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Dual frequency radar backscatter simulation : Implications on lunar water ice detection

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High resolution radar imaging of lunar polar region was done for the first time by Mini SAR onboard Chandrayaan-1. Major goal of the instrument was to detect buried water ice signature in lunar polar permanently shadowed region [1, 2]. The investigation showed that S-band circular polarization ratio (CPR), which is an important parameter that represent scattering associated with planetary ice as well as dihedral reflection was anomalously high inside some of the craters in the Polar Regions. The limitation of single frequency MiniSAR data for water ice detection was due to elevated CPR arising due to roughness of the surface. Similar limitation was also observed in data arising from Mini RF onboard in lunar reconnaissance Orbiter (LRO). In order to understand and resolve such issue, dual frequency radar backscatter simulation has been attempted at L-band band (1.25 GHz) and S-band (2.5 GHz) using a two layer electromagnetic model for various size of lunar water ice particles embedded in regolith. Frequency selection has been done on the basis dual of frequency SAR sensor onboard Chandrayaan-2.The conceptual lunar regolith model is described by a homogeneous fine-grained layer of thickness, d (2m), with a varying roughness (0.1 m) and dielectric constant of upper and lower interfaces. The middle layer contains scatterers as buried ice/ rock particles homogeneously distributed within middle layer (2.77 –i.003''). The regolith layer may contain either of buried ice or rock debris. The simulation assumes regolith as a Rayleigh medium within which the impurities (ice/rock) are assumed spherical, of radius a, dielectric constant e and volume fraction f. The layer is characterized by absorption coefficient and a volume scattering coefficient as described by Fung [3]. The model computes backscatter for various size of scattering ice or rock/debris embedded in the regolith [3]. Simulated values of backscatter were normalized as frequency index [2] and a plot of size vs. frequency index is shown in Fig 1. It can be seen the scattering from ice or debris can be distinguished with a possibility of assessing the size of scattering particles (rock/ice) within the layer.

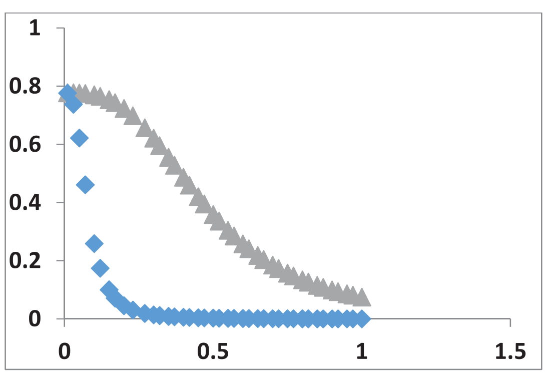

Figure 1. Variation of frequency index (Y-axis) with size of scatterer in cm (top : Ice , lower: Rock)

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2 Shiv Mohan and Anup Das, Chandrayaan-1 Mini SAR data investigation, Lambard Academic Publishers (Germany) 2012, ISBN-10: 36591768X, 2012

[3] Fung, A. K., Microwave Scattering and Emission Models and Their Applications, Artech House, Boston, 1994.