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A peek into the cosmic dawn from the Australian outback

V. Sridhar

A night-time view of an MWA tile in the Australian outback. The MWA project is the precursor to the much more ambitious and futuristic Square Kilometre Array project, which will reveal much about the dawn of the universe and provide answers to other age-old scientific questions. Photo Credit: Pete Wheeler, International Centre for Radio Astronomy Research, Perth, Australia.

The Murchison Widefield Array in the Australian outback. The MWA project is the precursor to the much more ambitious and futuristic Square Kilometre Array project, which will reveal much about the dawn of the universe and provide answers to other age-old scientific questions. Photo Credit: Curtin University, Australia.

Brian Schmidt.

One of modern science's great quests, the endeavour to take a peek at the "cosmic dawn" of the universe 13 billion years ago – about 600 million years after the Big Bang – is now closer at hand. The window to "view" the dawn, when the first sources of light in the universe originated in the form of the first stars, quasars and galaxies, has been made possible by a unique radio telescope project, the Murchison Widefield Array (MWA) located deep in the Australian outback, 800 km north of Perth. The project, undertaken by a consortium of research institutions from the host country, the US and the Raman Research Institute (RRI) in India seeks to answer these and other great puzzles that have baffled humanity for long.

In fact, the MWA is not a single telescope but a network of 2,048 dipole antennas, which are arranged in an array of 128 'tiles' with each tile consisting of 16 antennas. Scaled down from the original plans for a 512-tile array, the project has cost the consortium A$51 million (about Rs. 300 crores). The RRI played a crucial role by designing and developing the digital receivers, the hardware that is critical for the radio telescope.

A radio-quiet zone

"The sparsely populated Murchison area is also radio-quiet, which is critical for the project," says N. Udayashankar, a scientist at the RRI. The area has a population density of less than one person per square km, compared to about 36,000 persons per sq km. in Maharashtra.

Ravi Subrahmanyan, Director, RRI, says the institute was a natural choice for the project because of its "decades-long history in low radio frequency radio astronomy." The antennas sense electromagnetic fields and are passed on to the digital receivers, which are capable of high-speed sampling of the data as it comes in, he explains. "The receivers are basically special-purpose computers," Prof. Subrahmanyan says. A correlator or a central station, which is located a few kilometres from the telescope, "compares" the data from the 128 tiles to determine the nature and distribution of the radiation in the sky.

Brian Schmidt, who won the Nobel Prize for Physics in 2011, for his contribution to the discovery that the universe is expanding at an accelerating rate, not decelerating as previously thought, told The Hindu that "very few groups in the world have the expertise in the high-speed digital electronics that has been achieved by scientists at the RRI." Prof. Schmidt, a member of the MWA board, has guided the project since its inception in 2005, said, "The RRI has filled a hole in the project."

Telescope of the future

"The MWA project is a major step in the evolution of radio astronomy. It is new breed, which enables the harnessing of the power of computers rather than using large dishes as we used to do earlier," says Prof. Schmidt. "It is the precursor of the telescopes of the future," he points out.

"Galaxies make up the universe just as bricks make a house," explains Prof. Subrahmanyan, who did his doctoral thesis under the supervision of GovindSwarup, a pioneer of radio astronomy. "Telescopes such as the MWA can give us clues about the hows and whys of the origin of the universe," he observes.

Answering age-old questions

Asked if there is much point in undertaking this painstaking work and at high cost, Prof. Schmidt says: "Ten year olds from all over the world want to understand our place in the universe. Basically, we are trying to figure out how nothing became the world around us as we know it now," says Prof. Schmidt. "The first reason for seeking a look at the cosmic dawn is because it is such an important part of our humanity," he adds.

Prof Schmidt argues that scientific quests can lead to unexpected benefits as spinoffs. He refers to John O'Sullivan's search for "evaporating black holes," which led to the development of wi-fi, which drives much of the Internet use today.

A bigger project

But the MWA is only a precursor to a much bigger scientific enterprise, the Square Kilometre Array (SKA), which is a much bigger array of antennas to be located in Australia (close to the Murchison site) and in South Africa. India is only an associate member in this 20-member consortium. The project, which is expected to commence in 2024, is expected to cost $2 billion. "India as one of the leading radio astronomy powers of the world should become a full member in this project," says Prof. Schmidt.

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