

On the first year of astronomical discoveries by the James Webb Space Telescope

Bryan Dyne
16 July 2023

Wednesday marked the first anniversary of the start of science operations of the James Webb Space Telescope (JWST), the most powerful space-based astronomical observatory ever launched. It is jointly operated by NASA, the Canadian Space Agency (CSA) and the European Space Agency (ESA) and has, over the past year, already provided countless insights into the natural world, from inside the Solar System to the farthest reaches of the Universe.

The first anniversary of JWST was celebrated with the release of new data of the star-forming region Rho Ophiuchi. It is the nearest such cloud complex to Earth, about 390 light years away by the most recent estimates (a mere 3.7 million billion kilometers or 2.3 million billion miles), and one of the most studied. The image from the telescope shows about 50 very young stars, all 1 million years old or less (compared to our Sun's age of 4.6 *billion* years), all of which are about the mass of the Sun.

Many of the objects imaged are known as T Tauri stars, which shine not as a result of nuclear fusion in their core, but because of the radiation powered by the gravitational contraction of the star which is steadily shrinking. After about 100 million years, they will have shrunk enough to raise the temperature in their core to the level where nuclear fusion from hydrogen to helium will commence, beginning their life as a main sequence star, the stable mature form in which the star will spend most of its life.

The dark areas are thick clouds of dust, so dense that not even the specialized instruments of JWST can capture light emitted from inside them. The large red streams, sometimes called Dark River clouds or Rho Ophiuchi Streamers, consist of molecular hydrogen and are often formed when a newborn star finally emits

enough radiation to fling off its natal cocoon of dust and send out jets of material into deep space.

Some of the stars in the image also have signs of protoplanetary disks, potential future planetary systems still being formed.

The latest image from JWST reaffirms what a group of NASA, ESA and CSA researchers said last year when the telescope was fully commissioned, that “almost across the board, the science performance of JWST is better than expected.”

Another recently imaged protoplanetary disk, that surrounding the star d203–506 in the Orion Nebula, was recently confirmed using JWST data to have the molecule methyl cation (CH⁺). While CH⁺ was first predicted to be involved in interstellar chemistry in the 1970s, it was only first detected using the telescope's MIRI and NIRCам instruments. Initial results were released at the end of June.

Carbon compounds are carefully studied because they form the basis for all known life, and CH⁺ is particularly important because it does not react with hydrogen, which is most of the visible universe, but does react with a wide range of other molecules, indicating it could be a catalyst for the emergence of other molecules and more complex structures, such as amino acids and proteins, and ultimately the emergence of organic life.

The analysis of CH⁺ also provides insight into the contradictory nature of ultraviolet light in the formation of planetary systems. Those wavelengths of light are known to be very destructive when they interact with organic molecules (which is why too much sunlight, part of which is in the ultraviolet spectrum, produces sunburns and, in extreme cases, skin cancer).

Ultraviolet light is however also known to scour young planetary systems, including our own. The current research sheds light on the contradictory nature of ultraviolet light being detrimental to existing organic molecules, but also necessary to form the building blocks to make those molecules in the first place.

The lead investigator of this study, Olivier Berné of the University of Toulouse, France, elaborates, “This clearly shows that ultraviolet radiation can completely change the chemistry of a protoplanetary disc. It might actually play a critical role in the early chemical stages of the origins of life by helping to produce CH₄—something that has perhaps previously been underestimated.”

JWST has also continued to study distant galactic clusters. In February, the telescope was used to take a deep field of Abell 2744 (nicknamed Pandora’s cluster), which involved a total of 30 hours of observing time with the NIRC*am* instrument. The cluster itself is made up of at least four separate galactic clusters that initially collided some 350 million years ago, and have since produced a whole host of exotic phenomena that astronomers are still trying to uncover.

Similar to other galactic clusters, the colossal gravity of Abell 2744 also acts as a lens for the light of other, even more distant objects that are behind Abell 2744 relative to Earth. In total, JWST imaged more than 50,000 sources of infrared light at once, all of them either galaxies or galactic clusters from far back in cosmic history. There are at least two candidates from which light has traveled for more than 13 billion years (in astronomical terms, a redshift greater than 10) before being collected by JWST, providing insight into galactic formation in the earliest epoch of the Universe.

Earth’s planetary neighbors in the outer Solar System have also been studied by JWST. During its commissioning, the telescope observed Jupiter and its moons Europa, Thebe and Metis to test its capabilities to track moving targets. Another imaging campaign of the Jovian system was undertaken, this time including the moons Amalthea and Adrastea, as well as Jupiter’s rings and aurora.

The observatory has also produced the most high-resolution infrared images of Uranus and Neptune, which have been intermittently observed by Hubble and ground-based observatories for years, and only visited once each for close inspection by the spacecraft

Voyager 2 in 1986 and 1989, respectively. As JWST is viewing both in infrared light, it has provided new information about the structure of each planet’s ring system and the respective atmospheric dynamics.

The most recently released image from the outer Solar System was of Saturn, in late June. In contrast to the bright hues of images taken by the Cassini spacecraft, JWST in infrared sees Saturn as extremely dark, surrounded by extraordinarily bright icy rings. Some of the more interesting discoveries include the dark clouds in the planet’s northern hemisphere, which may be the result of planet-scale waves in Saturn’s atmosphere, a phenomenon not seen before.

A treasure trove of even more data has been collected over the first year of JWST’s operation, much of which is summarized in various press reports by the European Space Agency. It is to the immense credit of the tens of thousands who operate the telescope and process the data that so much has been achieved in so little time. Each new image provides further insight for humanity’s understanding of the natural world and our place within it. We eagerly await further discoveries.



To contact the WSWS and the Socialist Equality Party visit:

wsws.org/contact