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ALMA TELESCOPE: A NEW BRAIN!

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The Atacama Large Millimetre/submillimetre Array (ALMA) — a radio telescope comprising 66 antennas located in the Atacama Desert of northern Chile — is set to get software and hardware upgrades that will help it collect much more data and produce sharper images than ever before, the journal Science reported recently. It added that the upgrades would take around five years to finish and cost $37 million.

Modernization of ALMA and increase in efficiency

The most significant modernisation made to ALMA will be the replacement of its correlator, a supercomputer that combines the input from individual antennas and allows astronomers to produce highly detailed images of celestial objects.

"Today, ALMA's correlators are among the world's fastest supercomputers. Over the next 10 years, the upgrade will double and eventually quadruple their overall observing speed," said the National Research Council of Canada (NRC), whose Herzberg Astronomy and Astrophysics Research Centre will work along with the U.S. National Science Foundation (NSF) National Radio Astronomy Observatory (NRAO), Massachusetts Institute of Technology (MIT) Haystack Observatory and a Canadian industry partner to upgrade the telescope's "brain".

Participating Countries in ALMA

As ALMA is operated under a partnership among the United States, 16 countries in Europe, Canada, Japan, South Korea, Taiwan, and Chile, the announcement came after all the partners cleared the funding re-

quired for the improvements. Fully functional since 2013, the radio telescope was designed, planned and constructed by the US's National Radio Astronomy Observatory (NRAO), the National Astronomical Observatory of Japan (NAOJ) and the European Southern Observatory (ESO). Over the years, it has helped astronomers make groundbreaking discoveries, including that of starburst galaxies and the dust formation inside supernova 1987A.

What is ALMA?

ALMA is a state-of-the-art telescope that studies celestial objects at millimetre and submillimetre wavelengths — they can penetrate through dust clouds and help astronomers examine dim and distant galaxies and stars out there. It also has extraordinary sensitivity, which allows it to detect even extremely faint radio signals.

As mentioned before, the telescope consists of 66 high-precision antennas, spread over a distance of up to 16 km.

"Each antenna is outfitted with a series of receivers, and each receiver is tuned to a specific range of wavelengths on the electromagnetic spectrum. The antennas can be moved closer together or farther apart for different perspectives – like the zoom lens of a camera. The result is magnificent, never-before-seen imagery of deepest, darkest space," according to a report published by Science Node. Producing a single image from all the antennas is done by the correlator, it added.

Why is ALMA an interferometer?

ALMA is a single telescope of revolutionary design, composed initially of 66 high-precision antennas, and operating at wavelengths of 0.32 to 3.6 mm. Its main 12-metre array has fifty antennas, each measuring 12 metres in diameter, which together act as a single telescope — an interferometer.

Science with ALMA

ALMA is the most powerful telescope for observing the cool Universe molecular gas and dust. ALMA studies the building blocks of stars, planetary systems, galaxies and life itself. By providing scientists with detailed images of stars and planets being born in gas clouds near our Solar System and detecting distant galaxies forming at the edge of the observable Universe which we see as they were roughly ten billion years ago it lets astronomers address some of the deepest questions of our cosmic origins.

ALMA goals

Discovery of star formation, molecular clouds and the early universe.

What is the Atacama Large Millimeter/submillimeter Array (ALMA)?

High on the Chajnantor plateau in the Chilean Andes, the European Southern Observatory (ESO) together with its international partners, is operating the Atacama Large Millimeter/submillimeter Array (ALMA) a state-of-the-art telescope to study light from some of the coldest objects in the Universe. This light has wavelengths of around a millimetre, between infrared light and radio waves, and is therefore known as millimetre and submillimetre radiation.

What is submillimetre astronomy?

Light at these wavelengths comes from vast cold clouds in interstellar space at temperatures only a few tens of degrees above absolute zero, and from some of the earliest and most distant galaxies in the Universe. Astronomers can use it to study the chemical and physical conditions in molecular clouds, the dense regions of gas and dust where new stars are being born. Often these regions of the Universe are dark and obscured in visible light, but they shine brightly in the millimetre and submillimetre part of the spectrum.

Why is ALMA located in Chile's Atacama Desert?

ALMA is situated at an altitude of 16,570 feet (5,050 metres) above sea level on the Chajnantor plateau in Chile's Atacama Desert as the millimetre and submillimetre waves observed by it are very susceptible to atmospheric water vapour absorption on Earth. Moreover, the desert is the driest place in the world, meaning most of the nights here are clear of clouds and free of light-distorting moisture — making it a perfect location for examining the universe.

"For travelling from Japan, it takes 40 hours to get to the ALMA site in Chile including connection time. In spite of such a long distance, the selected site is still the ultimate observing site on Earth with ideal conditions for the ALMA telescope", the telescope's website said.

What are some of the notable discoveries made by ALMA?

With ALMA's capability of capturing high-resolution images of gas and dust from which stars and planets are formed and materials that could be building blocks of life, scientists are trying to find answers to age-old questions of our cosmic origins. One of the earliest findings came in 2013 when it discovered starburst galaxies earlier in the universe's history than they were previously thought to have existed. "These newly discovered galaxies represent what today's most massive galaxies looked like in their energetic, star-forming youth", NRAO said in a statement.

Next year, ALMA provided detailed images of the protoplanetary disc surrounding HL Tauri — a very young T Tauri star in the constellation Taurus, approximately 450 light years from Earth — and "transformed the previously accepted theories about the planetary formation", ESO said.

In 2015, the telescope helped scientists observe a phenomenon known as the Einstein ring, which occurs when light from a galaxy or star passes by a massive object en route to the Earth, in extraordinary detail. More recently, as part of the Event Horizon Telescope project, a large telescope array consisting of a global network of radio telescopes, it provided the first image of the supermassive black hole at the centre of our own Milky Way galaxy. The image was unveiled by scientists in May 2022.

Expected Question

Que. Consider the following statements-

1. Expansion of plateaus is found on 33% of the entire surface.
2. Chaznantor Plateau is located in Atacama Desert (Chile).

Which of the statements given above is/are correct?

(a) Only 1

(b) Only 2

(c) Both 1 and 2

(d) Neither 1 nor 2

Answer : C

Mains Expected Question & Format

Que.: What is ALMA? Explain with examples the importance of ALMA in the exploration of outer space.

Answer Format :

- Write about ALMA.
- Explain ALMA with examples.
- Write the importance of ALMA in the exploration of outer space.
- Conclude accordingly.

Note: - The question of the main examination given for practice is designed keeping in mind the upcoming UPSC mains examination. Therefore, to get an answer to this question, you can take the help of this source as well as other sources related to this topic.