Paper ID: 50531
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IAF MICROGRAVITY SCIENCES AND PROCESSES SYMPOSIUM (A2)
Microgravity Experiments from Sub-Orbital to Orbital Platforms (3)

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SIMULATING THE INTERMEDIATE AXIS THEOREM USING MATLAB AND AUTODESK FUSION 360

Abstract

The natural spin states of an object in freefall is of tremendous relevance to several areas of space sciences and technology. Whether the object is an irregular, massive asteroid, or a well-defined artificial communications satellite, each object will have inherent moment of inertia and tendencies to spin. Some of those spin states may be stable and others may be unstable. The stability of the spin states is descibed by the Intermediate Axis Theorem (IAT).

Here we describe the development of a useful tool specifically tailored to predict spin states of an object using the IAT. By specifying the geometry and mass distribution of the object, the tool applies the IAT and Langrangian equations of motion to determine how the object will spin. We demosntrate the application of the tool using several objects and compare our predictions against experimental data gathered on the International Space Station (ISS). Interestingly, our tool provides deeper insight into the ISS experiments: we can predict the critical conditions under which a transition from stable to unstable rotation and could be useful for the future design of novel IAT experiments or be exploited for spacecraft designs.