

MeerKAT: The South African radio telescope that's transformed our understanding of the cosmos

April 23 2024, by Ed Elson



Some of the satellite dishes that make up the MeerKAT. Credit: South African Radio Astronomy Observatory (SARAO)

South Africa's Karoo region is a vast semi-arid area that stretches across four of the country's provinces. It is sparsely populated and renowned for its wide open spaces.

In the heart of this landscape, near the small Northern Cape town of

Carnarvon, the [South African Radio Astronomy Observatory](#) operates a technological marvel that has transformed our understanding of the cosmos. The [MeerKAT radio telescope](#) has unlocked cosmic mysteries. It's fostered [scientific collaboration](#). It is also nurturing local talent.

MeerKAT, which is among South Africa's largest scientific infrastructure projects of the 30 year period since democracy, has emerged as a beacon of innovation and opportunity on the African continent. It comprises 64 dishes, each 13.5 meters in diameter, and is a precursor to the [Square Kilometer Array](#) (SKA) project. When it's fully up and running—[currently estimated to be in 2028 or 2029](#)—the SKA will be the world's most powerful radio telescope.

Over the past five years, MeerKAT has made remarkable contributions to both South African and international science. It possesses a unique combination of exceptional sensitivity and good resolution, enabling astronomers to study the universe in greater detail than ever before.

For instance, its prowess in detecting faint radio signals has led to groundbreaking discoveries in transient astronomy. This branch of astronomy deals with objects that have changing characteristics on relatively short timescales. In 2017, the telescope was involved with follow-up observations of the collision of two neutron stars. Multi-wavelength studies of this nature hold the key to better understanding these highly energetic events. This discovery has deepened our understanding of the universe's most energetic phenomena.

I'm an associate professor of astronomy in South Africa with a general interest in studying [galaxy formation](#) and evolution processes. Here are just four of MeerKAT's major breakthroughs that I've been involved in, and why the findings matter for our understanding of the universe.

Fascinating findings

In one project, MeerKAT was used to observe the center of our galaxy, the Milky Way. This [allowed our team to see](#) for the first time magnetic filaments that surround the [supermassive black hole](#) at the heart of our galaxy. A supermassive black hole is an extremely dense object with the mass of a million suns. Its gravity is so intense that not even light can escape its pull. The research provided valuable insights into the dynamic processes that shape the galactic environment.

MeerKAT has also spearheaded several galaxy surveys that are reshaping our understanding of cosmic evolution. The [Laduma](#), Mightee and [Mhongoose](#) surveys aim to map the distribution of galaxies and neutral hydrogen gas. They're also designed to study the properties of nearby and distant galaxies. These surveys do more than just expand our knowledge of the universe: they're also paving the way for future astronomical research.

One of the [most remarkable discoveries](#) to emerge from the Mightee project is the identification of giant radio galaxies—vast structures stretching across millions of light-years. These cosmic behemoths, powered by supermassive black holes at their centers, generate intense radio emission. This makes them visible to instruments like MeerKAT, whose unique capabilities have allowed for these impressive galaxies to be found and studied like never before.

One [intriguing discovery](#) made by the Laduma project is the detection of an OH megamaser. This is a cosmic amplifier powered by the intense radiation emitted by galaxies' active centers. It's among the most powerful sources of maser emission in the universe, capable of amplifying radio waves by factors of millions. The OH megamaser detected by Laduma is located in a distant galaxy. It offers valuable insights into the dynamics of galactic nuclei and the mechanisms driving their evolution.

The Mhongoose survey, meanwhile, [has revealed](#) a wealth of information about the distribution and properties of neutral hydrogen gas in nearby galaxies. Mapping the distribution of neutral hydrogen allows astronomers to trace the dynamics of galactic structures and uncover the hidden reservoirs of gas fueling star formation and galaxy growth. This information is crucial for understanding the complex interplay between gas, stars and dark matter in shaping the evolution of galaxies over cosmic time.

Growth and learning

Beyond its scientific impact, MeerKAT has become a driving force for human capital development in African astronomy.

Members of local communities around the site have [been employed](#) during both the construction and operation stages. [Engagements with those communities](#), and particularly with schools in the area, are breaking down barriers to participation in astronomy. This creates much-needed pathways for underrepresented groups to enter the field.

Through training programs and educational initiatives, MeerKAT is nurturing a new generation of African scientists and engineers, empowering them to pursue careers in science, technology, math and engineering fields so they can contribute to the global scientific community.

The project serves as a hub for international collaboration. It's attracted researchers from around the world to South Africa. For instance, I have been able to collaborate with astronomers from the UK, Australia, the Netherlands and the US.

And, thanks to initiatives like the [African Very Long Baseline Interferometry Network](#), MeerKAT is building capacity in radio

astronomy across the continent and positioning Africa as a leader in the field.

Given the many ground-breaking discoveries MeerKAT has already made, it promises to continue serving as a discovery machine that will push the boundaries of astronomical exploration into the SKA era.

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