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The Science and Technology of MeerKAT

Kenda Knowles[(1)]
(1) Centre for Radio Astronomy Techniques and Technology, Department of Physics and Electronics, Rhodes University, Makhanda, 6139, South Africa, e-mail: k.knowles@ru.ac.za

South Africa's Square Kilometre Array (SKA) mid-frequency precursor instrument, MeerKAT, is currently the most sensitive radio array at GHz frequencies in the Southern Hemisphere, expected to be surpassed only by the SKA itself. The 64-element dish array, described in detail in [1, 2] and which will eventually be subsumed by SKA1-mid, is located in a radio protected region of South Africa's Karoo desert and operates at UHF (580 – 1015 MHz), L (0.9 – 1.67 GHz), and S (1.75 – 3.5 GHz) bands. The 13.5-m diameter steerable dishes have fixed geographical positions, with three quarters of the array clustered within a 500-m radius core. The remaining 16 antennas are spread out around the core, providing a maximum baseline of 8 km. The arrangement of the antennas ensures MeerKAT has excellent sensitivity to extended structure (up to ~30 arcminutes at L band) while simultaneously able to resolve structures on scales of several arcseconds. MeerKAT makes use of advanced technologies which contribute to the sensitivity and varied usability of the telescope. Among these are a highly efficient offset Gregorian dish design that minimises system temperature and the influence of strong cosmic radio sources outside the primary field of view, and a sub-octave receiver system with two-stage Gifford-McMahon cryogenic cooling that further improves the instrument sensitivity and primary beam behaviour. The final MeerKAT specifications were informed by the science goals of ten Large-scale Survey Projects (LSPs) covering a wide range of research, from time domain topics to spectral and continuum studies. In addition to the LSPs, MeerKAT has carried out observatory-led programmes such as the MeerKAT Galaxy Cluster Legacy Survey [3] and has an open proposal system allowing for a diverse range of additional science projects to be conducted. The power of MeerKAT is apparent in the ever-increasing number of high quality science publications using its data which show a broad scope of research fields, with MeerKAT starting to help answer long-standing astrophysical questions (e.g., [4]) while raising many new ones due to its superb sensitivity (e.g. [5, 6]).

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