SQUARE KILOMETER ARRAY–A UNIQUE INSTRUMENT FOR RADIO ASTRONOMY TO EXPLORE THE MYSTERIES OF COSMOLOGY

Raj Mittra
Electromagnetic Communication Laboratory, Pennsylvania State University
University Park, PA, 16802, USA
rajmittra@ieee.org

Abstract

The Square Kilometer Array (SKA) is a radio telescope, which will have a total collecting area of approximately one square kilometer. It will operate over a wide range of frequencies and its size will make it 50 times more sensitive than any other radio instrument. By utilizing advanced processing technology, it will be able to survey the sky more than ten thousand times faster than ever before. With receiving stations extending out to distance of 3,000 km from a concentrated central core, it will continue radio astronomy's tradition of providing the highest resolution images in all astronomy. The SKA will be built in a country, most likely in the southern hemisphere where the view of our own galaxy, the Milky Way, is best and radio interference least.

The SKA will be a highly flexible instrument designed to address a wide range of questions in astrophysics, fundamental physics, cosmology and particle astrophysics. It will be able to probe previously unexplored parts of the distant Universe. Some of the key science projects will include: Extreme tests of General Relativity; Galaxies, Cosmology, Dark Matter and Dark Energy; Probing the Dark Ages — the first black The Origin and Evolution of Cosmic Magnetism holes and stars; The Origin and Evolution of Cosmic Magnetism; and, Exploration of the Unknown.

The design of this array is currently progressing at a very fast pace, concurrently in several countries. The talk will discuss some of the challenges encountered in the design of the SKA and the antenna configurations being explored to meet them.

A description of the SKA project may be found in [1], and the interested reader may also refer to the various websites of SKA, including those of ASKAP in Australia and ASTRON in the Netherlands. We also mention that some innovative analysis techniques for large arrays that are tailored for the SKA project have been described in [2] and [3].

Before closing, the author would like to acknowledge the help of Mariana Ivashina of ASTRON, Netherlands, and Stuart Hay as well as John O’Sullivan of CSIRO in Australia, for helpful information on the SKA.

References

[1] J. O’Sullivan, F. Cooray, C. Granet, R. Gough, S. Hay, D. Hayman, M. Kesteven, J. Kot, A. Grancea, R. Shaw, “Phased array feed development for the australian SKA pathfinder,” USRI General Assembly, Chicago, 2008.

[2] S. G. Hay, J. D. O'Sullivan, R. Mittra, "Analysis of connected patch arrays using the characteristic basis function method," IEEE International Symposium on Antennas and Propagation (AP-S 2008), San Diego, California, Art. No. 4619541, 2008.
[3] W. Yu, X. Yang, V. Liu, L. Ma, T. Su, N. Huang, R. Mittra, R. Maaskant, Y. Lu, Q. Che, R. Lu, Z. Su, "A new direction in computational electremagnetics: solving large problems using the parallel FDTD on the BlueGene/L superconductor providing teraflop-level performance," IEEE Antennas and Propagation Magazine, Vol. 50, No. 2, pp.26-44, 2008.

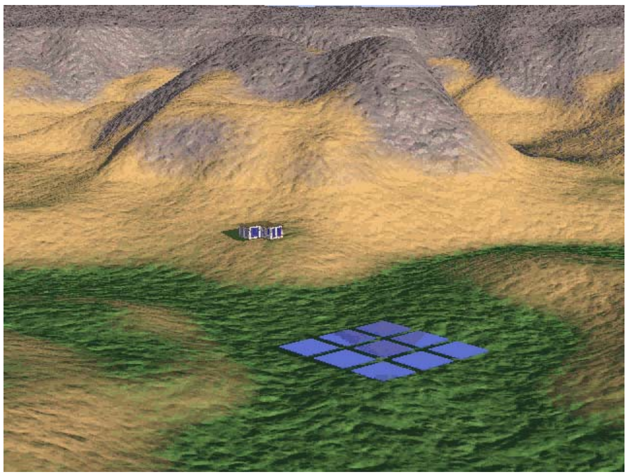

Figure 1: Antenna array technology is the heart of SKA.

Figure 2: Small dishes + wide-band feeds, USA.

Figure 3: Small dishes + wide-band feeds, USA.

