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PRESS RELEASE

The rise of the galactic empire: JWST discovers the nine most distant galaxies known

A study led by Pablo Pérez-González at the Centro de Astrobiología, (CAB), CSIC-INTA (Spain) recently discovered nine galaxies that are candidates to being the most distant galaxies known. By using a combination of images taken with the NIRCam instrument on the James Webb Space Telescope (JWST) these galaxies could be picked out from more nearby objects. The light coming from these galaxies was sent out a mere 100-200 million years after Big Bang, which means that they could be some of the very first galaxies formed in the universe.

October 2, 2025

Deep imaging surveys are the most efficient way to find very distant galaxies, by observing galaxies in filters of different wavelengths. Young galaxies contain stars that emit most of their light from the ultraviolet (UV) to the visual (what the human eye sees) and at wavelengths shorter than UV, the so called Lyman break, they emit little or no light. When galaxies are very far away, at high redshifts (z), the Lyman break is shifted to longer wavelengths and they become invisible in filters probing bluer light. For instance, when the universe was just 1.5 billion years old, galaxies become invisible in the visual while still seen at longer wavelengths (these are called drop-out galaxies). The redder the filter where a galaxy drops out, the more distant it is likely to be.

Ultimately, a spectroscopic observation is required to confirm the redshift, but since these are more expensive in terms of observing time and can only target a limited number of galaxies per observation, imaging surveys is the first step. Using this technique with the Hubble Space Telescope galaxies at redshifts up to approximately 10 could be found. With JWST, that probe wavelengths further into the infrared, many more very high redshift galaxy candidates have been found. Currently, the most distant spectroscopically confirmed galaxy is at a redshift of 14 (when the universe was just 300 million year old).

As a part of the MIDIS survey, led by professor Göran Östlin at Stockholm University in Sweden, and Luis Colina at the Centro de Astrobiología in Spain, unprecedentedly deep imaging of the Hubble Ultra Deep Field was obtained at wavelengths larger than 5 micrometers. In this survey the Near IR Camera (NIRCam) at JWST was staring at an area of the sky which had partly already been covered by another deep survey (NGDEEP). The images were co-added to achieve an unprecedented depth (90 hours of observations in the filter with longest exposure time) which made it possible to find very high redshift galaxy candidates through the dropout technique.

> "I was scrutinizing the data with the hope to maybe find a few extreme redshift candidates a little bit further away than the most distant ones previously discovered, but to my surprise I found nine candidates that are all significantly more distant. We could say that we are probing the epoch when the galaxies first appeared and started to dominate the Universe, the rise of the galactic empire, a fan of Star Wars would say", comments the lead author Pablo Pérez-González.

After carefully investigating all possible candidates and error sources he ended up with a set of nine solid candidates, six at redshift 17 and three at redshift 25, corresponding to having emitted their light 200 and 100 million years after Big Bang, respectively. These results imply that there are more such galaxies, and that galaxy formation commenced earlier than theoretical models had anticipated.

> "The MIRI Deep Imaging Survey, and its parallel observations with NIRCam, were designed to push the frontiers of our understanding of galaxies in the early universe. Finding such distant galaxy candidates extends beyond our initial expectations but demonstrates the power of JWST in changing the astrophysics landscape", says Göran Östlin.

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JWST program details

The astronomers observed the Hubble Ultra Deep Field and parallels as part of the JWST Guaranteed Time Observation (GTO) Program 1283, “The MIRI HUDF Deep Imaging Survey” (PIs: Göran Ostlin, Hans Ulrik Norgaard-Nielsen) and the GO5 Program 6511 “Galaxy mass buildup in the early universe - ultra deep imaging of the Hubble Ultra Deep Field to 10 microns” (PI: Göran Ostlin).

The MIDIS (MIRI Deep imaging Survey) collaboration consists of the following research institutions: Centro de Astrobiología, CSIC-INTA, Villanueva de la Cañada and Torrejón de Ardoz, Spain; Max Planck Institute for Astronomy, Heidelberg, Germany; Max Planck Institute for Extraterrestrial Physics, Garching, Germany; Physikalisches Institut, Universität zu Köln, Germany; Université Paris-Saclay, Orsay and Gif-sur-Yvette, France; Leiden Observatory, The Netherlands; KU Leuven, Belgium; Rijksuniversiteit Groningen, The Netherlands; University of Vienna, Austria; ETH Zürich, Switzerland; Université de Liege, Belgium; LESIA, Observatoire de Paris, Meudon, France; INAF, Napoli, Italy; Dublin Institute for Advanced Studies, Ireland; UK Astronomy Technology Centre, Edinburgh, UK; University of Leicester, UK; Radboud University, Nijmegen, The Netherlands; Space Research Institute, Graz, Austria; SRON, Groningen and Leiden, The Netherlands; Stockholm University Sweden; Cosmic Dawn Center (DAWN), DTU Space, Lyngby, Denmark; Onsala Space Observatory, Sweden; Amsterdam University, The Netherlands.

