Processing Bistatic Radar Observations of Comet 67P/Churyumov-Gerasimenko

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Objectives of the Rosetta Radio Science investigations included determining the dielectric properties, small-scale roughness, and rotational state of the nucleus of comet 67P/Churyumov-Gerasimenko (67P/C-G) from bistatic radar (BSR) measurements**.** The radio transmitter and high gain antenna (HGA) on the spacecraft beamed right circularly polarized (RCP) radio signals at two wavelengths - 3.6 cm (X-Band) and 13 cm (S-Band) - toward the nucleus surface. Parts of the impinging radiation was then scattered toward a 70-m ground station of the NASA Deep Space Network (DSN) on Earth, where it was received and recorded coherently in both RCP and left circular polarization (LCP).

Between late September and mid-December 2014, six BSR experiments were conducted successfully at 67P/C-G. BSR measurements had never been attempted before at such a small body in interplanetary space. The distances between the spacecraft and the comet varied from 10 km (September) to 30 km (December). For the BSR experiment planning, the location of specular reflection points were obtained for the surface of an ellipsoidal shape model. The related incidence angles ranged from 42° to 56°. During data processing, the actual surface reflection geometry has been reviewed on the latest available facet shape model of the comet.

In five of the experiments, the HGA footprint was close to the equator. On November 29, the footprint was close to the rotation axis. Both RCP and LCP signal returns were detected at X-band during the experiments. This poster discusses signal processing schemes of significance for the detection of spectrally adjacent, weak, narrow band signals. Such schemes are necessary for the reconstruction of BSR echoes from the irregularly shaped surface of 67P/C-G.

For a known incidence angle and measured RCP/LCP power ratio, the surface dielectric constant may be obtained by applying Fresnel theory, if the surface is sufficiently smooth. On November 22, the HGA illuminated the smoothest surface observed, near the equator of the greater lobe, at the border with the regions of Ash, Babi and Aten. We investigate the radar cross sections of this region. For the remaining measurements, the resulting power ratios yielded non-physical dielectric constants, possibly because of a combination of wave scattering and depolarization effects. A BSR signal simulation tool is being developed to resolve for the spectral components observed in the Rosetta datasets.