EPSC Abstracts
Vol. 6, EPSC-DPS2011-1051, 2011
EPSC-DPS Joint Meeting 2011

Rosetta at comet 67P/Churyumov-Gerasimenko: Spacecraft orbit modeling

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Abstract

The Rosetta spacecraft is on its way to its target comet 67P/Churyumov-Gerasimenko. The science objectives of the Rosetta Radio Science Investigations (RSI) experiment addresses fundamental aspects of cometary science such as the determinations of the nucleus mass and bulk density, its size and shape, its gravity field and internal structure, and its perturbed interplanetary orbit.

The radio carrier links at X-band (8.4 GHz) and S-band (2.3 GHz) transmitted by the Rosetta spacecraft and received on Earth will be used for these investigations. The motion of the spacecraft will be perturbed near the comet nucleus. The perturbed Doppler frequency shifts of the transmitted radio signals will be used to reconstruct the flown orbit.

In order to extract small changes of the perturbed Doppler frequency, a prediction of the unperturbed orbit is needed which must include best known estimates for all forces acting on the spacecraft. These forces are the nucleus gravity field, third body perturbations, the solar radiation pressure, the solar wind pressure and the cometary outgassing. The cometary outgassing is the dominant force near the comet nucleus during the entire escort mission phase (for heliocentric distances < 3.0 AU). The gas streams radially away from the nuceus and will cause perturbations in the dynamics of the spacecraft. During the perihelion passage of the comet the spacecraft may even be “blown” away from the nucleus. Simulations for different outgassing scenarios and their influence on spacecraft dynamics will be presented. Configurations that allow stable orbits, for at least a couple of days, will be shown.