URSI - RCRS 2022, IIT (Indore), India, 1 - 4 December, 2022

Design of a Subsurface Sounding Radar for future Indian Venus Exploration Mission

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As the Venusian surface is dominated by volcanic terrain (regional plains), subsurface exploration is essential to characterize the primordial crust, buried basins, stratigraphy of lava flows and estimate their thickness to understand the rate of resurfacing on Venus and its linkage to volcanism. An orbital surface penetrating radar will be extremely useful for exploration of subsurface features, which are completely unknown and unexplored. Such an instrument was previously flown to Mars (Mars Advanced Radar for Subsurface and Ionospheric Sounding (MARSIS) and Shallow Radar(SHARAD)[1]), Moon(Lunar Radar Sounder (LRS)[2]) and planned in future in the RIME[3] mission for Jovian Moon. The measurements from the instrument led to a few discoveries and resulted in rich science. A similar mission is also under study for European Space Agency's (ESA) EnVision mission [4] for Venus. However, such a radar has never flown to Venus yet and thus several scientific aspects are yet to be discovered.

Knowledge about sub-surface geology will be used to understand the Venusian geological history and the rate of resurfacing on Venus. The low frequency radar sounder will be able to map the vertical structure (dielectric interfaces) and properties of various geological units including (possible) active volcanic hotspots and lava flows. This space-borne radar sounder instrument can be complementary to a higher frequency SAR data by characterizing the shallow subsurface stratigraphy in the volcanic terrains for better understanding the geologic evolution of Venus.

This paper presents a case study of an orbiter based Subsurface Sounding Radar for determining the structure and stratigraphy of surface/sub surface features as well as volcanic hot spots of Venus. We will also describe the main science objectives of this mode, the performance evaluation under expected target conditions as well as the instrument design aspects.

The proposed payload is designed to have both, a ground-penetrating radar mode as well as a mode for studying topside ionosphere. It is planned such that the two modes share the same hardware and can operate on time-sharing basis. The ground penetrating mode is designed as a pulsed LFM based nadir looking radar sounder instrument with two operating modes i.e. High resolution mode from 16-30MHz and a low resolution high penetration mode operating at 10-15MHz. With a horizontal Resolution of ~3km, it can be used for global coverage with moderate resolution and thus give an insight into the geology upto higher depths since this is the first GPR mission on Venus and we do not have much knowledge of the exact depths of interest in the planet.

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