CONTROL ID: 2828345

TITLE: 3D high-resolution radar imaging of small body interiors

ABSTRACT BODY:

Abstract (2,250 Maximum Characters): Answering fundamental questions about the origin and evolution of small planetary bodies hinges on our ability to image their interior structure in detail and at high resolution (Asphaug, 2009). We often infer internal structure from surface observations, e.g. that comet 67P/Churyumov-Gerasimenko is a primordial agglomeration of cometesimals (Massironi et al., 2015). However, the interior structure is not easily accessible without systematic imaging using, e.g., radar transmission and reflection data, as suggested by the CONSERT experiment on Rosetta. Interior imaging depends on observations from multiple viewpoints, as in medical tomography.

We discuss radar imaging using methodology adapted from terrestrial exploration seismology (Sava et al., 2015). We primarily focus on full wavefield methods that facilitate high quality imaging of small body interiors characterized by complex structure and large contrasts of physical properties. We consider the case of a monostatic system (co-located transmitters and receivers) operated at two frequency bands, centered around 5 and 15 MHz, from a spacecraft in slow polar orbit around a spinning comet nucleus. Assuming that the spin period is significantly (e.g. 5x) faster than the orbital period, this configuration allows repeated views from multiple directions (Safaeinili et al., 2002)

Using realistic numerical experiments, we argue that (1) the comet/asteroid imaging problem is intrinsically 3D and conventional SAR methodology does not satisfy imaging, sampling and resolution requirements; (2) imaging at different frequency bands can provide information about internal surfaces (through migration) and internal volumes (through tomography); (3) interior imaging can be accomplished progressively as data are being acquired through successive orbits around the studied object; (4) imaging resolution can go beyond the apparent radar frequency band by deconvolution of the point-spread-function characterizing the imaging system; and (5) exploiting the known (and complex) exterior shape of the studied body facilitates high-resolution imaging and tomography comparable with what could be accomplished by bi/multi-static systems.

CURRENT CATEGORY: Comets: Origins and Theory

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