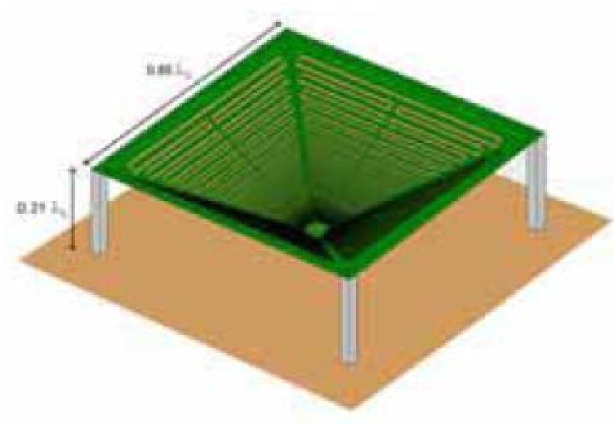

Figure 4: Small dishes + Focal Plane Arrays (FPAs), Australia, Canada.

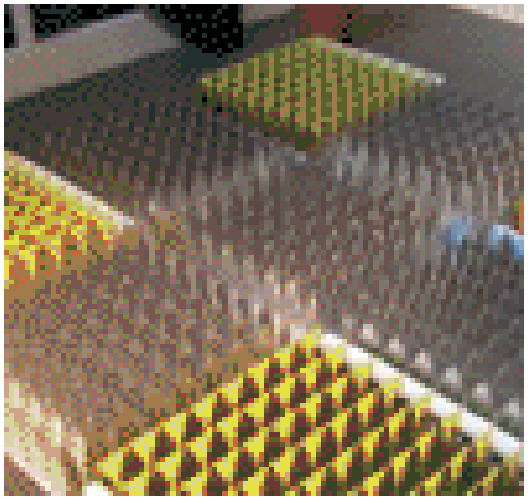

Figure 5: Aperture arrays, Europe.

Figure 6: 25000 antennas,
350 km in diameter.

Figure 7: 25000 antennas, 350 km in diameter.

