Phase–I SKA: Summary of Science Case

The capabilities of the SKA will grow with time as additional elements are brought on line. Thus, the Phase-I SKA is not just a significant technical milestone, but also a facility capable of breakthrough science. We here distil its science case as published in SKA Memo 100[1]. We will adopt the most conservative Phase-1 SKA comprising 620 small (~15-m diameter) dishes, each with a wide-band (0.5–10 GHz) single-pixel feed, yielding more than 10-times the sensitivity of the eVLA, alongside a 100–500 MHz sparse aperture array, yielding more than 10-times the sensitivity of LOFAR. Dramatic improvements in the rate of delivery of scientific results will accrue if, as expected, the Phase-1 SKA mapping speed is transformed via the maturation of phased-array feed and dense aperture array technologies on the relevant timescale.

The headline scientific results achievable with the conservative Phase-1 SKA include

- A deep survey of neutral Hydrogen (HI) detecting galaxies to redshift z~2, yielding the first measurements of the cosmic evolution of the most abundant element in the Universe beyond the current local (z~0.2) limit.
- All-hemisphere HI surveys detecting ~10^7 galaxies to z~0.5 and delivering power spectra that, alongside Planck data and optical redshift surveys, will determine how galaxy bias influences constraints on the dark energy w parameter and the mass scale of neutrinos.
- Factors of many increase in the number of known pulsars that, together with an order-of-magnitude increase in timing precision, will allow the discovery and study of systems more exotic than the `double pulsar', and perhaps the first fully relativistic binary, yielding fundamental tests of General Relativity.
- A timing array of millisecond pulsars that is an order of magnitude more sensitive to gravitational waves than any current effort that, according to simulations, is expected to yield a robust detection of the background due to binary super-massive black holes
- All-hemisphere Faraday rotation surveys providing the first detailed maps of the magnetic field in the Milky Way, and, alongside SZ and X-ray surveys, providing the first measurements of the cosmic evolution of the magnetic field in galaxy clusters to z~2.
- Direct observation of giant Stromgren spheres around quasars at z~7 establishing how super-massive black holes contribute to the re-ionization of the Universe.
- Site-lines to hundreds of bright z~7-10 radio sources mapping out, via HI absorption, the evolution of the neutral gas in and between proto-galaxies in the Epoch of Re-ionization.
- New classes of expected transient sources: e.g., prompt and afterglow emission from Gamma Ray Bursts, gravitational wave sources (detected, e.g., by Advanced LIGO), coalescing neutron stars, and exoplanets via magnetospheric bursts.
- The chance of unexpected discoveries via the dramatic opening up of time-domain radio astronomy, most excitingly extra-terrestrial emitters.

[1] http://www.skatelescope.org/PDF/memos/100_Memo_Schilizzi.pdf