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COSMOLOGY

Webb Shatters Galaxy Distance Records

THE FIRST RESULTS FROM the James Webb Space Telescope seem to indicate that massive and luminous galaxies had already formed within a couple hundred million years of the Big Bang. If confirmed, these discoveries could seriously challenge current cosmological thinking; however, for now that's still a big "if."

As galaxies' light moves through expanding space, the wavelengths stretch (*redshift*) all the way into the infrared, to which Webb's instruments are sensitive. But not all light makes it to Webb. Intergalactic hydrogen absorbs radiation at wavelengths shorter than 91.2 nanometers. That threshold, too, redshifts into the infrared for the most distant galaxies.

Thus, a quick-but-rough way to determine a galaxy's distance is to watch for its light to "drop out" at certain wavelengths. Webb's Near-Infrared Camera, NIRCam, has 29 filters that each cover a different wavelength band. A galaxy may thus be visible in some channels but not in others. The wavelength band in which the galaxy disappears may indicate its redshift and as a result its distance.

▲ Astronomers have found candidate record-breakers in the first images obtained for the Cosmic Evolution Early Release Science Survey (CEERS).

Just a week after Webb's first science data became available, two independent teams of astronomers, one led by Rohan Naidu (Center for Astrophysics, Harvard & Smithsonian) and the other by Marco Castellano (Rome Observatory, Italy), used the dropout technique to find two relatively bright galaxy candidates at redshifts of about 11 and 13, residing in a universe about 400 and 300 million years old, respectively.

In the days that followed, another two independent teams, led by Callum Donnan (University of Edinburgh, UK) and by Yuichi Harikane (University of Tokyo), announced the tantalizing find of an unexpectedly massive galaxy at a redshift of 17. That corresponds to looking back to just 225 million years after the Big Bang.

In yet another study, Haojing Yan (University of Missouri, Columbia) and his colleagues even claimed that some of their candidate galaxies might reach a redshift of 20 (180 million years after the Big Bang).

The distant galaxies seem to be more numerous and more massive than expected from the standard model of cosmology. "It worries me slightly that we find these monsters in the first few images," says cosmologist Richard Ellis (University College London).

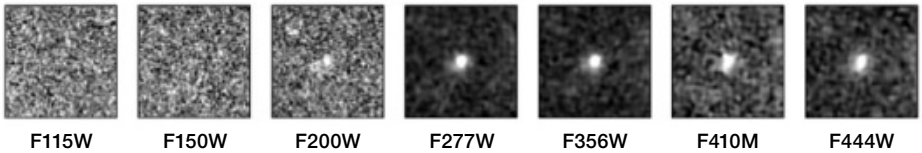
But these candidates still await confirmation via spectroscopy, which would give precise redshifts. "I'm sure some of them will be [confirmed], but I'm equally sure they won't all be," Mark McCaughrean (ESA) tweeted. "It does all feel a little like a sugar rush at the moment."

And there is reason to doubt at least some of the supposedly distant galaxies. For example, the galaxy candidate at a redshift of 17, variously referred to as CEERS 1749, CEERS 93316, and CR2-z17-1, has also earned the nickname "Schrödinger's Galaxy" because of its undecided nature. A team led by Jorge Zavala (National Astronomical Observatory of Japan) has made the case that this galaxy is actually much closer, at a redshift of 5. It would then reside in an older universe, 1.2 billion years after the Big Bang. It's so dusty that it vanishes at longer wavelengths in the same way more distant galaxies do. Post-launch instrument calibration may also affect distance measurements.

The fast pace of Webb science is keeping everyone on their toes, and there's a lot of work to do to confirm the most distant galaxies are really so far away. "Every day is a little adventure," Ellis says.

■ GOVERT SCHILLING

Find more details at https://is.gd/JWSTdistances.



F115W F150W F200W F277W F356W F410M F444W

▲ These "postage-stamp" images from Webb's NIRCam show the galaxy CEERS 93316 in seven wavelength filters. The galaxy isn't visible in the two shortest-wavelength bands (F115W and F150W).

DEEP-FIELD IMAGE FROM WEBB: NASA / STSCI / CEERS / TACC / S. FINKELSTEIN / M. BAGLEY / Z. LEVAY; LYMAN ALPHA DROPOUT: DONNAN ET AL. / ARXIV.ORG / 2207.12356