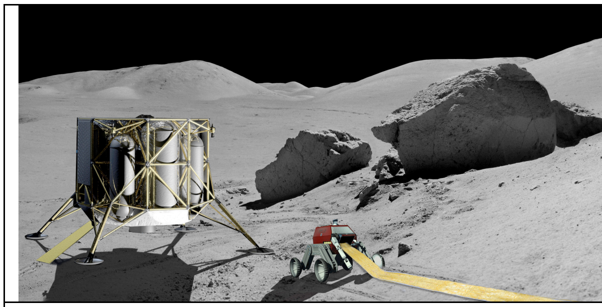
SCIENCE AND ANTENNA ARRAY TRADE STUDIES FOR LOW FREQUENCY RADIO OBSERVATORIES ON THE LUNAR SURFACE. R. J. MacDowall[1] and J. O. Burns[2], [1]NASA Goddard Space Flight Center (robert.macdowall@nasa.gov), [2]University of Colorado, Boulder (Jack.Burns@colorado.edu)

Introduction: A "low-frequency" radio astronomy observatory on the lunar surface would serve to address science goals that cannot be achieved by ground-based observatories, because the radio emission occurs at frequencies below the terrestrial ionospheric cutoff (~10 MHz) or because the sources of radio frequency interference (RFI) must be blocked by placing the Moon between the RFI and the observatory.

Solar Radio Burst Imaging: To image solar radio bursts at frequencies less than ~10 MHz requires an array of antennas somewhere outside the terrestrial ionosphere. The capability to do so is compelling, because 10 MHz corresponds to the plasma frequency (f_P) at a distance from the Sun of about 2 solar radii (R_s). Outside of the sphere ~2 R_s in radius, the plasma frequency is lower and cannot be observed from the ground. Consequently, radio bursts produced inside most of the inner heliosphere have neve been imaged. The capability to image the radio bursts as their emitting sources (flare or shock-accelerated electrons) move away from the Sun would be valuable for understanding the emission mechanisms better, useful for tracking shock particles and coronal mass ejections from the Sun to 1 AU, and valuable for space weather prediction. We discuss the current status and plans for a radio observatory designed to image these bursts.

Detection of the Radio Signature of Cosmic Dawn and Habitable Exoplanets: Cosmic Dawn is a transformative event when the first stars and galaxies formed in the early Universe (35<z<10). The first ~0.5 billion years after the Big Bang are largely unexplored because we lacked theoretical insights and instruments to probe this epoch. We now have the modeling tools and technology to investigate this era using the highly redshifted 21-cm (1420 MHz in rest frame) signal from neutral hydrogen. The Moon's farside is uniquely shielded from terrestrial RFI and free from ionospheric effects that will permit these redshifted observations at <100 MHz. An observatory capable of Cosmic Dawn measurements could also provide a capability to detect magnetospheric radio emissions from exoplanets, which indicate that the surface of the planet is protected from energetic particles by a magnetosphere and consequently more habitable.

Teleoperated Systems to Facilitate Observatory Deployment: A small lunar array with a limited number of antennas could be deployed from a small lander, such as those being proposed by commercial companies. Larger arrays, to provide greater angular resolution or greater sensitivity, might well be deployed by rovers teleoperated by astronauts on Orion and/or Habitat missions in cis-lunar orbits. Such activities would serve as an important proving ground for future exploration missions in deep space.



Surface teleoperation of rovers from orbiting facilities is a key technology for astronaut-assisted deployment of a lunar farside antenna array.

The Network for Exploration and Space Science (NESS): NESS is a newly-selected team of the NASA Solar System Exploration Research Virtual Institute (SSERVI) with goals that address these topics. Our team will conduct trade studies to advance the design of a low frequency radio array, wide-band receivers, and new calibration techniques. Ideally, we will find a scaleable design that can serve for a small to medium-sized solar radio observatory, as well as a larger observatory for "astrophysical" radio sources. It is also our goal to complete a design for a radio observatory pathfinder that will be ready for proposal to a flight opportunity in the near future.

The NESS website http://www.colorado.edu/ness/ provides an indication of the multifaceted, multidisciplinary, and innovative investigation by NESS in the space sciences, including the areas of astrophysics and heliophysics that are enabled through human and robotic exploration of the Moon.