INSTITUTE OF ASTRONOMY
PUBLIC OPEN EVENING

— 30 November 2022 —

Non-detection teaches astronomers about early galaxies

Researchers led by the University of Cambridge were able to use data from India's SARAS3 telescope to observe the universe as it appeared only 200 million years after the Big Bang.

The signal of interest was the 21cm hydrogen line, which is the spectral line created by a change in the energy state of neutral hydrogen ions. This signal is useful in observations as its frequency allows it to penetrate through dust clouds. It provides a more complete map of hydrogen than stars themselves, as the visible light from stars is obscured by these dust clouds.

Researchers did not observe the 21cm signal, allowing them to determine that early galaxies cannot have been efficient producers of radio emissions and bringing us closer to determining how the universe went from having almost no stars to being full of them (rough estimates suggest there are 200 billion trillion stars in the universe). "Our analysis places limits on some of the key properties of the first sources of light including the masses of the earliest galaxies and the efficiency with which these galaxies can form stars. We also address the question of how efficiently these sources emit X-ray, radio and ultraviolet radiation" said co-lead author Dr Anastasia Fialkov from Cambridge's Institute of Astronomy.

This study conducted with SARAS3 data is the first study in which radio observations of the 21cm signal have been used to investigate the properties of the first galaxies by placing limits on certain properties. It indicates that the first galaxies must have been efficient at heating hydrogen gas. The first stars and galaxies are therefore likely to have made a significant contribution to the cosmic background radiation.

"It's amazing to be able to look so far back in time – to just 200 million years after the Big Bang – and be able to learn about the early Universe," said Harry Bevins, a PhD student from Cambridge's Cavendish Laboratory and the paper's lead author.

TONIGHT'S SPEAKER

Yamini Rao

Unravelling the Sun's mysteries

Our weekly welcome

WELCOME to our weekly public open evenings for the 2022/23 season. Each night there will be a half-hour talk which begins promptly at 7.15pm. Please note that the talk will be recorded and archived for online streaming.

The talk is followed by an opportunity to observe if (and only if!) the weather is clear. The IoA's historical Northumberland and Thorrowgood telescopes, along with our modern 16-inch telescope, will be open for observations. In addition, the Cambridge Astronomical Association will provide a floorshow outdoors on the Observatory lawns, relaying live images from their telescopes and providing a commentary. If we're unlucky and it's cloudy, we'll offer you a conciliatory cup of tea after the talk (with perhaps some more astro-information in the lecture theatre for those who want to stay on).

If you have any questions, suggestions or comments about the IoA Open Evenings please contact Matt Bothwell at bothwell@ast.cam.ac.uk.

The talk schedule for this term can be viewed at: www.public.ast.cam.ac.uk

Microbes could survive for 280 million years on Mars

Until recently it was thought that bacteria could not survive for a prolonged period on Mars. Surprisingly, the incredibly low average temperature of 210 kelvin (or -55 degrees Celsius) and lack of water do not pose a significant problem as bacteria have been observed to withstand millennia of extreme conditions such as these. Instead, the limiting factor is the harsh radiation on Mars, which over time would result in significant radiation damage to DNA, ultimately killing cells.

However, new results suggest that a species of bacteria called D.radiodurans can withstand enough radiation to survive in a state of stasis beneath Mars' surface for up to 280 million years. Researchers now think that if there was ever life on Mars it could still be there to this day. "I would assume that if life ever existed there, it would still be there," said Michael Daly of the Uniformed Services University (USU). "I can't imagine that if life evolved on Mars, that somehow it would just all disappear".

Facilities at USU and Cornell University were used to subject D.radiodurans to large doses of radiation. A human will die after being exposed to five grays of radiation. D.radiodurans only died after receiving 140,000 grays of radiation, enough to kill a human over 25,000 times and approximately the same amount of radiation a microbe would be exposed to after spending 280 million years on Mars.

Future missions, such as ESA's ExoRover capable of drilling up to a depth of two meters, could therefore result in Martian life being brought to Earth.

Citizen scientists using JWST to discover brown dwarfs

Backyard Worlds: Planet 9 is a NASA-funded citizen science project that aims to find cool, dim objects in our stellar neighbourhood. These objects include brown dwarfs, a class of objects between gas giants and stars. Brown dwarfs have masses between 15 and 80 times that of Jupiter, which means they are not massive enough to fuse hydrogen into helium but are massive enough for a form of hydrogen fusion known as deuterium burning.

Studying these objects could teach astronomers more about the atmospheres of giant gas planets, such as their composition and behaviour. However, due to their low temperatures, brown dwarfs are difficult to spot in images as they do not show up in the same way bright, hot stars do. Scanning all the images from JWST in search for difficult to spot objects is an unrealistic task for researchers alone. The images are instead made available to citizen scientists, who search for brown dwarfs and alert astronomers that can then carry out follow up investigations to learn more.

Over 100 objects discovered by citizen scientists have gone on to be observed with powerful telescopes, which now includes JWST. This telescope is capable of high-resolution spectroscopy that allows astronomers to determine the age, temperature, mass and atmospheric components of brown dwarfs, and obtain a better understanding of the atmospheric processes of exoplanets.

If you are reading this, you could be the next citizen scientist to discover a brown dwarf by heading to the Backyard Worlds page on zooniverse.org.

Joke of the Week

I heard that oxygen and magnesium got together. OMg! What? It was oxygen and potassium? That's OK.