LoCo1: Pathfinding space based low frequency cosmology

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Recent interest in high redshift cosmology observations with the redshifted 21cm line has rekindled exploration of the VHF radio band (50-200MHz) for radio astronomy. Single antenna instruments like the ground-based EDGES and the proposed lunar orbiting DARE have the goal of characterizing the global HI signal and extracting astrophysical and cosmological information. One limitation over much of the band is strong man-made and naturally occurring interference, which DARE avoids by observing as it orbits the far side of the moon. Another advantage of space-based observing is avoidance of the ionosphere which becomes increasingly reflective at the lower end of the VHF band. Technical challenges to this type of mission include development of lower power wide-band spectrometers, better mapping of Earth originating interference, and incorporation of lessons learned from ongoing ground-based experiments. One of the main challenges faced by EDGES, observing the narrower but clean stretch of bandwidth found in Western Australia, is calibrating the spectral response of the antenna at the required 0.01dB level.

Meanwhile, radio receiver technology is at the heart of many space science research and operations applications, including Earth and planetary remote sensing, space weather and heliophysics, astrophysics, cosmology, threat-detection, and spacecraft communication. For scientific applications, large bandwidths improve scientific return by improving sensitivity to continuum emission phenomena (both thermal and non-thermal mechanisms), providing access to multiple spectral lines simultaneously, and enabling multiplexing of detector readout (e.g. for kinetic induction devices), among additional benefits. Existing radio receivers for Smallsat platforms, and especially CubeSat form factors, are very limited, however. Due to power restrictions, only small 4 MHz bandwidth throughput is available to current systems.

LoCo1 is a proposed satellite mission with the goal of retiring risk on several of the areas relevant to high redshift cosmology and wide-band space-based spectrometers. The mission will seek to make wide-band measurements in the Dark Ages band from low earth orbit. Using low power ASIC components recently developed at JPL we can now build suitable spectrometers that fit within the size and power envelope of a 3U Cubesat (10x10x30cm). Using a novel, reverse tensioned deployable tape as both antenna and gravity stabilizer, LoCo1 will record radio spectra between 50 and 200MHz from Low Earth Orbit. These spectra will demonstrate the on-orbit performance of the spectrometer while mapping the spatial distribution of interference around the globe. Between the interference will be galactic foreground emission which will be used to assess the calibration of the free-flying antenna.

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