Determination of the Gravity Field and Rotational Dynamics of an Asteroid by Tracking an Orbiting Spat.ccraft

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The Near Earth Asteroid Rendezvous (NEAR) mission to the asteroid 433 Eros provides the first opportunity to observe an asteroid at c1osc range. At spat.cc.ra.ft orbit radii of 35 km, the perturbation of the spat.ccraft trajectory is directly observable with navigation i nstru - mentation. This instrumentation consists of the tracking stations that comprise NASA's Deep Space Network (DSN) and imaging instruments onboard the spacecraft. The data types are coherent two-way Doppler measurements of the line-of-sight velocity between tracking station antennae and the spat.ec.raft and optical images of Eros landmarks.

The data are processed by orbit determination software using filtering techniques developed for spacecraft navigation. Solutions arc obtained for the spacecraft trajectory, Eros rotational motion and the physical parameters that are used to model Eros. These physics] parameters include a 16th degree and order gravity field, the inertia tensor, mass and a data base of reference landmarks that may be used for shape modelling. A high degree of precision in estimating these physic al parameters is obtained by solving for all parameters including spacecraft motion in a joint solution involving as many as 500 parameters.

The physical parameters that describe Eros provide valuable insight into the internal structure of Eros. The bulk density provides a direct measure of the materials that comprise Eros. The gravity h armonics provide additional insight into Eros internal structure when compared with a shape model. The location of the center of mass obtained from the first degree gravity harmonics gives a direct indication of overall mass distribution. The inertia tensor may be determined by combining observations of any free precession of Eros with the second degree gravity harmonics. The inertia tensor provides a direct measure of the radial distribution of mass.

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