Investigation into the rotational dynamics of the defunct satellite TOPEX/Poseidon

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The satellite TOPEX/Poseidon was launched in 1992 and operated successfully until it malfunctioned in January 2006. Since then, it has become one of the largest pieces of space debris in orbit. Defunct spacecraft represent a significant risk to active and future space missions. Active Debris Removal (ADR) has been proposed as a solution to this problem, where a removal spacecraft would be launched, rendezvous with a target, stabilize and capture it, and finally remove it from orbit. However, precise knowledge of the target's rotational parameters ahead of time is key for the stabilization and capture of the debris.

Satellite Laser Ranging (SLR) observations of TOPEX/Poseidon have found that since its end-of-mission, the satellite has been experiencing a consistent increase of its angular velocity. In order to investigate the long-term evolution of its rotational motion in more detail, a novel comprehensive coupled orbit-attitude propagation model will be used. First, an analytical method to estimate the unknown inertia properties of the spacecraft from SLR observations will be derived. Second, the propagation model will be employed and the influence of external torques, namely the gravity-gradient, solar radiation, and eddy-current torques, will be analyzed, obtaining a better characterization of the evolution of the satellite's rotational motion. Simulation results will then be compared to SLR observations. Finally, uncertainty on the satellite's derived moments of inertia and on other model input parameters and their influence on the attitude dynamics of the spacecraft will be analyzed.