Cosmology Science Working Group

The Square Kilometre Array (SKA) is a global enterprise to build the largest scientific instrument on Earth, both in physical scale and in terms of the volume of data it will generate. Combining two telescope arrays located respectively in Australia and South Africa and managed from the SKA Organisation headquarters in the UK, the SKA promises to revolutionise our understanding of the universe. The primary role for the SKA is the potential to expand our view beyond the radio windows community, accessing signals in wide range of areas of physics, cosmology and astrophysics. Science working groups (SWGs) and Focus Groups (FGs) covering all these areas have been set up to further explore the SKA science case, providing a conduit for interactions between the SKA Organisation science team and the astronomical community. This banner provides a summary of the Cosmology Science Working Group.

The SKA will enable pioneering cosmological surveys, probing immense volumes of the Universe which to date have been unexplored at radio wavelengths. This will be done by observing emission in both radio continuum and the 21 cm spectral line of neutral hydrogen (HI). The positions in the radio sky of millions of galaxies, and intensity maps made by their collective HI emission, trace the large-scale structures of the Universe, which can reveal the form and growth of dark matter structures over time. Light travelling from distant galaxies is bent by the intervening dark matter, thus creating small shape distortions (weak gravitational lensing) that can be measured to detect this otherwise invisible component. These surveys will enhance our understanding of various epochs of cosmic history, including the dark energy component of the potential period of inflation, the dark ages of galaxy formation as well as the nature of gravity, dark matter and dark energy which determine the growth of late time large-scale structure.

**Cosmology Science Goals**

**DARK ENERGY**
- Investigate the nature of Dark Energy by measuring the expansion rate of the Universe at different times
- **DARK MATTER**
- Probe the nature of Dark Matter through its gravitational interaction with normal matter
- **MODIFIED GRAVITY**
- Test for deviations from General Relativity
- **HI EVOLUTION**
- Constrain the evolution of the abundance of neutral Hydrogen in the Universe for 0<z<6
- **DARK MATTER**
- Probe the nature of Dark Matter through its gravitational interaction with normal matter
- **NON-GAUSSIANITY**
- Detect imprints of inflationary physics at ultra-large scales

**Weak Lensing**

A statistical measurement of the shapes of millions of galaxies as a function of sky position and redshift enables us to track the abundance of these. This allows us to track the abundance of these structures and how they have grown. The combination of optical and radio weak lensing measurements will be crucial to detect this otherwise invisible component. These surveys will enhance our understanding of various epochs of cosmic history, including the dark energy component of the potential period of inflation, the dark ages of galaxy formation as well as the nature of gravity, dark matter and dark energy which determine the growth of late time large-scale structure.

**HI Intensity Mapping**

The mapping of the HI spectral line via integrating over multiple surveys within a 3D grid to create tomographic maps tracing the large-scale structure for each 3D grid. For SKA-MID, the HI intensity mapping survey will map on the “single-dish mode” of observation, such that the maps are adequate to reveal the largest wavelengths on the sky. Dark energy and neutrino mass constraints will be comparable with the flux from Stage IV surveys like Euclid.

**HI galaxy redshift survey**

The unique clustering properties of HI-detected galaxies provide a measure of large-scale structures that is complementary to optical surveys, while accurate distance measures coupled with peculiar velocities along the line of sight, enabled by the full/faster mission can probe modified gravitational physics and test General Relativity. The proposed Medium-every survey at 1 GHz will be done in conjunction with the SKA HI SWG, measuring the scientific return for a single survey.