

SKA PROJECT DEVELOPMENT OFFICE



South Africa hopes to play host to a fascinating space project

Is there anyone out there?

PART 4
Space exploration

LEFT: An artist's impression of the SKA telescope antennae. This giant telescope will consist of about 3 000 dishes and possibly other antennae spread across a large area.

BELOW: The dishes of the KAT-7 radio telescope. It's built in a remote area of the Northern Cape between Carnarvon, Williston, Brandvlei and Vanwyksvlei where there are few man-made radio signals which can interfere with the telescope's operations.

EVERYTHING in the world – people, the air we breathe and the stars we see at night – is made up of atoms.

Atoms consist of protons, neutrons and electrons. Until fairly recently scientists thought everything in the universe was made up of this matter.

This week Marina Joubert of the South African SKA (Square Kilometre Array) project tells us more about SA's bid to build a giant radio telescope that will enable us to explore dark matter and energy in the universe.

The mysteries of the universe

Scientists are uncovering more evidence there are some things in the universe that we don't understand yet. Things we know for certain are:

- > Everything that can be detected and measured in the universe – including all life as we know it – makes up less than 5 per cent of it.
- > About 23 per cent of the universe consists of cold, dark matter.
- > The remaining 72 per cent is dark energy.

We don't yet understand how dark matter and dark energy work so there's a lot more about the universe that we don't know than what we know.

What is the SKA?

The SKA is a giant radio telescope that will help scientists investigate the 95 per cent of the universe that little is known about.

It will consist of about 3 000 antennae spread over a large area. The surface area of all these dishes added together would be about one square kilometre

(1 km²) – hence the name: Square Kilometre Array.

Remember one square kilometre is equal to one million square metres. To get an idea of how big this is try to imagine a million home satellite dishes together.

These dishes will be linked using fiberoptic cables so they can work as one telescope to explore the universe.

The SKA will be about 100 times more sensitive than current radio telescopes and will be able to take snapshots of the universe 10 000 times faster.

Engineers and astronomers from South Africa and 22 other countries such as Britain, America and the Netherlands are already working on the design of the SKA. Construction is expected to begin in 2016 and should be completed by 2024.

What will the SKA be used for?

Scientists across the globe are excited about the SKA because they expect the telescope will help them understand the universe a lot better.

No one knows exactly how big the universe is but it encompasses all the material and energy in existence. People have been studying the billions of galaxies, stars and planets in the universe for centuries but there are still plenty of unanswered questions such as:

- > how did the universe come into being and how big is it?
- > how are new galaxies formed?
- > what are black holes?
- > how does dark energy work and what is dark matter?
- > is there life on other planets in a galaxy far from ours?

Scientists believe the universe was formed after a huge explosion of concentrated matter and energy about 13,7 billions years ago. This event is known as the big bang. The remains of this explosion and others constantly taking place in the universe can be detected with sensitive telescopes and satellites.

A radio telescope can "turn back the universe's clock" to a time when the universe was very young. Capturing and deciphering these radio waves provides

a picture of what objects looked like billions of years ago when they were generated. The stronger and more sensitive the radio telescope the better it can detect weaker and older waves. A radio telescope could be thought of as a time machine.

The SKA will be powerful enough to "look back in time" until shortly after the big bang to help unravel the mysteries of how the universe was formed and how galaxies came into being and constantly change.

Galaxies are huge collections of stars, gasses and space matter held together by the force of gravity. There are billions of galaxies in the universe and they're constantly moving away from one another. The constant expansion of the universe can't be explained but the SKA could help to solve the mystery.

There's also the possibility the SKA will detect another life form – or the right conditions for the existence of life – elsewhere in the universe.

Will the SKA help advance technology?

Scientists say the SKA will be able to gather more data in a week than has been gathered over the past few centuries.

In addition the SKA's dish technology will enable it to collect about 50 times more data in a moment than what is distributed worldwide on the internet at that same moment. Processing and storing so much data will require a new generation of supercomputers.

Such sophisticated technology and instruments are expensive and could take a long time to



Naledi Pandor, Minister of Science and Technology, recently opened two science and computer laboratories at Carnarvon High School in conjunction with the SKA project and partners. Here Grade 11 learners (from left) Francois Baartman, Lee-Ann Snyders and Deowin Hoorn are busy with an experiment.

develop. It will be a challenge for engineers, programmers and scientists to keep the SKA project affordable and complete it on time.

The development of new expertise – especially among young South Africans and students from the rest of the African continent – is an important part of the SKA project.

Who will host the SKA?

SA is competing with Australia to host the SKA. The decision as to where it will be built will be announced in 2012.

Why does South Africa want to build the SKA?

