MeerKAT

AR 1.5

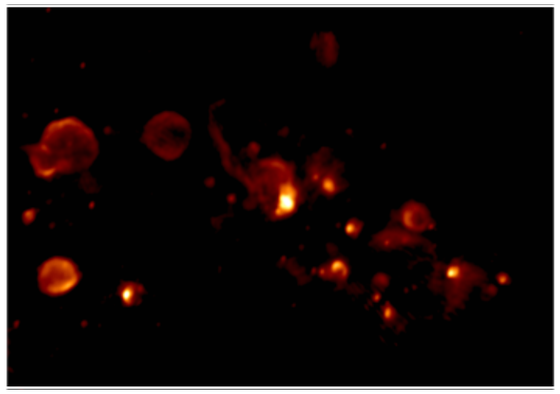
A STAR-FORMING REGION IN THE MILKY WAY

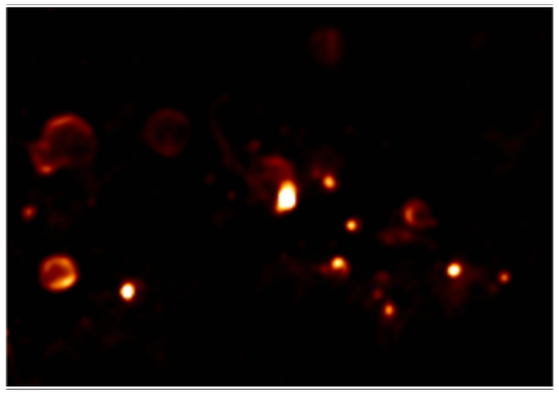
Stars are formed in the dense, dark molecular clouds found along the Milky Way. If you look up at the night sky you may notice some of these dark patches in the Milky Way. These areas light up at infrared and radio wavelengths. Newly born stars start heating up their natal molecular cloud, causing the dust and gas to glow.

The most massive stars of all give off copious amounts of ultraviolet light, which ionises the hydrogen gas in the cloud, which in turn gives off radio waves. These stars also have strong stellar winds, which start pushing the surrounding cloud outwards, forming large scale bubbles and arcs.

Here we see a small section of the Milky Way (an area approximately 25 times larger than that of the Moon), imaged with MeerKAT in April 2017 (left panel), compared to an equivalent observation made earlier by the Australia Telescope Compact Array (right panel). The MeerKAT image is sharper and more sensitive, showing some fainter features with additional detail not visible in the previous best image of this patch of sky.

Credit: Left: SKA South Africa's MeerKAT radio telescope. Right: CSIRO's ATCA radio telescope.



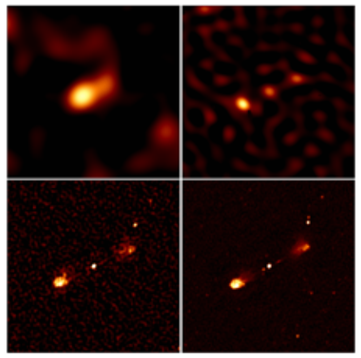


INCREASED OBSERVING POWER OF MEERKAT

A galaxy in the distant Universe imaged with ever better South African radio telescopes

This image shows the same black hole observed with increasingly improved arrays of antennas. What's visible is produced in the distant Universe by jets of particles accelerated by the black hole at the centre to near the speed of light. These jets can extend over millions of light years.

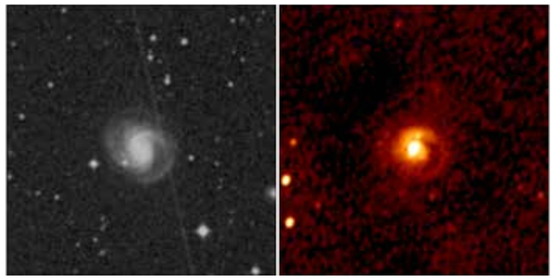
On the top left panel the black hole was observed with the KAT-7 telescope, the precursor to MeerKAT in the Karoo region of the Northern Cape. The top right shows the first view that MeerKAT had of the black hole, when the array consisted of merely 4 antennas. The bottom panels show the view MeerKAT has with 16 antennas: from the initial array release of June 2016 ("First Light" image) on the bottom left, and from the array of April 2017 on the bottom right. Notice the increased detail, and fainter features, that can be seen as the telescope improves. The radio jets span approximately 1/10th the diameter of the Moon.



