms of damage on the target and mass of ejecta fragments, is reported, and the severity of each scenario is related to the different shapes effect.