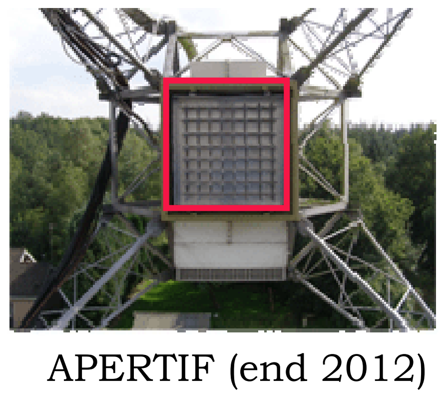

Figure 8: Focal Plane Arrays at WSRT

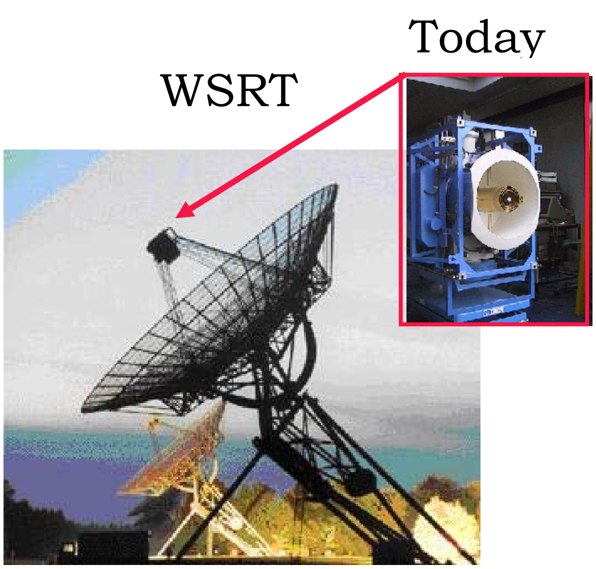

Figure 9: Focal Plane Arrays at WSRT

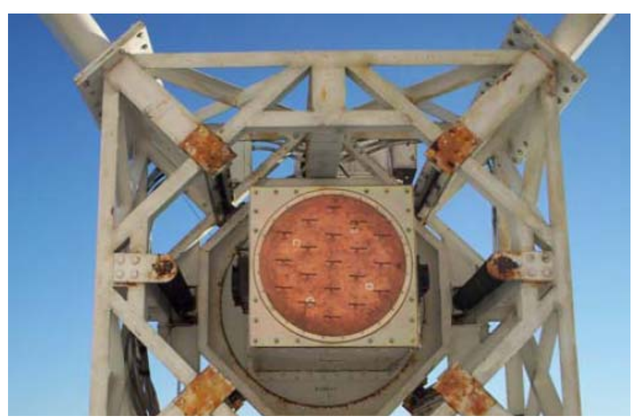

Figure 10: An innovative technology, Focal Plane Arrays. NRAO, USA

Figure 11: An innovative technology, Focal Plane Arrays. NRAO, USA

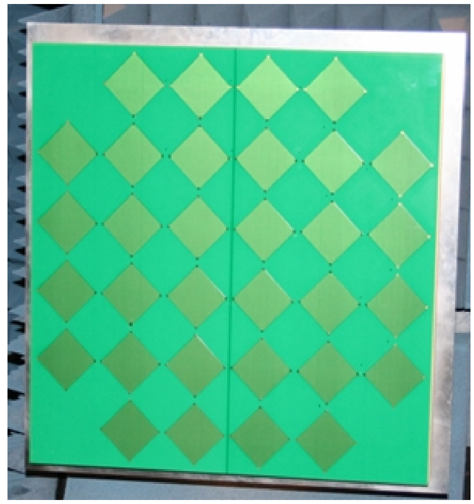

Figure 12: An innovative technology, Focal Plane Arrays. CSIRO, Australia.

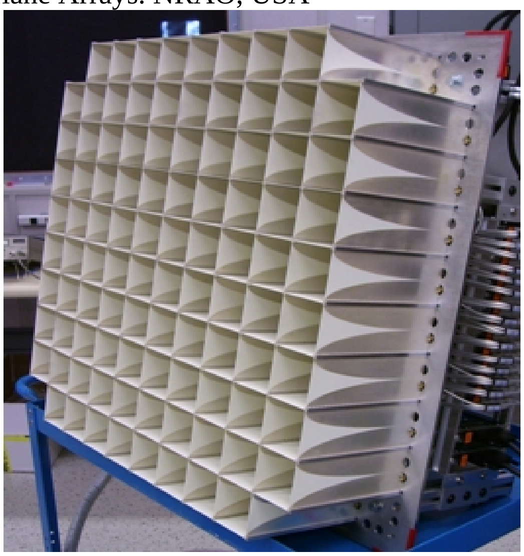

Figure 13: An innovative technology, Focal Plane Arrays. DRAO, Canada.

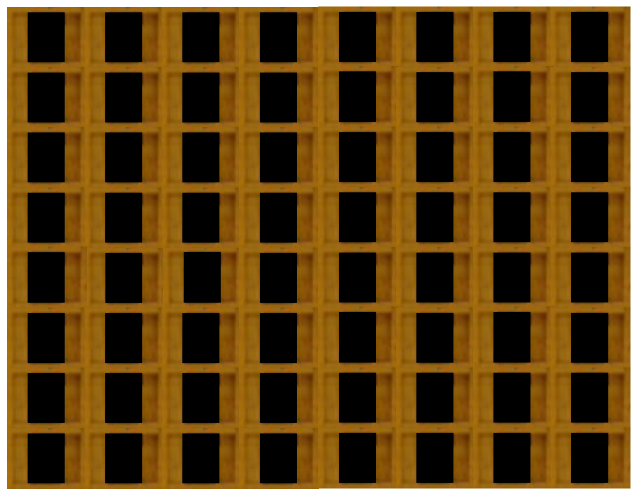

Figure 15: Array examples.

Figure 16: Array examples.

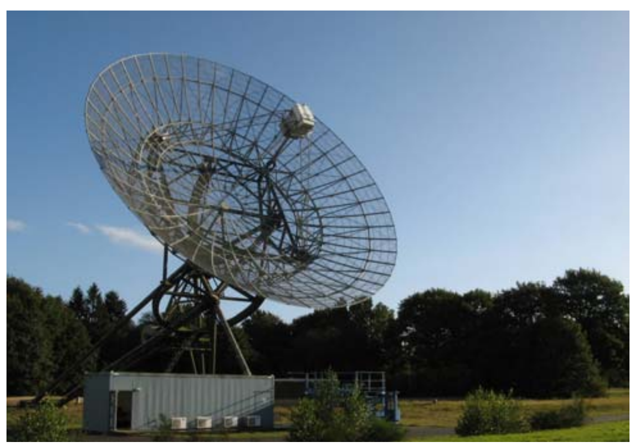

Figure 17: Array Examples.