DEEP2 SPIRAL GALAXY

First radio image of a spiral galaxy 230 million light years from Earth

In one small patch of the "DEEP2" field, MeerKAT's commissioning scientists have made the first ever radio image (right panel) of a spiral galaxy previously photographed in visible light (left panel; the streak is an image artifact). This spiral galaxy spans only 1/30th the size of the Moon, and appears to be much smaller than the famous M83 because it is 15 times farther from the Earth. Both the visible light on the left and the radio waves on the right left this galaxy 230 million years ago, as the first dinosaurs were roaming the Earth. As for M83, we expect that this galaxy contains neutral hydrogen well beyond the visible spiral disk of stars. What it looks like in detail awaits future MeerKAT observations.



Credit: optical data from the Digitized Sky Survey; radio data from SKA South Africa's MeerKAT telescope.

In March 2017 SKA South Africa achieved the integration of AR1.5, 32 antennas of the MeerKAT radio telescope with a single polarisation correlator

Front cover image credit: optical data from Palomar Observatory Sky Survey; radio data from SKA South Africa's MeerKAT

M83

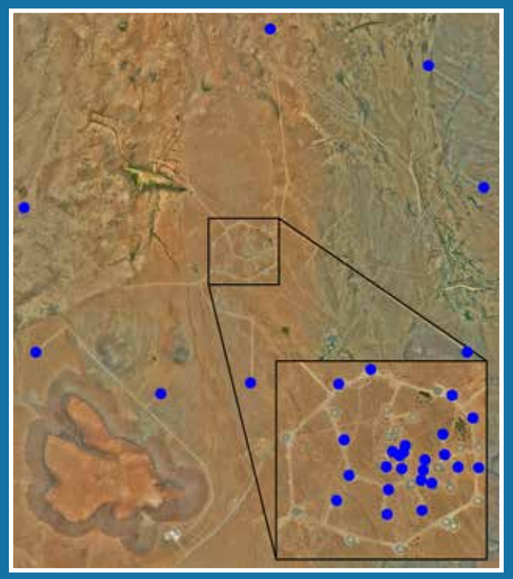
MeerKAT in the Northern Cape provides a magnificent view of the hydrogen gas in M83, a famous galaxy discovered in Cape Town in 1752.

In the image on the front cover, blue and green colours show star light – both from stars in our own Milky Way, and from the beautiful spiral galaxy M83, located about 15 million light years from Earth.

Red represents radio waves detected by MeerKAT at a wavelength of 21 centimetres in April 2017. These trace out the distribution of neutral hydrogen atoms in the galaxy – the fuel ultimately used to form new stars. Pink indicates the presence of both star light and hydrogen atoms.

The radio emission spans approximately 1 degree on the sky (twice the diameter of the Moon), much larger than the stellar core of the spiral galaxy.

While similar images have been made of this famous galaxy with other radio telescopes, it is remarkable that MeerKAT was able to do it using much less observing time, only seven 50-minute exposures. This exquisitely sensitive image of a galaxy discovered in Table Bay in 1752 points the way to numerous discoveries to come with SKA South Africa's MeerKAT.

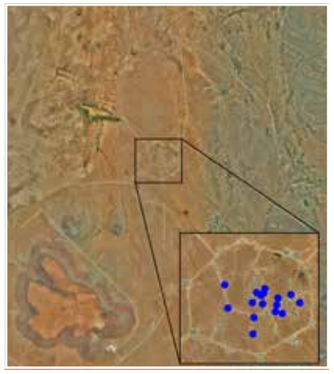


The 32 AR1.5 antennas include 24 in the core and 8 on "long baselines" (located approximately on a circle about 4 kilometres from the core). These 32 positions are indicated by the collection of blue dots. The square box, showing a zoomed-in version of the core of the MeerKAT array, is 1.2 kilometres on the side.

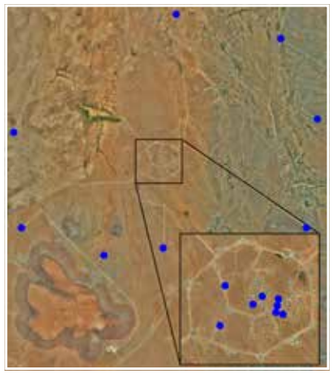
In March 2017, SKA South Africa achieved its target of a working MeerKAT array made up of 32 dishes and a single polarisation correlator (a specialised very powerful computer that combines signals from many dishes to make images of the radio sky) – the so-called Array Release 1.5 (AR1.5).

SEVERAL DIFFERENT MEERKAT ARRAY CONFIGURATIONS WERE USED TO MAKE THE IMAGES SHOWN HERE

The images of the M83 galaxy and the star-forming region in the Milky Way were made with 16 densely packed antennas in the core of the array.



The "DEEP2" observations, done at 900-1670 MHz, used 8 antennas in the 1-kilometre-wide core and 8 "long baseline" antennas.

