Observations shed more light on the morphology and environment of a very distant galaxy

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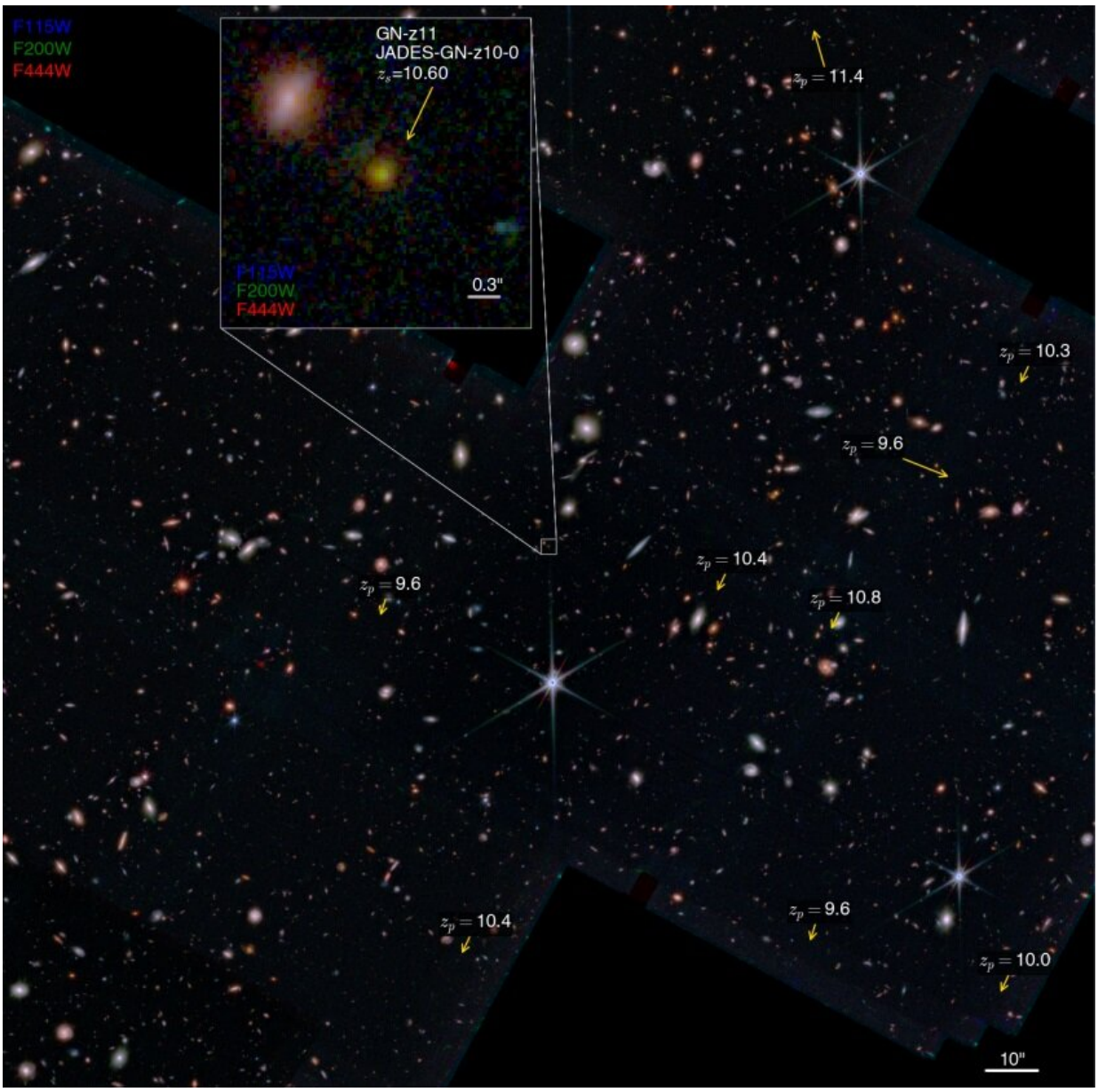

The region around GN-z11. Credit: Tacchella et al, 2023

An international team of astronomers has employed the James Webb Space Telescope (JWST) to conduct near-infrared imaging of GN-z11—one of the most distant galaxies known to date. Results of these observations yield important information regarding the morphology and environment of this galaxy.

Investigating the properties of the most distant galaxies may be crucial in order to advance our knowledge about the earliest stages of galaxy formation and evolution, including the formation of the first stars and black holes. Astronomers perceive such galaxies as excellent probes for a range of baryonic processes, structure formation and the nature of dark matter.

At a redshift of approximately 10.6, GN-z11 is one of the farthest known galaxies from Earth ever discovered. It has a size of about 4,000 ± 2,000 light years and its stellar mass is estimated to be 1.3 billion solar masses. The galaxy is observed as it existed 13.4 billion years ago, just 430 million years after the Big Bang.

GN-z11 is a particularly bright galaxy and hosts a young stellar population with an age of about 90 million years. What is noteworthy is that the galaxy has a relatively large stellar mass for its young age, which suggests a rapid build-up of stellar mass.

Due to its brightness, GN-z11 is a good target for observations, even using ground-based facilities. Therefore, a group of astronomers led by Sandro Tacchella of the University of Cambridge, U.K., observed GN-

z11 with JWST's Near Infrared Camera (NIRCam). The observational campaign was conducted as part of the JWST Advanced Deep Extragalactic Survey (JADES).

JWST observations revealed complex morphology of GN-z11. The galaxy was resolved into a point source, from which about two-thirds of the emission arises, and a nearly exponential disk with a half-light radius of about 650 light years. The core of GN-z11 was found to be extremely compact.

The researchers detected a low-surface brightness haze about 0.4 arcseconds to the northeast of GN-z11. They assume that this haze is likely to be a lower redshift galaxy, but might yet be another component of GN-z11.

The study found that GN-z11 is actively forming stars with a star-forming rate (SFR) at a level of 21 solar masses per year. The results suggest that the SFR has increased about 60 million years ago, peaked at a lookback time of 10–20 million years, and has slightly decreased in the recent 10 million years. The stellar age of the galaxy was determined to be 24 million years, therefore lower than previously estimated.

When it comes to the large-scale environment of GN-z11, the astronomers searched for faint neighbors that may be associated with this galaxy as such massive galaxies at a high-redshift tend to be highly clustered. In result, they found a population of nine objects with photometric redshifts consistent with 10.6 in the vicinity of GN-z11.

"Searching more broadly, nine other galaxies from 0.5' to 2' appear to be F115W dropouts with photometric redshifts consistent with z = 10.6. Our initial impression is that this is a mild angular overdensity, but we leave this study to future work," the authors of the paper concluded.

More information: Sandro Tacchella et al, JADES Imaging of GN-z11: Revealing the Morphology and Environment of a Luminous Galaxy 430 Myr After the Big Bang, *arXiv* (2023). DOI: 10.48550/arxiv.2302.07234