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First Rosetta Radio Science Bistatic Radar Observations of 67P/Churyumov-Gerasimenko

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The Rosetta spacecraft was successfully inserted on 6th August 2014 into orbit around comet 67P/Churyumov-Gerasimenko. In September Rosetta was placed into bound orbits with an initial distance of 30 km and a decreasing distance until the end October. After lander delivery, bound orbits were maintained again at 20 km and 30 km.
One of the objectives of the Rosetta Radio Science Investigations (RSI) is to address the dielectric properties, small-scale roughness, and rotational state of the nucleus of the comet, which can be determined by means of a surface scattering experiment, also known as Bistatic Radar. The radio subsystem transmitter located on board the Rosetta spacecraft beams right circularly polarized radio signals at two wavelengths -3.6 cm (X-Band) and 13 cm (S-Band) - toward the nucleus surface. Part of the impinging radiation is then scattered toward a receiver at a ground station on Earth and recorded.
On September 29th, 2014 the first Bistatic Radar experiment ever at a comet was successfully conducted. The distance between 67P/Churyumov-Gerasimenko and Rosetta was 20 km and both right circularly polarized (RCP) and left circularly polarized (LCP) reflected signals from the comet's surface in X-Band were detected during the experiment at the Goldstone complex of the NASA Deep Space Network. The ultra-stable oscillator (USO) on board Rosetta served during the experiment as a very stable reference frequency source. The direct and reflected signal were separated during the experiment by only a fraction of 1 Hz. The extreme stability of the USO allowed a detection and separation of the weak signals even on the required long integration times.
Five additional Bistatic Radar experiments were conducted successfully between mid-October and mid-December 2014 with the 70-m DSN ground stations in Goldstone and Canberra at different distances to the comet (10 km, 20 km and 30 km) and reflected signals were observed in each case.