With the SKA on South African

soil the country will be at the forefront of new knowledge and technology for years to come.

Local engineers and scientists will be part of international teams involved in pioneering work.

The best researchers in the fields of engineering, maths, physics and computer technology will come to South Africa to work with our experts.

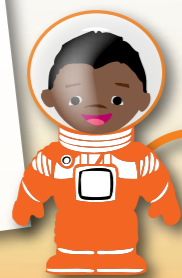
The project will bring new expertise and infrastructure to the whole of Africa.

"It will be like winning the World Cup of science," Dr Bernie Fanaroff, director of the South African SKA project, says.

(Turn over)

FAST FACT

The most common chemical element is hydrogen – it makes up 75 per cent of a star's matter.





LEFT: Groups of scientists and students often visit the site of the KAT-7 radio telescope, the MeerKAT's predecessor, in the Northern Cape.

- > Mathematicians develop new formulae to control the necessary instruments and systems constantly.
- > Technicians build new components for the telescope and maintain them.

Apply for a bursary

SKA South Africa wants to help young people become part of this project and has supported 293 researchers and students.

Learners who are interested must take mathematics and science as subjects and their results must be above average.

Information technology is also a good subject to choose.

Under and postgraduate students in astronomy, math, physics and engineering may also apply.

There are also bursaries available for tradesmen and technicians who enrol for specific courses. Visit www.ska.ac.za/students/bursaries.php to find out more. **S**

SCIENCE CONSULTANTS: ANITA LOOTS AND CASE RIJSDIJK

Where is the best place to build the SKA?

If South Africa wins the bid the core of the SKA will be built in the Northern Cape, in the remote area near Carnarvon, Williston, Brandvlei and Vanwyksvlei.

This region was chosen because there are few manmade radio waves broadcasting at the same frequency as those which the SKA will use.

The signals from cellphones, radar systems and other manmade radio transmitters are far stronger than the signals from deep space which a radio telescope attempts to pick up.

Too many local radio signals can interfere with a radio telescope and make it "deaf".

Fortunately South Africa has a law to protect parts of the Northern Cape for astronomical research.

This law will stop any developments that could hamper research by disturbing electromagnetic radiation across a wide range of frequencies.

Smaller SKA stations – each with about 20 dishes or other antennae – will be spread across Africa, up to 3 000 km from the core.

SKA stations may be built in countries such as Namibia, Botswana, Ghana, Kenya, Madagascar, Mauritius, Mozambique and Zambia.

What about the telescope under construction near Carnarvon?

South Africa is building a prototype telescope – the MeerKAT – about 100 km from Carnarvon.

MeerKAT will prove SA can build and use a world-class telescope and it will be a powerful radio telescope that will enable scientists to carry out top-notch research for years to come.

MeerKAT will consist of 64 dishes, each with a diameter of 13,5 m. A prototype called KAT-7 has seven dishes and it's being used to develop systems for MeerKAT.

Scientists have used it to obtain images of distant galaxies. MeerKAT will be ready for full research purposes in 2016.

What professions are involved in radio astronomy?

> Astronomers and astrophysicists plan the research and study

signals from radio telescopes and the universe is their laboratory.

> Engineers help to design and build the telescopes. They also develop the software and systems that allow a radio telescope to work.