The James Webb Space Telescope (JWST) is the world's leading observatory for space research. JWST is an international programme led by NASA with its partners, ESA (European Space Agency) and CSA (Canadian Space Agency). MIRI was built by a consortium involving research institutes and universities in 9 European countries and USA.

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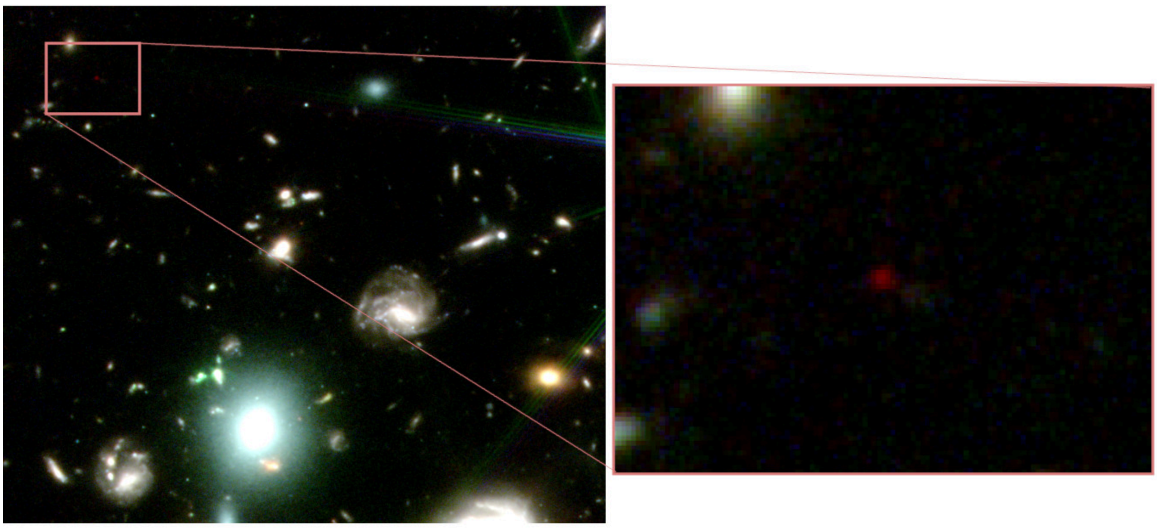
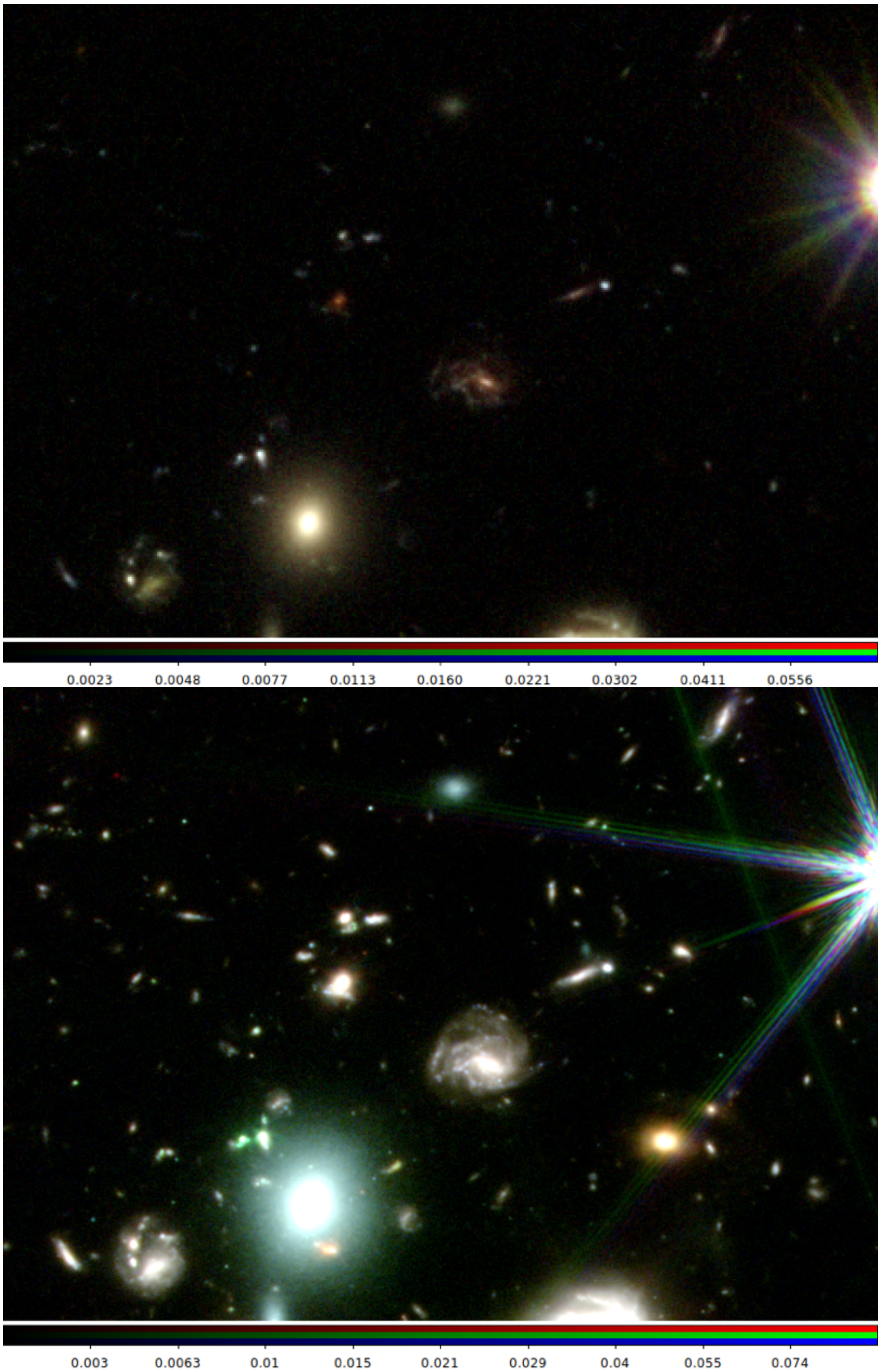
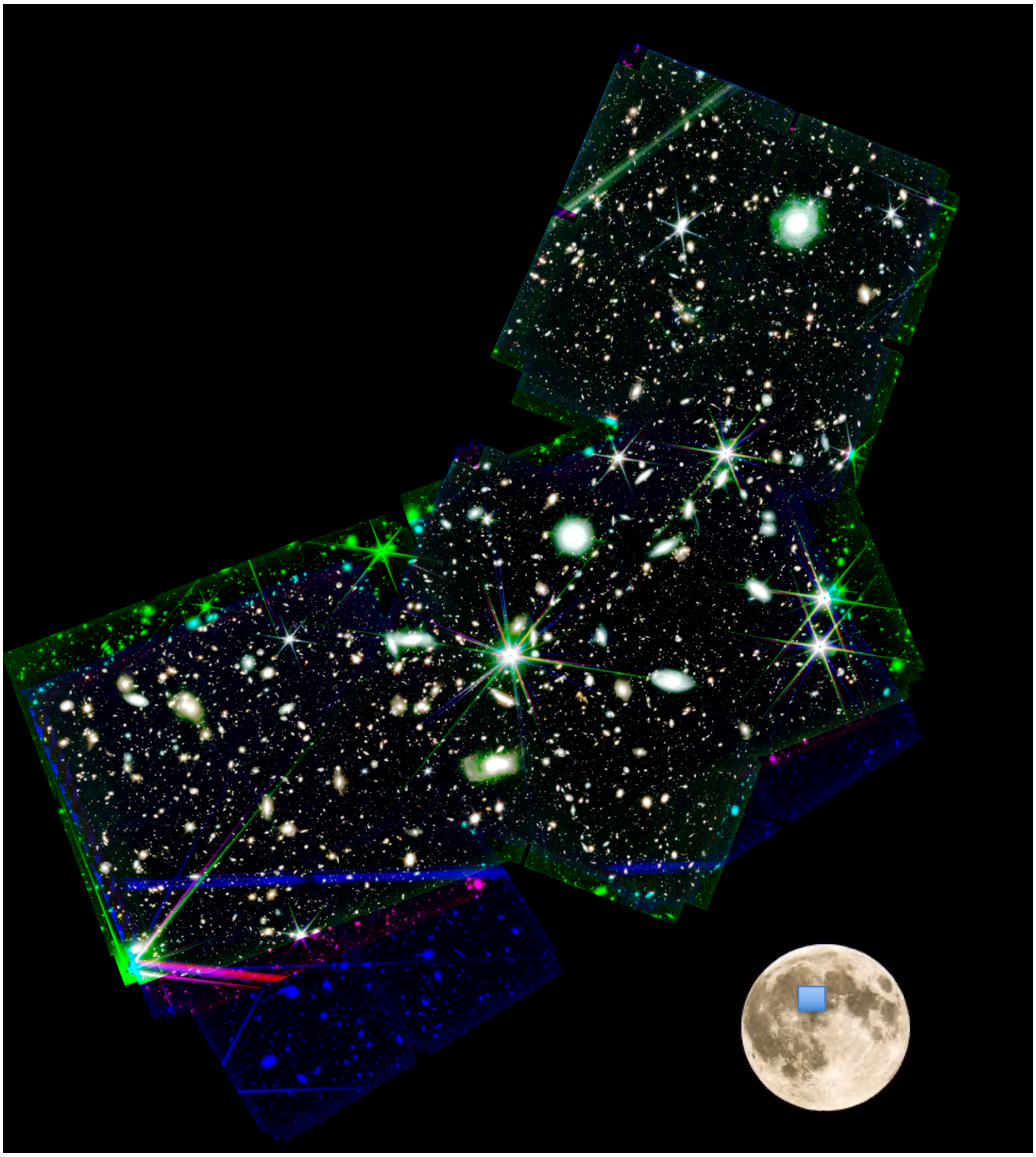


