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# USING A CONSTELLATION OF SMALL SATELLITES TO CHARACTERIZE THE RF QUIESCENCE OF THE LUNAR FARSIDE

**Abstract**

Radio images of red-shifted 21-cm signals from neutral hydrogen originating from the very early Universe, the so-called Dark Ages before the first stars formed, are impossible to obtain from Earth due to man-made radio frequency interference (RFI) and the opacity of the ionosphere below 30 MHz. To efficiently block the RFI, which would otherwise overwhelm the weak cosmological signal, requires a large low-frequency radio array on the far-side of the Moon. Such a lander mission is technically challenging and carries a budget that is currently unlikely to be included in any national or international mission plan. Our goal is to use a constellation of small satellites in lunar orbit to collect pathfinder data to demonstrate the feasibility of using the Moon as a radio-shield, and map out the spatial extent of this RF quiescent zone.

The underlying science objectives for such measurements include answering fundamental questions about the Universe: (1) When did the first stars form? (2) When did the first accreting black holes form? (3) When did reionization begin, where intense UV light from the first stars broke atoms into nuclei and electrons, making the sky transparent, as we find it today?

The team led by the Hawaii Space Flight Laboratory (HSFL) at the University of Hawaii at Manoa is designing a mission to characterize the spatial extent of the RF quiescence zone on the lunar farside to support future missions to explore the cosmos using radio observatories on the surface. This paper examines the design of this mission starting with a baseline architecture that uses a modified SSTL X50

satellite bus as mothership, inserted directly into Lunar orbit, that carries nanosats to lunar orbit where it will deploy them to form the constellation and act as the communications relay between them and Earth. The initial baseline has the mothership and three nanosats evenly distributed in an 800-km altitude equatorial lunar orbit. This would allow measurement of the relevant RF environment continuously for at least a year, allowing the diurnal/seasonal variability of radio contamination to be studied. The nanosats would crosslink the collected data to the mothership, which will relay the data to Earth as well as act as an RF collecting station itself. Alternative orbits, constellation and payload designs will be analyzed to optimize the mission for performance (payload mass, sensitivity and angular resolution) and cost.