New Scientist

WEEKLY July 16 - 22, 2022

BILLIONS OF STARS
Space telescope's amazing new view of the universe

ILLOGICAL THINKING
DeepMind AI learns physics by watching nonsense videos

LOOPY MATH
The surprising importance of untangling knots

BLUE THERAPY

The extraordinary benefits of time spent close to water

BEES v WASPS
A scientific showdown

PLUS WHY MEN EAT MORE IN SUMMER / **THREE-EYED PREDATOR** / **RISK OF FALLING ROCKETS** / A GUIDE TO ROCK POOLING

Science and technology news **www.newscientist.com**

No3395 US$6.99 CAN$9.99

Astronomy

Seeing further than ever before

This stunning full-colour image from the James Webb Space Telescope is just a taste of what is to come, says **Leah Crane**

THE first deep-field image from NASA's James Webb Space Telescope (JWST) has revealed galaxies we have never seen before. Released on 11 July, it is zoomed in further than any previous infrared picture we have taken of the cosmos. But the record won't stand for long, as the telescope continues to push the limits of astronomical observation. As *New Scientist* went to press, four more images were scheduled to be released.

"Being able to see so deeply into the universe will help astronomers understand the earliest stars"

JWST launched from French Guiana at the end of 2021 and arrived in its final orbit around the sun in early 2022. Images with high enough quality to use for science have now started to beam down to Earth. US president Joe Biden announced the first of these in a press conference at the White House on 11 July.

The image, right, shows a region of space called SMACS 0723, which contains what astronomers call a gravitational lens. In areas like this, a massive object relatively close to Earth behaves like a magnifying glass, distorting space and stretching the light of anything behind it. The gravitational lens in SMACS 0723 is particularly strong because the nearby object distorting space-time isn't one galaxy, but a large cluster of galaxies.

The small specks and streaks of light amplified by the lens and visible around the edges of the image are distant, incredibly faint galaxies – some of the first that ever formed.

We couldn't see these galaxies before now. That is partly because of the expansion of the universe: the further away an object is, the faster it is moving away from us and the redder its light appears because of that motion. JWST can spot these because it uses infrared light, allowing it to see objects that appear so red that they have become invisible to its predecessor, the Hubble Space Telescope, which observes light mainly in visible wavelengths.

Being able to see so deeply into the universe – and thus far back in time – will help astronomers understand the earliest stars.

"We think that when stars form from primordial material in the distant universe, they form in a very different way, but we've never really observed that before," says Stephen Wilkins at the University of Sussex in the UK. "There's a lot of crucial physics there that we don't know anything about."

Understanding the formation of these early stars and galaxies could also help solve the mystery of how the seeds of supermassive black holes form.

This first image is a tantalising

NASA, ESA, CSA, AND STSCI

A region of space called SMACS 0723 that contains a light-warping gravitational lens

1.5m

Distance JWST is from Earth, in kilometres

2021

Year JWST launched from French Guiana

hint of what is to come from JWST, in the form of both more pictures and detailed observations of the universe. In the coming weeks and months, the floodgates of JWST science are set to open and transform our understanding of the cosmos.

"All the data we've seen before now has just shown that it's actually working – but [this] is the first data that we can potentially do science on, and very soon we'll get data that we can definitely do science on," says Wilkins. ▮

Technology

How JWST's striking first colour image was made

Will Gater

ON MONDAY, US president Joe Biden unveiled "Webb's First Deep Field", the first full-colour image released by the James Webb Space Telescope (JWST) team (see main story, left).

For Joseph DePasquale, the lead JWST image processor at the Space Telescope Science Institute in Baltimore, Maryland, the release was a moment of "relief" and "gratitude" after months of what he describes as, at times, an emotional task.

He recalls working on one of the first images downloaded from the telescope – four more of these were due to be released as *New Scientist* went to press. "I got really deep into the details. Then, at one point, I took a step back and I pulled myself out of the pixel level and looked at the image as a whole. It was a very overwhelming, kind of moving, experience," he says.

"[I was] literally sitting at my desk looking at the very first real-colour image from Webb knowing that I'm the first person in the world to ever have seen this. That moment for me was just amazing."

> "When you first open the raw image, it essentially just looks like a blank screen, just black"

The pictures DePasquale and his colleague, Alyssa Pagan, have been processing were beamed back across the 1.5 million kilometres of space between Earth and the telescope as a stream of 1s and 0s.

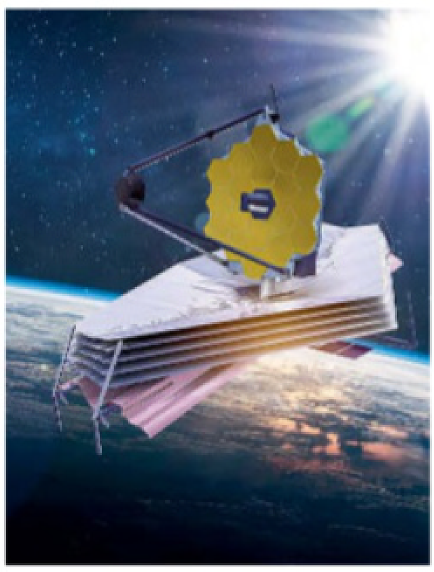
This binary information was then formed into an image file at the Space Telescope Science Institute, the project's US base. But these raw images look very different from the one we saw this week.

For starters, the raw data has an enormous dynamic range. This means that much of the detail is contained in the dark regions of the picture, says DePasquale. "When you first open that image, it essentially just looks like a blank screen, just black," he says. Image-processing software is used that brightens the picture to reveal hidden subtleties within.

The resulting scenes are black and white, however, as the detectors in JWST's instruments only create monochromatic data. To make colour views, the team had to map different filtered wavelengths of infrared light, captured in monochrome by the telescope, onto three colours – red, green and blue. By combining the resulting three images, whose bright and dark areas now represent the contribution of each of those assigned hues, a final full-colour picture takes shape.

The shades that emerge from this mix really depend on which of the telescope's instruments is being used, says DePasquale. "NIRCam [JWST's primary imager] has produced images that have more earthy brown and deep-blue hues in them, depending on the object. MIRI [a second imager on JWST], seeing in mid-infrared, sees the sky very differently and produces some very interesting colours leaning more towards blues and purples," he says.

JWST's golden mirror is made up of 18 hexagonal segments



SHUTTERSTOCK/DIMA ZEL

Six points

One striking aspect of the new JWST imagery are six-pointed stars bisected by a thin line (see image left). "That's very unique to Webb and I think at some point that's going to become an iconic indicator [of a JWST image]," says DePasquale. The spiky motif is what's known as a diffraction pattern and it is something that arises from a characteristic of the telescope called the point spread function.

This point spread function reflects the way in which the JWST optical system "imprints" itself on the light that it captures of a point source, such as a bright star, explains DePasquale. "It's very highly dependent on the construction of the observatory," he says. Hubble's internal optics, for example, bent and interacted with light from point sources in such a way as to produce images of stars that had four lines sticking out of them.

"Webb, because it has hexagonal mirrors, imprints a completely different-looking point spread function," says DePasquale.

Aside from the telescope's optical idiosyncrasies, DePasquale says it is the sharpness of the pictures that really makes JWST's images special. "Webb, with its precision and its resolution, is able to bring out a level of detail that we have never been able to see in the infrared universe." ▮