Zoomed image into the deepest images obtained by JWST, obtained by the MIDIS and NGDEEP JWST programs, where one of the candidates of a galaxy at redshift 17 is marked and shown in detail on the right panel. These color composite images has been constructed with three different filters of the NIRCam instrument, covering wavelengths 1.5 (red), 2.0 (green) and 2.77 (red) micrometers, not detectable by the human eye and best observable from space. Every little dot in the images is a galaxy (or, in a few cases, stars). The red color of the galaxy at z~17 is due to the very high redshift, causing it to drop out from the bluer filters on NIRCam. The galaxy is not detected in these bluer filters and thus appears red in the color composite.The newly discovered galaxies would have been formed in the first 125 to 200 million years after the Big Bang, when the universe age was 1% of today's. Credit: ESA/Webb, NASA & CSA, Pablo Peréz-González, Jens Melinder.



Comparison of the images taken by Hubble (top) and JWST (bottom) for the MIDIS field used in this work. In this zoomed-in image, which covre around 5% of the entire image obtained by the program, around 800 galaxies are detected in the Hubble data, 5000 galaxies are detected in the JWST data, one of them is a candidate at redshift z~17. Credits: ESA/Webb, NASA & CSA, Pablo G. Pérez-González.



Entire image used in this work. The three filters used in this composite do not cover the same area, so the edges are only seen in blue and green. The dataset is able to detect nearly 100000 galaxies in a region of the sky whose are is around 2% of the Moon, as shown in the bottom right corner of the image.

Scientific paper published in *The Astrophysical Journal*

Reference: "The rise of the galactic empire: luminosity functions at z~17 and z~25 estimated with the MIDIS+NGDEEP ultra-deep JWST/NIRCam dataset", Pablo G. Pérez-González et al., ApJL, 991, 179
https://iopscience.iop.org/article/10.3847/1538-4357/adf8c9

About CAB

Centro de Astrobiología (CAB) is a joint research center of the National Institute of Aerospace Technology (INTA) and the National Research Council (CSIC) of Spain. Created in 1999, it was the world's first center dedicated specifically to astrobiological research and the first non-US associate member of NASA's Astrobiology Institute (now the NASA Astrobiology Program). It is an interdisciplinary research center whose main objective is to study the origin, presence and influence of life in the universe from a transdisciplinary approach. In 2017, CAB was distinguished by the Ministry of Science and Innovation as "María de Maeztu Unit of Excellence".

CAB has led the development of the REMS, TWINS and MEDA instruments, all operational on Mars since August 2012, November 2018 and February 2021, respectively; as well as the science of the RLS and RAX Raman instruments, which will be launched in this decade on board of ExoMars and MMX missions. In addition, CAB develops the SOLID instrument, aimed at the search for life in planetary exploration. Likewise, CAB participates in different missions and instruments of great astrobiological relevance, such as CARMENES, CHEOPS, PLATO, BepiColombo, DART, Hera, the MIRI and NIRSpec instruments at JWST and the HARMONI instrument at ESO's Extremely Large Telescope (ELT).

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