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

M. Hahn (1), M. Pätzold (1), S. Tellmann (1), B. Häusler (2) and T. Andert (2)

(1) Rheinisches Institut für Umweltforschung, Abteilung Planetenforschung, Cologne, Germany, (Matthias.Hahn@uni-koeln.de)
(2) Institut für Raumfahrttechnik, Universität der Bundeswehr, Munich, Germany

Abstract

Rosetta 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 the perturbed interplanetary orbit of the comet nucleus.
The radio carrier links at X-band (8.4 GHz) and S-band (2.3 GHz) between the Rosetta spacecraft and the Earth will be used for these investigations. The motion of the spacecraft will be perturbed near the comet nucleus. The Doppler frequency shifts of the transmitted radio signals can be used to reconstruct the flown orbit.
In order to extract small changes of the Doppler frequency, a prediction of the orbit is needed which includes best known estimates of all forces acting on the spacecraft. These forces are the nucleus gravity field, third body perturbations, the solar radiation pressure, the solar wind pressure, the cometary outgassing, etc. It is then possible to determine iteratively low degree and order harmonic coefficients of the nucleus gravity field or the gas pressure force and the gas production rate from the outgassing from the differences between the predicted and the observed frequency shifts.