Appendix A: Radio Astronomy Worksheet

Meerkat, the World Class Science Instrument

Figure 1: The Meerkat telescope that consists of sixty-four dishes and a precursor of the Square Kilometre Array (SKA). Image Credit: SARAO

The Meerkat radio telescope is an interferometric array based in the South African Karoo region in the Northern Cape province, also a precursor of the Square Kilometre Array. The array consists of sixty-four antennas conduct astronomical measurements from 580 MHz to 14.5 GHz, with a maximum baseline length of $\sim$8 km. Each antenna comprises the main reflector of 13.5 m effective diameter and a 3.8 m diameter sub-reflector.

The main reflector of a radio telescope collects the electromagnetic radiation from cosmic radio sources to the sub-reflector. Further, it transmits the radio waves to the feed horn of the receiver. All the antennas consist of up to four receivers and four digitizers and can be steered to the selected receiver observation frequency. The captured electromagnetic waves are then converted to a voltage signal and amplified by cryogenic receivers. The analog to digital converter within the digitizers converts the radio frequency voltage signals to the digital signals.

At the digitization stage, the signals are also sampled at a rate of 1 712 million samples every second; the signals are then sent to the correlator at the Karoo Array Processor Building (KAPB) using a total of 170 km fiber optic cables. To ensure proper alignment of signals from all receptors, the signals are synchronized to the same clock. The correlator coherently adds the signals from all the antennas to form several narrow, high sensitivity beams used for pulsar science. The data is stored at the KAPB, and some of the data is transferred to Cape Town via fiber connection. Several sensors (temperature sensors, weather conditions, power consumption, etc.)

Figure 2: Another photograph of the Meerkat radio telescope at the Karoo site. Image Credit: SARAO

are embedded in the telescope's control and monitoring system.

The Meerkat telescope's commissioning began in 2012 and was finished in 2018 at a specifically chosen site in the Karoo for its RFI-quiet environment and favorable physical site characteristics. The instrument has already given the world a glimpse into the star-formation history of the universe. The other science topics that Meerkat has or will reveal include "radio pulsar timing, Looking at the Distant Universe with the MeerKAT Array (LADUMA), MeerKAT Search for Molecules in the Epoch of Re-ionisation (MESMER), MeerKAT Absorption Line Survey, MeerKAT HI Observations of Nearby Galactic Objects: Observing Southern Emitters (MHONGOOSE), Transients and Pulsars with MeerKAT (TRAPUM), Galaxy formation and evolution in the cluster environment, MeerKAT High-Frequency Galactic Plane Survey (MeerGAL), MeerKAT International GigaHertz Tiered Extragalactic Exploration Survey (MIGHTEE), The Hunt for Dynamic and Explosive Radio Transients with MeerKAT (ThunderKAT), and Very Long Baseline Interferometry" according to SARAO.

The SKA SA has invested in the Northern Cape communities by funding, empowering, and encouraging the youth/learners to pursue science, technology, engineering, and mathematics fields, supporting local contractors and community programs.

The Meerkat project team acknowledges the South African Department of Science and Innovation, through the National Research Foundation and SARAO for investing more than R760 million in the precursor of the SKA.

Appendix B: EMC Chamber Worksheet

An enclosure used to shield electronic components/equipment from radio frequency interference (RFI) is called a Faraday cage. Faraday cages are also used for lightning protection against humans. The continuous covering of a mesh of conductive material may form a Faraday cage. The operation of a Faraday cage is caused by an external electric field, which causes the electric charges within the enclosure's conducting material to be distributed to cancel the field's effect in the interior of the cage.

A Microwave oven is a hybrid Faraday cage. The microwave glass window consists of a series of holes placed in a metal screen to act as one side of the Faraday cage. The energy given off by the electromagnetic pulse is kept in the microwave's three conductive metal walls and metal mesh viewing window.

In a radio telescope environment, someone can use it for performing RFI emission measurements from several electronic components/ equipment.

An anechoic chamber is a room covered with radiation absorbent material (RAM) to avoid the reflected RF radiation from surfaces. It is also designed in such a way that it shields inward intereferences.

A reverberation chamber is an environment/room for measuring equipment or systems' capability to perform adequately in their electromagnetic environment without introducing unbearable electromagnetic interference to anything in that environment. Stirrers are used in reverberation chambers to reduce the spatial dispersion of the electrical and magnetic field strength.

They can be used to enclose the device under test (antenna or radar) to measure the radiation pattern, gain, RFI, and performance under specified conditions.