THE LOW FREQUENCY SPACE ARRAY (LFSA)

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At the lowest radio frequencies (≤30 MHz), the Earth's ionosphere transmits poorly or not at all. This relatively unexplored region of the electromagnetic spectrum is thus an area where high resolution, high sensitivity observations can open a new window for astronomical investigations. Also, extending observations down to very low frequencies brings astronomy to a fundamental physical limit where the Milky Way becomes optically thick over relatively short path lengths due to diffuse free-free absorption.

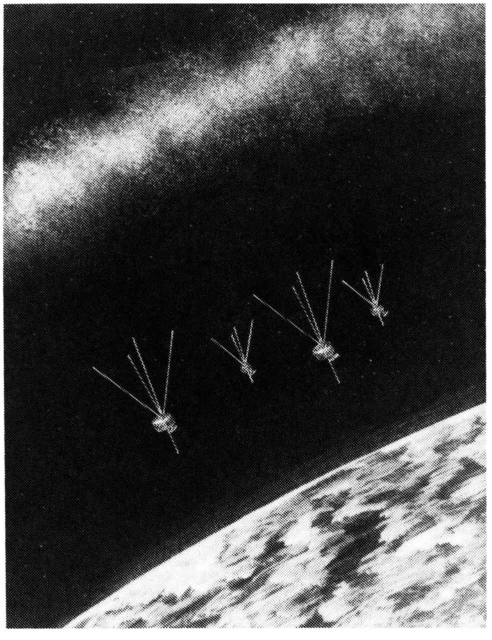
To obtain data at these frequencies requires the difficulty and expense of placing radio telescopes into Earth orbit, but the scientific rewards of a space mission are likely to be great. Even without considering the serendipitous discoveries which have always accompanied the opening of a new realm of frequency, resolution, or sensitivity in astronomy, a low frequency telescope in space can:

1. map the entire sky, with emphasis on the galactic background non-thermal emission, with high resolution and sensitivity;
2. determine the distribution of galactic diffuse ionized hydrogen by surveying its absorption to discrete background sources;
3. study of the interstellar plasma by investigating the origin, distribution, and magnitude of its scattering and refraction;
4. study individual source spectra for energy production mechanisms and such processes as synchrotron self-absorption, Razin-Tsytovich effect, HII absorption, inverse Compton scattering, and synchrotron losses;
5. study the origin of the correlation between low frequency steep spectrum clusters of galaxies and their enhanced x-ray emission;
6. search for "fossil" radio components in "radio quiet" objects and extend the counts of sources to the low frequencies where synchrotron lifetimes approach the age of the universe;

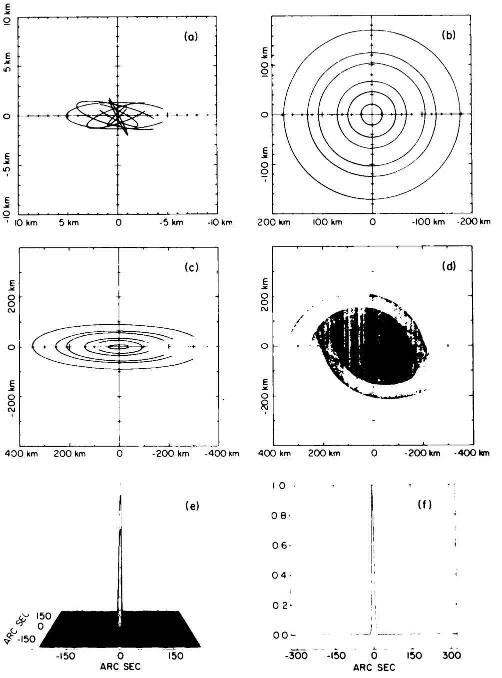
M. J. Reid and J. M. Moran (eds.), The Impact of VLBI on Astrophysics and Geophysics, 459–460.

7. image individual sources with high resolution (~10′ at ~1 MHz to ~5" at ~30 MHz) to investigate spectral index changes across source components and to search for extended halos;
8. study the impulsive emission from Jupiter and the Sun and search for similar radiation from other Solar System bodies; and
9. search for the coherent radiation found from Solar System bodies but undetected so far in larger systems.

A scientific justification and technical description has been developed for construction of a Low Frequency Space Array (LFSA) to carry out full sky mapping and individual source imaging between 1.5 and 26.3 MHz.



Artist's conception of the Low Frequency Space Array (LFSA) with four array elements.



Aperture plane coverage by a 4 element array for a source at RA = 6^h, Dec = 45^o for one orbit on (a) Day 1, (b) Day 180, and (c) Day 360. The total coverage during 1 year is given in (d) and the resulting beam pattern in (e). For a cross cut through the beam pattern better illustrating the sidelobe levels see (f).