Square Kilometer Array Project

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Why is in news? What is the Square Kilometer Array project, significance of India joining it

The newyear ushered in the news that **India had decided to formally join the Square Kilometer Array (SKA) project**, an international scientific collaboration working to build the world's largest radio telescope.

About:

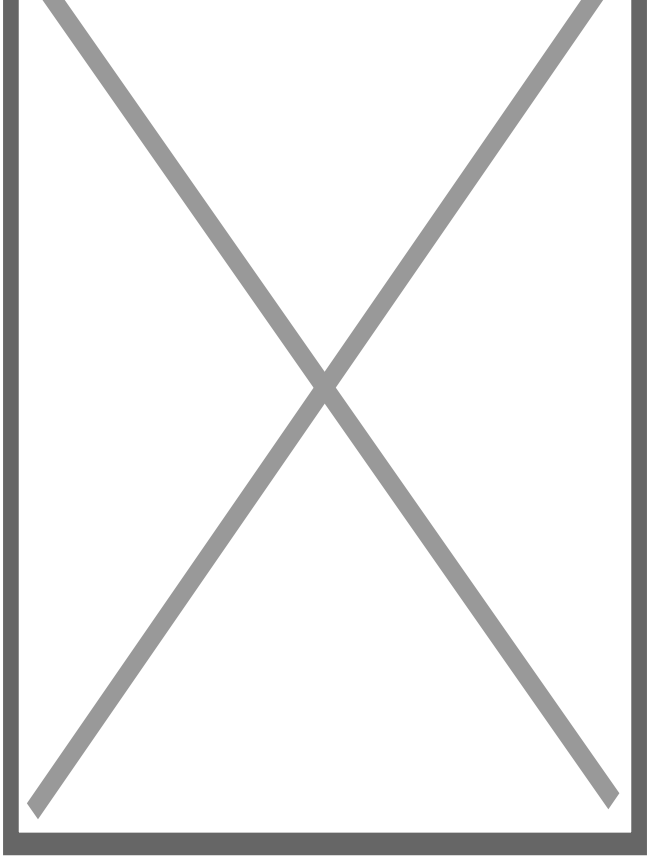
India had **already been contributing to the project** for the past several years, **but the full member status**, which offers greater scientific opportunities to use the upcoming facility, **requires countries to sign and ratify an international treaty, and also make a financial commitment**.

India has approved Rs 1,250 crore for the project, which includes its funding contribution for the construction phase.

The decision to join SKA as a full member ensures India's participation in yet another international mega science project in the most advanced areas of scientific research.

India has **already decided to build a gravitational wave detector** to **join the international LIGO** (Laser Interferometer Gravitational Wave Observatory) network, and is a **full member of the ITER project**, which is working to harness energy from nuclear fusion reactions.

India also has a **strong participation in the Large Hadron Collider** (LHC), the world's largest and most powerful particle accelerator that is running some of the most exciting experiments in particle physics.



SKA:

The Square Kilometer Array will **not be a single large telescope**, but a collection of thousands of dish antennas operating as a single unit.

The name, Square Kilometer Array, comes from the **original intention to create one square kilometre** (one million square metre) **of effective area for collecting radio waves**.

This was meant to be achieved by installing thousands of smaller antennas in a specific array design that would make them function like a single radio telescope.

As of now, it appears that the USD 2.4-billion project (2021 prices) would eventually have a lesser collecting area than one square kilometre, but the original name has been retained.

The antennas, about **200 of them in South Africa** and **more than 130,000 in Australia**, are being installed in sparsely populated locations, chosen to ensure they are as far away from human activities as possible.

This has been done in order to **minimise signal interference from undesirable Earth-based sources**.

Construction at both the sites began in December 2022, and the first phase of the project is expected to be completed by next year.

Once operational, SKA would be **between 5 to 60 times more powerful** than the most advanced existing radio telescopes functioning in comparable frequency ranges.

Scientific Objectives:

The SKA Observatory aims to address **fundamental questions in astrophysics, cosmology, and astrobiology**.

These include the nature of dark matter and dark energy, the origins of cosmic magnetism, and the search for extraterrestrial intelligence (SETI).

Understand the birth of the Universe.

Detect Gravitational Waves.

A gravitational wave is an invisible ripple in space.

