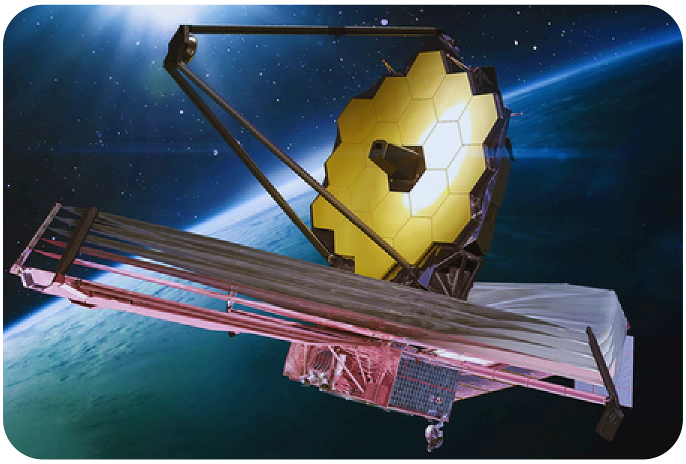
ALAKNANDA - A Spiral Galaxy From The Early Universe

Recently, Indian astronomers using NASA's James Webb Space Telescope (JWST) have discovered one of the most distant spiral galaxies ever observed. Alaknanda is a massive, beautifully structured cosmic pinwheel that existed when the universe was only 1.5 billion years old. Named after the Himalayan river Alaknanda, it lies behind the gravitational lensing cluster Abell 2744. What makes this galaxy remarkable is its maturity. Even though we observe it at a redshift of ~4.05, essentially meaning the light has been travelling for more than 12 billion years, it still shows a clear two-armed spiral structure and a bright, concentrated central region. Its disk spans about 30,000 light-years, carries roughly 10 billion solar masses in stars, and is forming new stars at nearly 63 solar masses per year.

Galaxies at such an early stage of the universe's history are usually irregular and dynamically chaotic, shaped by frequent collisions and turbulent gas flows, but Alaknanda's unexpectedly stable morphology at only about 1.5 billion years after the Big Bang pushes against long-standing assumptions about how quickly large disk galaxies can settle and organize themselves. Alaknanda also shows organized star-forming clumps along its arms, reinforcing the idea that its structure is not temporary but genuinely disk-like. This makes it one of the clearest examples of early spirals and a strong challenge to current galaxy formation models, suggesting that the early universe may have been capable of producing mature galactic structures far more rapidly than expected.

JWST NIRCam instrument



DETECTION

“The Abell 2744 cluster” acts as a gravitational lens, revealing the ancient spiral galaxy Alaknanda.

The galaxy’s detection relied heavily on gravitational lensing. The mass of Abell 2744 bends spacetime enough to magnify and stretch the faint background galaxy, bringing its structure within reach of JWST’s infrared instruments. JWST then observed it across 21 photometric filters, enabling scientists to estimate its stellar population, dust content, and star formation activity despite its large distance. Astronomers observed the galaxy’s ultraviolet light, which appears in infrared wavelengths due to its great distance. They also identified a “beads-on-a-string” pattern in the bright star-forming regions along its spiral arms. This pattern resembles that of the nearby galaxies observed today. These observations collectively reveal the picture of a galaxy that is unusually well-formed for such an early point in the universe's history.

JWST color-composite reconstruction of the Alaknanda galaxy

IMPLICATIONS

Its presence suggests that disk formation and stabilization may occur far faster in certain environments than theoretical models usually predict. It raises questions about how early dark matter halos settled, how rapidly cold gas could accumulate and cool, and how efficiently angular momentum could organize itself into a rotating disk. Further JWST and ALMA (Atacama Large Millimeter Array) observations may reveal whether it exhibits true rotational support, how its metals are distributed across the disk, and whether it has smaller companion structures. These measurements will determine whether Alaknanda represents a rare case or an early hint that the young universe was capable of building ordered systems much sooner than expected. If more galaxies like Alaknanda are identified, cosmological simulations will need to account for a broader and more rapid range of evolutionary pathways than previously assumed. Ultimately, it shows that our picture of early galaxy growth may need a second look.