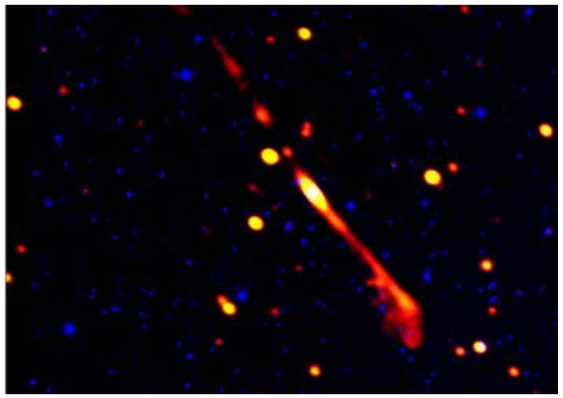


A GIANT RADIO GALAXY

MeerKAT identifies a new Giant Radio Galaxy

Most radio images of the sky show galaxies in the distant Universe. Unlike our Milky Way, many of these are "active" galaxies, with supermassive black holes at their centres ingesting surrounding gas while spewing powerful jets of electrons moving at close to the speed of light to vast distances, out into intergalactic space.

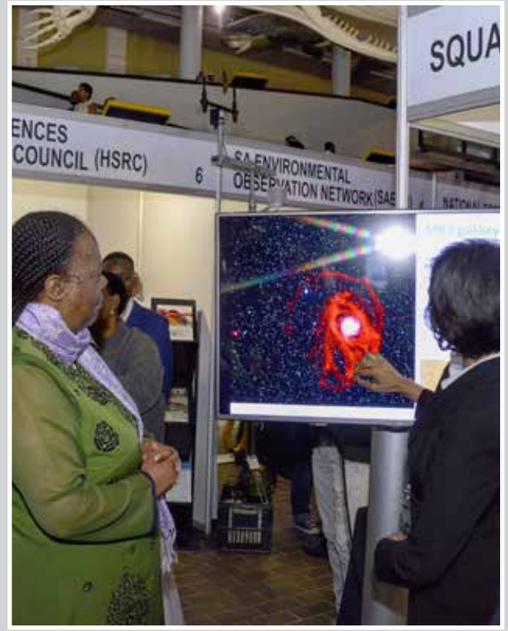
Such jets are typically detected using radio telescopes like MeerKAT. In a few instances, these jets and lobes of radio emission are truly gargantuan in size, even by astronomical standards.



This image shows infrared emission in blue and MeerKAT emission in orange (detected over the radio frequency range 900-1670 MHz). The linear radio feature running from upper left to lower right spans approximately 0.8 degrees. At the known distance of the galaxy at the centre, this corresponds to an enormous size of 4 million light years. (This compares to the 100,000-light-year diameter of our Milky Way galaxy, and the 2.5-million-light-year distance between the Milky Way and our nearest large neighbour, the Andromeda galaxy.) This size classifies this object as a Giant Radio Galaxy, the first such extreme galaxy identified by MeerKAT.

Credit: infrared data from NASA's Wide-field Infrared Survey Explorer; radio data from SKA South Africa's MeerKAT telescope.

The discovery age of MeerKAT has started, 265 years after M83 was discovered in Cape Town. These initial discoveries show that this superb telescope in the Karoo is poised to open a new window into our understanding of the Universe.



THE MINISTER OF SCIENCE AND TECHNOLOGY, NALEDI PANDOR, DELIVERED THE BUDGET VOTE OF THE DEPARTMENT OF SCIENCE AND TECHNOLOGY IN PARLIAMENT ON 16 MAY 2017.

Students sponsored by SKA South Africa and staff members were invited to attend in the gallery.

Prior to the Budget Vote, the Minister embarked on a tour of the exhibition at the Iziko Museum, where SKA South Africa joined other exhibitors for the showcase.

During the Minister's visit to the exhibition, SKA SA Head of Science Commissioning Dr Sharmila Goedhart presented to the Minister the recent AR1.5 results, images achieved by using various configurations of the 32 antennas currently operational in the Karoo.

This milestone of the integration of 32 antennas with a single polarisation correlator was achieved on schedule by the end of March 2017. The 32 antennas are part of an eventual 64 which are being built at the Karoo radio astronomy observatory site in the Northern Cape.

Among other images, Dr Goedhart presented to the Minister the view of the hydrogen gas in M83, a famous galaxy discovered in Cape Town in 1752, generated by MeerKAT. The image required only seven 50-minute exposures – achieving this detail and sensitivity much faster than any previous observations.

Minister Pandor congratulated SKA SA Managing Director "Dr Rob Adam and the entire SKA team" for reaching "another milestone with the integration of the 32 antennas", while noting that "75% of MeerKAT components have been sourced locally" in South Africa.