Paper ID: 34888
student

SPACE EXPLORATION SYMPOSIUM (A3)
Interactive Presentations (IP)

Author: Ms. Samantha Rieger
University of Colorado Boulder, United States

Prof. Daniel Scheeres
Colorado Center for Astrodynamics Research, University of Colorado, United States
Mr. Brent Barbee
National Aeronautics and Space Administration (NASA), Goddard Space Flight Center, United States

ORBITAL STABILITY REGIONS FOR HYPOTHETICAL NATURAL SATELLITES OF NEAR-EARTH ASTEROIDS

Abstract

The Origins, Spectral Interpretation, Resource Investigation, Security-Regolith Explorer (OSIRIS-REx) mission to return a sample from potentially hazardous near-Earth asteroid Bennu will become NASA's third New Frontiers Class mission when it launches in September of 2016. The mission planning team is currently investigating whether Bennu might possess any natural satellites in long-term stable orbits that could interfere with spacecraft operations in Bennu's vicinity. Bennu has been the target of an extensive ground-based observation campaign since its discovery in 1999, and those observations have ruled out the presence of any natural satellites larger than 15 m in diameter.

In previous research we investigated the possible size and stability of a natural satellite around Bennu. The focus of the research was solely on the existence of stable orbits for a natural satellite and purposefully places how the satellite migrated to this orbit outside the bounds of this research. Numerical simulations modeling J_2, 3rd-body dynamics and solar radiation pressure were used on a large set of initial conditions that vary in semi-major axis, inclination, longitude of periapsis and satellite diameter. Stable orbital initial conditions for a given natural satellite diameter remained in orbit for more than a thousand years without escape or collision from Bennu. By observing all the data given in this study, stable and unstable regions were identified. Patterns in the stability of these regions were explained by phenomena such as the modified Laplace plane, Sun-terminator plane or Kozai resonance.

The next step of this research will be to understand how these stability regions compare for other asteroids. The first step is to understand how the stability will change if more spherical harmonics for Bennu are modeled. Next, is to understand how the orbit around the Sun or spin-pole orientation of Bennu affects the stability of these orbital regions. Finally, other asteroid models will be used to determine how asteroids of varying shape and mass will affect natural satellite stability. The intent of this research is to understand where possible natural satellites can exist for a multitude of asteroids with varying spherical harmonics, heliocentric orbits, obliquities, and masses. Through varying this information, we will understand how the modified Laplace plane, Sun-terminator plane or Kozai resonance are affected by these parameters. This will give insight into the size and the distance from the asteroid a natural satellite will be in order to remain stable for long periods of time.