



# How does the James Webb Space Telescope work?

KS2 KS3 Ages 7-14 ⌚ 5 min read

In the summer of 2022, NASA released the first images from the James Webb Space Telescope. They showed thousands of galaxies in a patch of sky smaller than a grain of sand held at arm's length — some of them from a time when the universe was less than 5% of its current age. How does a telescope see that far back in time?

## Light as a time machine

Light travels fast — about 300,000 kilometres per second — but space is unimaginably vast. When you look at a star 100 light-years away, you're seeing it as it was 100 years ago, because that's how long its light took to reach you. The most distant galaxies Webb can observe are so far away that their light has been travelling for nearly 13.5 billion years. We're not just seeing far away — we're seeing the early universe.

📡 Imagine receiving a letter that was posted 13.5 billion years ago by one of the first galaxies ever formed. That's essentially what Webb is doing — reading messages sent by the early universe, written in light. The further away the source, the older the message.

## Why infrared?

This is where it gets clever. The universe is expanding, and as light travels across those billions of light-years, the expansion of space stretches its wavelength. Visible light from the early universe has been stretched so much that it has shifted into the infrared — a wavelength our eyes can't see. Hubble primarily detected visible and ultraviolet light. Webb was specifically designed to detect infrared, which is why it can see what Hubble couldn't.

Infrared detection requires the telescope itself to be very cold — otherwise the heat from the telescope would swamp the faint infrared signals from distant galaxies. Webb sits at a point in space called L2, 1.5 million kilometres from Earth,

permanently shielded from the Sun by a tennis-court-sized sunshield. Its instruments operate at  $-233^{\circ}\text{C}$ .

## **The mirror**

Webb's primary mirror is 6.5 metres across — more than twice the diameter of Hubble's — made of 18 hexagonal gold-coated beryllium segments that folded up for launch and unfolded in space. Gold was chosen because it reflects infrared light particularly well. Larger mirrors collect more light, which means Webb can see fainter, more distant objects. The whole telescope had to fold origami-style to fit inside the rocket, then autonomously unfold in space over two weeks in a deployment that was called "the most complex ever attempted."

## **What has it found?**

Beyond the stunning images, Webb has revealed galaxies that formed earlier and grew faster than models predicted, provided the most detailed chemical analysis of exoplanet atmospheres, and fundamentally changed our picture of the early universe. It's already made discoveries that require revisions to our models — which is exactly what good science should do.