Astronomers use Webb data to measure rapid increase in oxygen in the early universe

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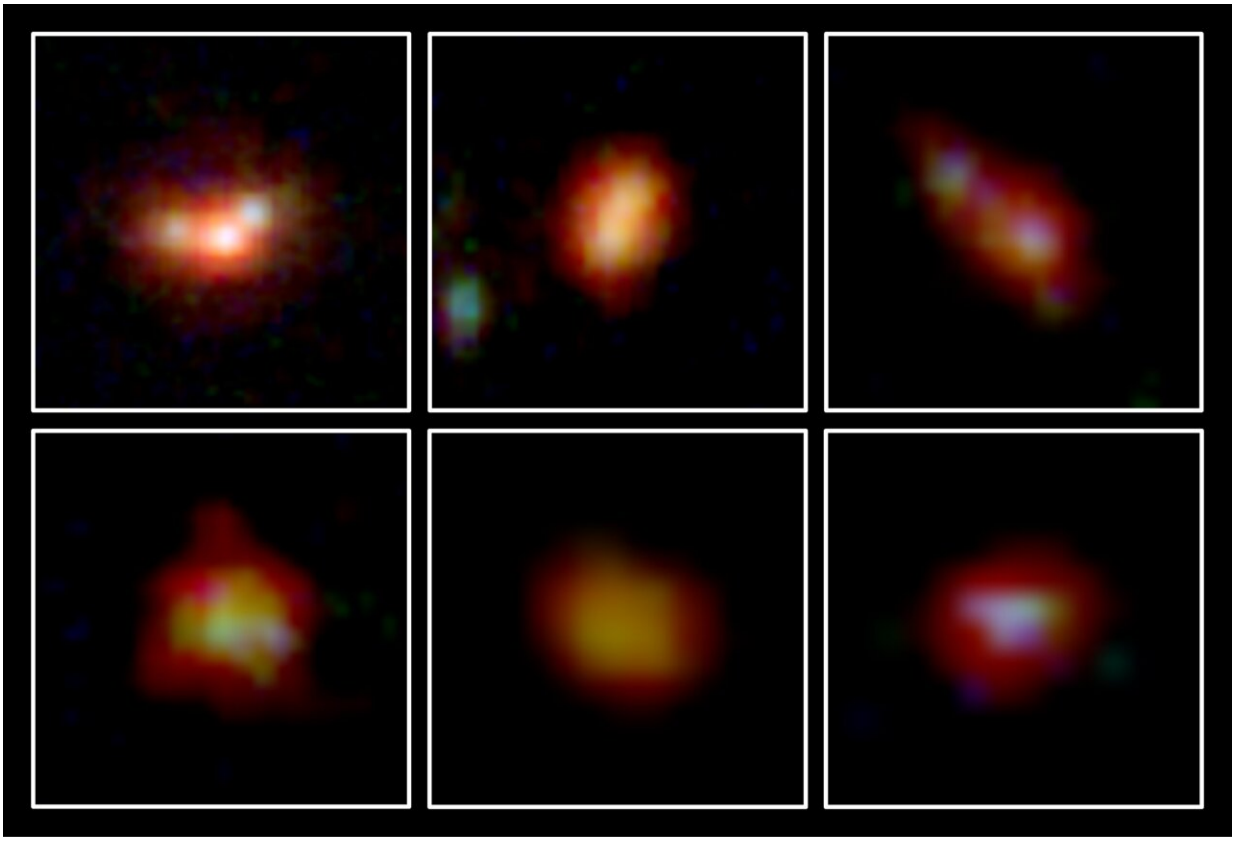

JWST infrared images of six galaxies from 500–700 million years after the birth of the universe. All six have low oxygen abundances compared to modern galaxies. Credit: NASA, ESA, CSA, K. Nakajima et al

Using new data from the James Webb Space Telescope, astronomers

have measured the abundance of oxygen in the early universe. The findings, accepted for publication in *The Astrophysical Journal Supplement Series* and posted to the *arXiv* preprint server, show that the amount of oxygen in galaxies increased rapidly within 500–700 million years after the birth of the universe, and has remained as abundant as observed in modern galaxies since then. This early appearance of oxygen indicates that the elements necessary for life were present earlier than expected.

In the early universe, shortly after the Big Bang, only light elements such as hydrogen, helium, and lithium existed. Heavier elements like oxygen were subsequently formed through nuclear fusion reactions within stars and dispersed into galaxies, primarily through events like supernova explosions. This ongoing process of element synthesis, unfolding over the vast expanse of cosmic history, created the diverse elements that constitute the world and living organisms around us.

A research team led by Kimihiko Nakajima at the National Astronomical Observatory of Japan used data from the James Webb Space Telescope (JWST) to measure the oxygen in 138 galaxies that existed in the first 2 billion years of the universe. The team found that most of the galaxies had oxygen abundances similar to modern galaxies. But out of the seven earliest galaxies in the sample, those that existed when the universe was only 500–700 million years old, six of them had roughly half the predicted oxygen content.

This rapid increase in oxygen content occurred earlier than astronomers were expecting. This opens the possibility that with the necessary ingredients, like oxygen, already readily available in the early universe that life may have appeared sooner than previously thought.

More information: Kimihiko Nakajima et al, JWST Census for the Mass-Metallicity Star-Formation Relations at z=4-10 with the Self-

Consistent Flux Calibration and the Proper Metallicity Calibrators, *arXiv* (2023). DOI: 10.48550/arxiv.2301.12825 10.3847/1538-4365/acd556