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BREAK-UP MODELLING AND TRAJECTORY SIMULATION UNDER UNCERTAINTY FOR ASTEROIDS

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ABSTRACT

Near Earth Objects (NEOs) pose a very real and severe threat to the Earth population. The recent event in Chelyabinsk highlights the nature of such a threat. Casualty avoidance and decision making for ground impact require credible and realistic modeling of breakup events and post-breakup trajectory simulations. The University of Strathclyde, within the framework of the EU-ITN Stardust project, is currently developing a new tool, OS-TRANSPArent (Open Source Tool for Re-entry ANalysis of SPace-debris and Asteroids), that will allow the survivability analysis of entry objects. OS-TRANSPArent integrates a multi-fidelity tool for the rapid computation of aerodynamic and aerothermodynamic properties of entry objects (spacecraft and space debris, and asteroid) with a trajectory propagator to simulate the evolution of the objects from the point of atmospheric entry to the final event that can be either the ground impact or the disintegration and burn-up during the atmospheric flight. The module devoted to the analysis of the asteroid entry will incorporate the break-up models used by Artemieva et al, (2001, 2009). Post break-up modeling and tracking of the fragmented pieces will be performed using the empirical models we develop based on the data obtained by S. J. Laurence et al, (2012), which link the transverse velocity of the fragments to their relative size. The data of Laurence et al is extrapolated to Mach Numbers typical of asteroids. The uncertainties affecting this kind of simulations, such as on the entry conditions and the mechanical properties of the asteroids, will be characterized and the tool will also provide uncertainty quantification and propagation analysis to have a probabilistic characterization of the final event. In the present work, the tool will be applied to an asteroid with characteristics similar to the Chelyabinsk event using the incorporated models and results will be presented.

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