Panorama of the Universe:
Daily all-sky surveys with the SKA

John D. Bunton, *CSIRO TIP,* **Ronald D. Ekers,** *CSIRO ATNF* and **Elaine M. Sadler,** *University of Sydney*

Introduction

Filled aperture antennas with electronic scanning can efficiently image large areas of sky. The cylindrical-reflector SKA concept proposes to image 96 square degrees of sky in one minute with a sensitivity of 6 μJy at 1.4 GHz (i.e. going deeper in 60 seconds than any existing radio telescope has so far probed). This would allow the entire sky (30,000 square degrees) to be imaged every day with unprecedented sensitivity. We discuss some of the possibilities this opens up for studies of supernovae, gamma-ray bursts, starburst galaxies, AGN, X-ray binaries, and extreme scattering events.

A daily all-sky survey at 1.4 GHz

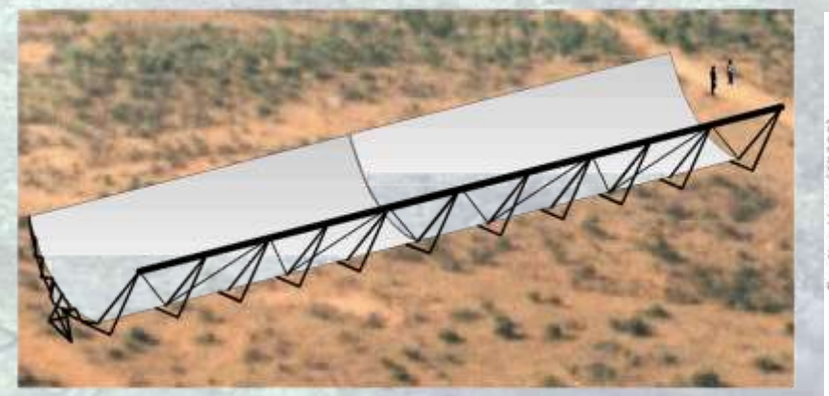
The cylindrical reflector concept has a 1.4 GHz field of view (FOV) of 120° by 1° at the input to the station beamformer. By reducing the bandwidth, much this FOV can be made available to the correlator. For a 400 MHz, bandwidth the FOV is 96 deg^2. In the proposed FX correlator, this FOV can be processed with the same hardware as the 64-beam, 600-station full bandwidth correlator.

A survey of the whole available sky (30,000 deg^2) can be done in less than 6 hours if one minute integration are used. This all-sky survey would have a (5σ) continuum sensitivity of 6 μJy, and would generally be unaffected by confusion.

The mechanical stress imposed by the survey is low: four 1.5 hour declination scans, with the reflector stepping one degree every minute.

Radio Supernovae and Starburst Galaxies

The peak radio emission from typical Type II supernovae will be detectable out to redshifts of z=0.2 to 0.5 with this survey, allowing a direct measurements of the supernova rate in starburst galaxies over this redshift range, in a way which is unaffected by dust. Longer integrations could be used to extend beyond z=0.5.



Proposed cylindrical reflector SKA antenna station as described by Bunton et al. [SKA memo 23]

X-ray Binaries

The survey will be able to detect the transient radio emission from individual black-hole X-ray binaries in galaxies throughout the Local Group.

Extreme Scattering events

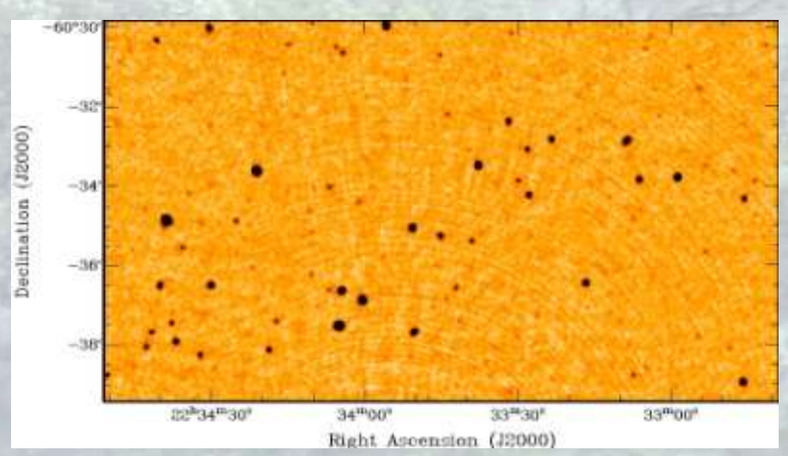
Characterising the radio-wave lenses which give rise to ESEs requires intensive monitoring programs on large numbers of compact sources. This survey will monitor the fluxes of thousands of quasars and pulsars on a daily basis.

Active Galactic Nuclei

The survey will be able to detect quasars, BL Lac objects and similar objects, out to high redshift, by their radio variability.

IDVs

It will also identify and monitor a large numbers of candidate intra-day variable (IDV) sources, whose rapid scintillation can be used to probe the structure of the ISM on scales of μarcseconds.



ATCA 1.4 GHz image of a region near the Hubble Deep Field South, [Minh Huynh (ANU) et al.] This is one of the deepest radio images ever made, with an rms noise level of 11 μJy after 700 hours. A cylindrical-reflector SKA would be able to image the entire sky to levels fainter than this in less than a day

Gamma Ray Bursts

This survey would be able to detect the unbeamed radio emission from 'orphan' bursts in which the jet of gamma-rays is pointed away from the observer. Radio afterglows of GRBs typically peak at flux densities of 100-300 μJy for objects at z=1-2, and can persist for weeks or months. Thus the survey will be able to detect and monitor the radio emission from GRBs out to redshifts as high as z=10.