GMRT in Pune help to detect a radio signal from atomic hydrogen in an extremely distant galaxy

January 20, 2023

In news– Astronomers from Canada and India have used data from the Giant Metrewave Radio Telescope (GMRT) in Pune to detect a radio signal originating from atomic hydrogen in an extremely distant galaxy.

About the radio signal-

- The **astronomical distance over which such a signal has been picked up is the largest so far by a large margin**. This is also the **first confirmed detection of strong lensing of 21 cm emission from a galaxy.**
- **Atomic hydrogen is the basic fuel required for star formation in a galaxy**.
- **When hot ionised gas from the surrounding medium of a galaxy falls onto the galaxy, the gas cools and forms atomic hydrogen**, which then becomes molecular hydrogen, and eventually leads to the formation of stars.
- Therefore, understanding the evolution of galaxies over cosmic time requires tracing the evolution of neutral gas at different cosmological epochs.
- **Atomic hydrogen emits radio waves of 21 cm wavelength, which can be detected using low frequency radio telescopes like the GMRT.**
- Thus, 21 cm emission is a direct tracer of the atomic gas content in both nearby and distant galaxies.
- However, this radio signal is extremely weak and it is nearly impossible to detect the emission from a distant

galaxy using current telescopes due to their limited sensitivity.

- Until now, the most distant galaxy detected using 21 cm emission was at redshift z=0.376, which corresponds to a look-back time – the time elapsed between detecting the signal and its original emission – of 4.1 billion years (Redshift represents the change in wavelength of the signal depending on the object's location and movement; a greater value of z indicates a farther object)
- Using GMRT data, researchers at the Department of Physics and Trottier Space Institute of McGill University, and Nirupam Roy, Associate Professor, Department of Physics, IISc, have detected a radio signal from atomic hydrogen in a distant galaxy at redshift z=1.29.
- Due to the immense distance to the galaxy, the 21 cm emission line had redshifted to 48 cm by the time the signal travelled from the source to the telescope.
- **The signal detected by the team was emitted from this galaxy when the universe was only 4.9 billion years old; i**n other words, the look-back time for this source is 8.8 billion years.
- **This detection was made possible by a phenomenon called gravitational lensing,** in which the light emitted by the source is bent due to the presence of another massive body, such as an early type elliptical galaxy, between the target galaxy and the observer, effectively resulting in the **"magnification" of the signal.**
- **The team also observed that the atomic hydrogen mass of this particular galaxy is almost twice as high as its stellar mass.**
- These results demonstrate the feasibility of observing atomic gas from galaxies at cosmological distances in similar lensed systems with a modest amount of observing time.
- It also opens up exciting new possibilities for probing the cosmic evolution of neutral gas with existing and

upcoming low-frequency radio telescopes in the near future.

- Here, ‘Redshift’ refers to the change in wavelength of the signal depending on the object’s location and movement. Furthermore, the greater the value of z, the farther the object is.
- GMRT is a low-frequency radio telescope that helps investigate various radio astrophysical problems ranging from nearby solar systems to the edge of the observable universe.

Further reading: https://journalsofindia.com/giant-metrewave-radio-telescope-gmrt/