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Small Bodies Missions and Technologies (Part 2) (4B)

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SIMULATION OF THE DETECTABILITY OF DIFFERENT SURFACE PROPERTIES WITH BISTATIC RADAR OBSERVATIONS

Abstract

The bistatic radar technique is a well-established method to probe surfaces of planets and also small bodies like asteroids and comets. The radio subsystem onboard the spacecraft serves as the transmitter and the ground station on Earth as the receiver of the radio signal in the bistatic radar configuration. A part of the reflected signal is scattered towards the receiver and both the right and left circularly polarized echo components (RCP and LCP, respectively) are recorded there. From the measurement of those, geophysical properties like surface roughness and dielectric constant can be derived. Such an observation aims at extracting the radar reflectivity coefficient of the surface which is also called the radar-cross section. This coefficient depends on the physical properties of the surface. We developed a bistatic radar simulation tool that utilizes hardware acceleration available on modern GPUs. A Shooting and Bouncing Rays (SBR) method (sometimes also called Ray-Launching Geometrical Optics) for estimating the scattering of electromagnetic waves from surfaces using hardware accelerated ray tracing has been implemented. A high-performance implementation of the SBR method is highly desirable since surfaces can become very large relative to the surface features that need to be resolved by the simulation method. For example, the asteroids 1 Ceres and 4 Vesta have mean diameters of around 974 km and 529 km and therefore a very large surface which needs to be considered for estimating the scattering. But even smaller objects can require a large number of rays for sampling the surface with a density large enough for accurate results. We will present the highly performance method, its application to several examples with various shape and surface properties, and examine limits of the detectability of water ice on small bodies.