SOLAR RADIO BURST OBSERVATIONS BY THE FARSIDE LUNAR SURFACE RADIO ARRAY.

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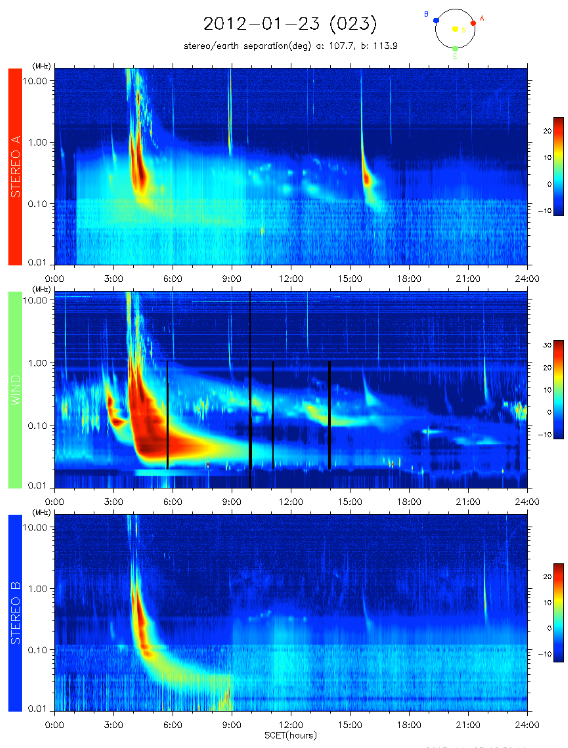
Our view of the Universe at wavelengths longer than about 15 m (frequencies < 20 MHz) is impeded significantly by the Earth's ionosphere. These wavelengths correspond to frequencies comparable to or below the plasma frequency of the ionosphere, so that any celestial radiation is blocked. Therefore, the low frequency observations of space are made by spacecraft, such as the Wind spacecraft and the STEREO spacecraft. As shown below, these spacecraft provide sensitive measurements of solar type II and type III radio bursts, from shock-accelerated and flare-accelerated electrons, respectively.



The figure above shows 3 panels of spacecraft radio data in "dynamic spectrum" format, i.e., radio signal level color-coded and positioned as a function of frequency (ordinate) and time (abscissa). The top panel represents 24 hours of data (0.01-16 MHz) from STEREO-A, the center panel represents 24 hours of data (0.01-13 MHz) from the Wind spacecraft, and the bottom panel represents 24 hours of data (0.01-16 MHz) from STEREO-B. The bright (red), predominantly-vertical bursts are solar type III bursts; the less intense and more horizontally evolving bursts are solar type II bursts, occurring on Jan. 23, 2012.

So, there is extensive data for the solar radio bursts, but they have never been imaged from space. Antenna arrays on the ground do make images at frequencies greater than ~20 MHz, but there is no capability to do so in space. The FARSIDE array, for which the concept will be provided to the 2020 Astrophysics Decadal Survey, could provide images. It is primarily a Farside lunar Astrophysics Radio Science Instrument for Dark ages cosmology and Exoplanet research (FARSIDE); however, when the FARSIDE array is on the day-side during the lunar rotation, it will observe many solar radio bursts. Fortunately, during the lunar night, the cosmology/exoplanet studies will not be inhibited by the more intense solar radio bursts..

Radio burst imaging will improve understanding of radio burst mechanisms, particle acceleration, and space weather. Although solar radio observations do not require an observatory on the farside of the Moon, such a location would permit study of less intense solar bursts because the Moon occults the terrestrial radio frequency interference. The required components of a lunar radio observatory array for solar observations include the antenna system consisting of 10 – 100 antennas distributed over a square kilometer or more; the FARSIDE array will meet these requirements.

Radio burst mechanisms for type II and type III bursts have been extensively studied, but there remain some questions that imaging at an angular resolution of 1 degree would aid in resolving. Because the electrons beams producing the radio emission follow the magnetic field lines, the imaging would provide some data about structures in the interplanetary magnetic field. There are essentially no dangerous Solar Energetic Particle (SEP) events without related complex type III bursts and intense type II bursts, so the radio bursts play a role in space weather alerts. Imaging would be an improvement, because it would help to clarify the source locations of the radio emission producing electrons, providing additional detail about the SEP source and evolution.

Ideally, a pathfinder radio telescope array on the Moon will be in place by the upcoming solar maximum (~ 2024-2026). We could directly demonstrate the value of the data as an SEP alert for astronauts (and hardware). The FARSIDE array would be well-suited to make such measurements. Of course, for 24-hour space weather monitoring of this nature, we require a radio array on both sides of the Moon.