

## The James Webb Space Telescope reveals the central role of low-mass galaxies in the reionization process of the Universe

Paris, 28 February, 2024

The James Webb Space Telescope (JWST)<sup>1</sup>, developed by NASA and ESA, has just obtained the first spectra of very low-mass galaxies less than a billion years after the Big Bang. A technological feat made possible by the unique combination of JWST sensitivity and the gravitational lensing effect of the Abell 2744 cluster: nearby galaxies act like cosmic magnifiers, distorting space and amplifying the light of background galaxies. By demonstrating that small galaxies are very likely at the origin of the reionization of the universe, this discovery represents a major breakthrough in our knowledge of the cosmos. The international research team brought together the Universities of Pittsburgh, Swinburne and Texas in Austin in collaboration with the Paris Astrophysics Institute (Sorbonne University/CNRS). These results were published in *Nature* magazine on the 28 February, 2024.

Reionization, which occurred some 500 to 900 million years after the Big Bang, marks a crucial period in the history of the Universe, following the recombination<sup>2</sup>. It represents the transformation of neutral hydrogen, which predominated in the Universe, into ionized gas. Identifying the sources responsible for this cosmic reionization has given rise to a number of hypotheses. These include supermassive black holes containing gas accretion disks that eject high-energy radiation; large galaxies with masses in excess of one billion solar masses; and small galaxies with masses of less than 1 billion solar masses. Confirmation of the hypothesis relating to low-mass galaxies proved particularly difficult, given their low luminosity.



The Pandora cluster (Abell 2744) used as a magnifying lens to study the faintest galaxies at the epoch of reionization. This JWST color image shows clusters galaxies in bright white, while distant background galaxies are red and often distorted by the gravitational lensing effect. Credits (NASA, ESA, CSA, I. Labbe (Swinburne University of Technology), R. Bezanson (University of Pittsburgh), H. Atek (IAP), A. Pagan (STScI)

For the first time, an international research team involving the Paris Astrophysics Institute (Sorbonne University/CNRS) has managed to unravel the mystery by obtaining spectroscopic observations of these galaxies during the reionization period. By analyzing these very low-mass galaxies, comparable to dwarf galaxies in the local Universe, the scientists have demonstrated that small galaxies played a major role in cosmic reionization. The combination

<sup>1</sup> In orbit around the sun since 25 December, 2021

<sup>2</sup> Recombination is the first phase transition in the history of the Universe, and corresponds to the recombination of electrons and protons to form neutral hydrogen atoms. This event occurred 378,000 years after the Big Bang, and gave way to a Universe filled with neutral hydrogen until the second transition: reionization.

of deep observations from the JWST telescope and gravitational lensing amplification of the Abell 2744 galaxy cluster now makes it possible to determine the abundance of small galaxies and their ionizing properties during the first billion years of the Universe.

Hakim Atek, astrophysicist at Sorbonne University and researcher at the Paris Astrophysics Institute, is the first author of this study. He explains: *"We found that small galaxies outnumbered massive galaxies by about a hundred to one during this epoch of reionization of the Universe. These novel observations also reveal that these small galaxies produced a considerable amount of ionizing photons, exceeding by four times the canonical values usually assumed for distant galaxies. This means that the total flux of ionizing photons emitted by these galaxies far exceeds the threshold required for reionization."*

The researchers now want to extend this study to a larger scale, to confirm that this particular location is representative of the average distribution of galaxies in the Universe.

Beyond the reionization process, their observations are essential to understanding the formation of the very first galaxies, which, over 12 billion years later, would constitute our present-day galaxies.

#### Reference:

Most of the photons that reionized the Universe come from dwarf galaxies, Hakim Atek, Ivo Labbé, Lukas J. Furtak, Iryna Chemerynska, Seiji Fujimoto, David J. Setton, Tim B. Miller, Pascal Oesch, Rachel Bezanson, Sedona H. Price, Pratika Dayal, Adi Zitrin, Vasily Kokorev, John R. Weaver, Gabriel Brammer, Pieter van Dokkum, Christina C. Williams, Sam E. Cutler, Robert Feldmann, Yoshinobu Fudamoto, Jenny E. Greene, Joel Leja, Michael V. Maseda, Adam Muzzin, Richard Pan, Casey Papovich, Erica J. Nelson, Themiya Nanayakkara, Daniel P. Stark, Mauro Stefanon, Katherine A. Suess, Bingjie Wang and Katherine E. Whitaker, *Nature*, the 28 February, 2024.

DOI: 10.1038/s41586-024-07043-6

#### About Sorbonne University:

Sorbonne University is a multidisciplinary, research-intensive university covering the humanities, health, science and engineering. Anchored in the heart of Paris and with a regional presence, Sorbonne University has 55,000 students, 3,300 teaching and research staff, 4,000 national researchers and over a hundred laboratories. Alongside its partners in the Sorbonne University Alliance, and via its institutes and multidisciplinary initiatives, it conducts research and educational activities to strengthen its contribution to the challenges of three major transitions: a global approach to health (One Health), resources for a sustainable planet (One Earth), and changing societies, languages and cultures (One Humanity). Sorbonne University is also a member of Alliance 4EU+, an innovative model for European universities that develops strategic international partnerships and promotes the openness of its community to the rest of the world. <https://www.sorbonne-universite.fr/en>

#### About the CNRS:

The French National Center for Scientific Research is one of the most recognised and renowned public research institutions in the world. For more than 80 years, it has continued to attract talent at the highest level and to nurture multi-disciplinary and interdisciplinary research projects at the national, European and international levels. Geared towards the public interest, it contributes to the scientific, economic, social and cultural progress of France. The CNRS is above all 33,000 women and men, more than 1,000 laboratories in partnership with universities and other higher education institutions bringing together more than 120,000 employees and 200 professions that advance knowledge by exploring the living world, matter, the Universe, and the functioning of human societies. The CNRS ensures that this mission is carried out in compliance with ethical rules and with a commitment to professional equality. The close relationship it establishes between its research missions and the transfer of acquired knowledge to the public makes it today a key player in innovation in France and around the world. Partnerships with companies are at the heart of its technology transfer policy, and the start-ups that have emerged from CNRS laboratories bear witness to the economic potential of its research. The CNRS provides also access to research findings and data, and this sharing of knowledge targets many audiences: scientific communities, the media, decision-makers, economic players and the general public. For more information: [www.cnrs.fr](http://www.cnrs.fr)

---

### International Press Contact

Katherine Tyrka

01 44 27 51 05 [Katherine.tyrka@sorbonne-universite.fr](mailto:Katherine.tyrka@sorbonne-universite.fr)

### Researcher Contacts

Hakim Atek, astrophysicist at the Paris Astrophysics Institute, Sorbonne University [atek@iap.fr](mailto:atek@iap.fr)