Understand the evolution of Galaxies, Dark matter and

Cosmic Magnetism.

The SKA project **drives technological innovation** in several areas, including high-performance computing, signal processing, and data management.

The sheer volume of data generated by the telescope requires advanced computational capabilities and storage solutions.

Advantages for India in joining this project:

Though **none of the SKA facilities would be located in India**, there are **immense science and technology gains** for the country by participating in the project as a full member.

In this regard, SKA offers opportunities similar to the LHC or the ITER, which too are located on foreign soil but have brought rich dividends to the Indian scientific community.

Radio astronomy is something in which India already has highly developed capabilities.

The **Giant Meterwave Radio Telescope (GMRT) near Pune** is one of the most advanced — and sought-after — facilities in the world, which has been producing remarkable scientific results. There are other similar facilities in **Ooty, Nainital and Bengaluru**.

The SKA, which will become the most promising tool for research in the most pressing scientific questions in astronomy, offers the next logical step forward for Indian scientists working in this area.

A full member status would **provide India preferential access** to the SKA facilities.

Most existing telescopes operate **under an open-use policy** which allows research groups from any country to get time on the facility through competitive bidding by making a scientific case. This is how the GMRT also works.

But there is a growing argument that countries that contribute to building any large international project should have priority access to that facility. This is likely to be the case with the SKA.

Member countries will get preferential allocation of time on the radio telescope, roughly in proportion to their contribution to the project, and only limited time slots would be available through competitive bidding.

There are **technology benefits** as well.

The SKA would **work on highest-end technologies**, including electronics, software, materials science and computing.

The intellectual properties generated by the project, though owned by the SKA Observatory, would be accessible to all the member countries. This can offer **huge learning opportunities** for scientists, academics and even private industry.

Participating in the project is also **expected to result in expanding the science and technology base** in this area, along with capacity building and training opportunities.

The Indian participation in the project is being **led by Pune-based National Centre for Radio Astrophysics** (NCRA), but **22 institutions are collaborating on SKA-related activities** in the country.

These include not just leading research institutions and some IITs and IISERs, but also a couple of universities and colleges. A few private companies are also involved.

India's involvement:

India has been involved in the SKA project right from its inception in the 1990s, and **contributed to the design and development** of the telescope as well as in **negotiating the SKA Observatory Convention**, the international treaty that established the facility as an intergovernmental organisation.

The main contribution has come in the development, and operation, of the Telescope Manager, the 'neural network' or the software that will run the entire facility.

There are **plans to set up an SKA regional centre in the country** that will be part of the global network to process and store data and make it available for the scientific community.

Indian scientists have **identified several areas of research** for which they want to use the SKA telescopes.

These include studies relating to the evolution of the early universe, the formation and evolution of galaxies, neutron star physics, and solar sciences.

More than 150 scientists, researchers, and students from over 30 different Indian institutions, including a few private companies, have been participating in ongoing science activities related to the SKA.

Square Kilometre Array Observatory (SKAO):

SKAO is an **intergovernmental organization** that aims to **build and operate cutting-edge radio telescopes**.

Its global headquarters is located in the **Jodrell Bank Observatory, United Kingdom**.

The project will not have a single telescope but an array of thousands of antennas, to be installed in remote radio-quiet locations in South Africa and Australia, that will operate as one large unit meant to observe and study celestial phenomena.

SKAO objectives also include study of gravitational waves.

Some of the countries taking part in building the SKA include the **UK, Australia, South Africa, Canada, China, France, India, Italy and Germany**.

Radio Telescope:

A radio telescope is a specialized type of antenna and receiver system used to **detect and collect radio waves emitted by celestial objects**.

Radio waves are EM (Electromagnetic) waves that have wavelengths between 1 millimeter and 100 kilometers.

Unlike optical telescopes, radio telescopes can be **used in the daytime as well as at night**.

Major Radio Telescopes:

Giant Metrewave Radio Telescope - India

SARAS 3 - India

Atacama Large Millimetre/submillimetre Array (ALMA) - Atacama Desert, Chile

Five-hundred-metre Aperture Spherical Telescope (FAST) - China

Conclusion:

India’s participation in the Square Kilometre Array Observatory project goes beyond scientific exploration, offering opportunities for technological advancement, global collaboration, skill development, and the enhancement of India’s standing in the international scientific community.