Imaging Magnetospheric Transient Emissions with a Lunar Nearside Radio Array

A. M. Hegedus, J. Kasper, J. O. Burns, and R. J. MacDowall

University of Michigan, Department of Climate and Space Sciences and Engineering, Ann Arbor, MI, USA, University of Colorado Boulder, Boulder, CO, NASA Goddard Space Flight Center, Greenbelt, MD, USA. (alexhege@umich.edu)

A Sister FARSIDE Array on the Nearside could Localize Earth’s Transient Magnetospheric Emission to ~10 km

Key Details:
- Clone of FARSIDE array
- 10 km diameter, 128 x 100 m antennas
- Limited 0.1 – 10 MHz Frequency Range
- Imaging Pipeline for high SNR transients
- Lay ground work for exoplanet searches

Simulated Array Inputs
- LRO LOLA Lunar Surface Maps
- SPICE Ephemeris of Moon & Earth
- Find Minimum Variance Elevation near (0, 0) Lunar ME
- Situated so Earth always at zenith
- 10 km Asymmetrical Petals

Dominant Noise Sources
- Surface Electron Quasithermal Noise
- Amplifier Noise
- Galactic Background Noise

Conclusions
- Localization far beyond array diameter limited beamwidth possible
- Lunar surface measurements needed to characterize quasithermal noise
- Single antenna missions like LuSEE and ROLSES will provide accurate event rates and noise budget
- Array could provide unprecedented local magnetospheric electron information
- 1-10 km localization possible for high SNR emission
- Could lay ground work for exoplanet searches & image Solar bursts too

References

Acknowledgments
Thank you to the Lunar Reconnaissance Orbiter (LRO) and Lunar Orbiter Laser Altimeter (LOLA) teams for mapping the moon to an unprecedented degree. This work was directly supported by the NASA Solar System Exploration Research Virtual Institute cooperative agreement number 80ARMC017M0006, as part of the Network for Exploration and Space Science (NESS) team.

<table>
<thead>
<tr>
<th>Transient Source (Point Source)</th>
<th>Frequency</th>
<th>Lunar Flux Density</th>
<th>10 km Array Dirty Resolution</th>
<th>UVModelFit Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auroral Kilometric Radiation</td>
<td>700 kHz</td>
<td>$10^{10}$ Jy</td>
<td>1.85 degrees</td>
<td>&lt; 1 arcsec</td>
</tr>
<tr>
<td>Auroral Hiss</td>
<td>500 kHz</td>
<td>$6 \times 10^8$ Jy</td>
<td>2.5 degrees</td>
<td>8.5 arcsec</td>
</tr>
<tr>
<td>Auroral Roar</td>
<td>3.0 MHz</td>
<td>$10^8$ Jy</td>
<td>0.47 degrees</td>
<td>10 arcsec</td>
</tr>
<tr>
<td>Medium Frequency Bursts</td>
<td>4.0 MHz</td>
<td>$10^8$ Jy</td>
<td>0.35 degrees</td>
<td>7.5 arcsec</td>
</tr>
</tbody>
</table>

- 1 arcsec = 1.86 km at Earth
- Accurate plane of sky measurement
- High SNR → More-Precision than 10 km limited Beamwidth

1 arcsec = 1.86 km at Earth
Accurate plane of sky measurement
High SNR → More-Precision than 10 km limited Beamwidth