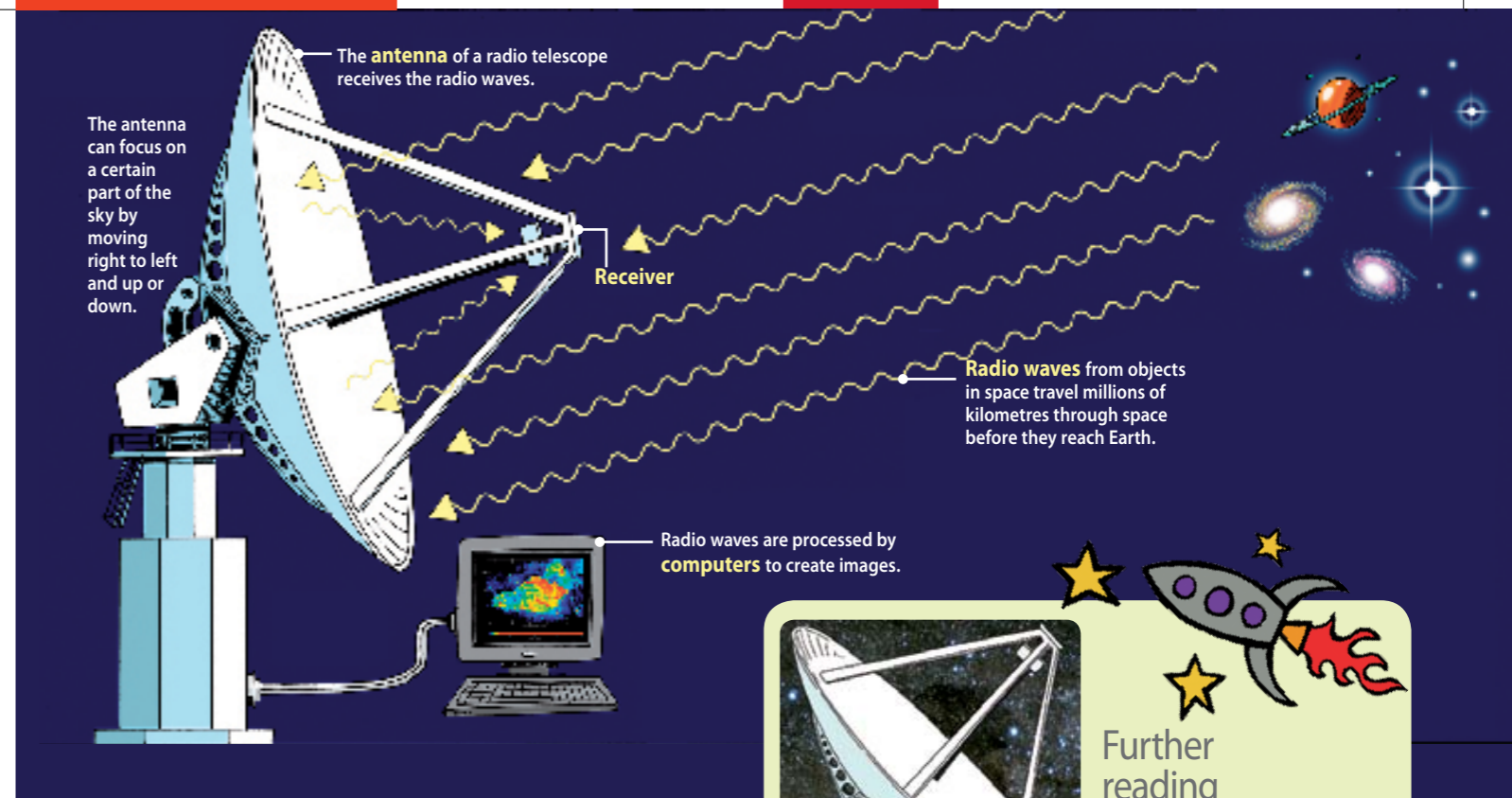
> Computer experts build the newest high-speed machines and write computer programs which translate the signals.

FRANK CURTOLLO



ABOVE: There are plenty of regular flights to whisk engineers and astronomers between the project office in Cape Town and the telescope building site in Carnarvon. The photograph shows Carnarvon from an aircraft about to land in the town.

KAT-7 TELESCOPE



HOW DOES A RADIO TELESCOPE WORK?

Just as you use your radio to listen to your favourite stations so scientists can use radio telescopes to pick up radio waves from objects millions of light years from Earth.

A radio telescope consists of two parts:

1 An antenna, which looks like a dish or saucer, is directed at the sky to receive radio signals. The concave surface of the dish reflects the waves to a point of focus. After that the waves are fed to a sensitive radio receiver.

2 The receiver amplifies the signal and converts it to figures which computers process into images.

ANDRECIA RAMNATH



ABOVE: A radio telescope has to be built in a dry area because too much moisture in the atmosphere can absorb the radio waves it detects. This is why the arid Karoo is an ideal place to build the SKA.

Further reading

The two Mission MeerKAT books document the adventures of Hanna, a girl from a small Karoo town, who learns more about radio astronomy from a meerkat and a jackal. Download the books from www.ska.ac.za/education/mkcartoon.php. The cartoons were created by Jive Media (www.jivemedia.co.za).

South Africa's SKA project is an initiative of the Department of Science and Technology (www.dst.gov.za).

For educators

Ask the learners to discuss the following:

- > what sort of telescope will the SKA be?
- > where does the name Square Kilometre Array come from?
- > what sort of research will be done using the SKA?
- > why is this telescope sometimes also called a time machine?
- > why can't the SKA be built near a large town?
- > which country is competing with South Africa to build the SKA?
- > how will it benefit South Africa to build the SKA here?
- > what school subjects should I choose if I want to become an astronomer or engineer?

Find out more

> Colourful posters showing our place in the universe, our solar system and the electromagnetic spectrum can be downloaded at www.ska.ac.za/education/materials.php

> Visit www.ska.ac.za for more information about the SKA project in South Africa and www.skatelescope.org for more on the world-wide project.