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Determination of comet 67P/Churyumov-Gerasimenko outgassing parameters by the Radio Science Experiment onboard Rosetta

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Abstract

The Rosetta spacecraft is on its way to its target comet 67P/Churyumov-Gerasimenko. The science objectives of the Radio Science Investigation (RSI) experiment addresses fundamental aspects of cometary science such as the determinations of the nucleus mass and bulk density, its size and shape and its gravity field and internal structure.
The radio carrier links transmitted by the spacecraft and received on Earth will be used for these investigations. The perturbed motion of the spacecraft near the comet nucleus leads to perturbed Doppler frequency shifts of the transmitted radio signal recorded on Earth. Perturbing forces acting on the spacecraft are the nucleus gravity field, third body perturbations, the solar radiation pressure and the cometary outgassing pressure.
Outgassing depends on the heliocentric distance of the nucleus. The comet is expected to be nearly inactive beyond 3.5 AU. During this time a gravity observation campaign will reveal precise information about the gravitational parameters of the comet nucleus. With this knowledge, the non-gravitational forces acting on the spacecraft shall be investigated.
Solar radiation pressure is assumed to be constant over one observation period (a few hours tracking time, typically) and predictable with sufficient accuracy. Outgassing pressure, however, may vary a significantly on short time scales during a single observation period. A strong phase angle dependency is expected as the outgassing is controlled by the solar radiation influx. There might be only a few active areas on the nucleus surface, however, which lead to jet-like structures with very high gas densities and flow velocities.
Different scenarios will be modeled and used in a parameter estimations process. First studies using a complex force model for spacecraft orbit simulations were carried out. An analysis of Doppler frequency shifts caused by cometary outgassing forces shall be presented. Different activity cases will be used as well as various distributions of active areas on the surface. The sensitivity of the radio science method to different outgassing scenarios will be shown.