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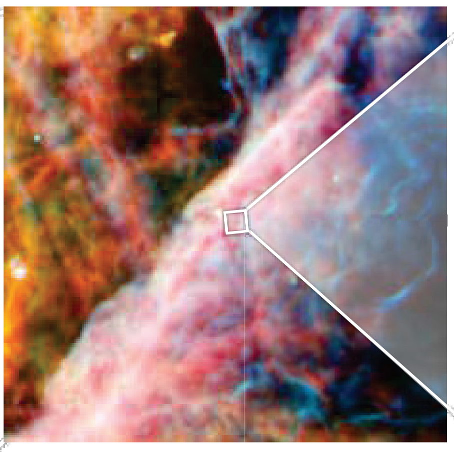
HUNTING FOR THE SEEDS

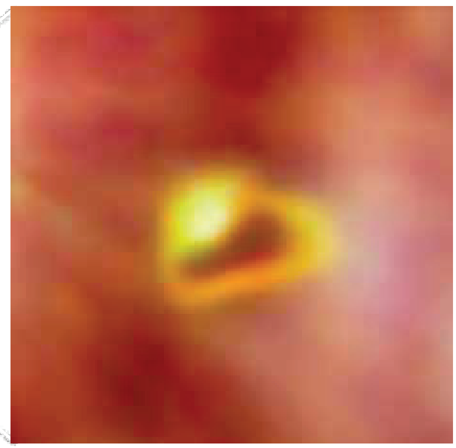
JWST's Near-Infrared Camera snapped this image of the Orion Bar, where energetic ultraviolet radiation from the Trapezium Cluster (located off the image's northwestern [upper left] corner) encounters denser nebular material. The two brightest stars here belong to the Theta^2 (θ^2) Orionis triple system. ALL IMAGES: ESA/WEBB/NASA/CSA/M. ZAMANI (ESA/WEBB)/THE PDRS4ALL ERS

For the first time, astronomers detect a carbon molecule in space that could play a critical role in the origin of life. BY RICHARD TALCOTT

OF LIFE



JWST's Mid-Infrared Instrument captured this close-up of the Orion Bar.



The protoplanetary disk d203-506 sits front and center. JWST discovered the methyl cation — molecules scientists view as vital for interstellar organic chemistry and the beginnings of life — in this disk.

SCIENTISTS SUSPECT OUR SOLAR SYSTEM formed some 4.6 billion years ago in a vast stellar nursery that ultimately gave birth to a few thousand stars. Today, our part of the galaxy holds only one comparable region: the Orion Nebula (M42). This spectacular deep-sky object lies just 1,350 light-years from Earth and provides astronomers with a ringside seat for exploring stellar birth.

The James Webb Space Telescope (JWST) recently discovered another startling similarity between our solar system and the Orion Nebula: They are the only two places in the cosmos known to harbor a molecule that likely plays a key role in interstellar organic chemistry and the genesis of life. The methyl cation (CH_3^+) turned up in observations of a protoplanetary disk surrounding a star cataloged as d203-506. (A cation is an atom or molecule with a net positive charge because it suffers a deficit of one or more electrons.)

Scientists began speculating in the 1970s that CH_3^+ could help create the more complex organic molecules that form the basis for life as we know it. The methyl cation makes a near-perfect facilitator for forming complex organic (carbon-based) compounds because it reacts easily with a wide range of other molecules, even in the frigid conditions of interstellar space.

Using JWST's unprecedented sensitivity and resolution, scientists studying d203-506's disk detected a series of emission lines that correspond precisely to the unique spectral signature of the methyl cation. Although astronomers traditionally identify molecules through their radio emissions, CH_3^+ emits only at infrared wavelengths that Earth's atmosphere absorbs, so the space observatory proved crucial.

The star is a dim red dwarf with a mass one-tenth that of the Sun that only recently began fusing hydrogen into helium in its core. It lies near the heart of the Orion Nebula, just a stone's throw from the massive 5th-magnitude star Theta² (θ^2) Orionis A, which itself lies barely 2 arcminutes southeast of the Trapezium Cluster that energizes the entire nebula.

Ultraviolet light pours from the cluster's hot, massive stars, ionizing the nebula's hydrogen gas and causing it to glow with a distinctive reddish hue. This powerful radiation also tends to destroy complex molecules, raising the question of how the methyl cation survives. The international team of scientists that made the observations suspects that ultraviolet light actually supplies the energy CH_3^+ needs to form while simultaneously breaking apart any water molecules nearby. This could explain why no traces of water were found around d203-506.

JWST's observations of other protoplanetary disks located farther from sources of intense ultraviolet radiation reveal lots of water. "[Our study] clearly shows that ultraviolet radiation can completely change the chemistry of a protoplanetary disk," said team leader Olivier Berné in a press release. The CNRS, CNES, and University of Toulouse researcher added, "It might actually play a critical role in the early chemical stages of the origins of life by helping to produce CH_3^+."

Intriguingly, meteorites that date to the origin of our solar system also show evidence that the material that ultimately formed the Sun and planets was bathed in ultraviolet radiation from a nearby massive star. Because such behemoths live for only a few million years, it has long since disappeared from our neighborhood.

Perhaps the same fate awaits the protoplanetary disk surrounding d203-506. And maybe one day, millions or billions of years from now, life will take root on a planet orbiting this dim red star.

Contributing Editor ***Richard Talcott*** *wrote about the 60th anniversary of quasars as well as JWST's observations of Fomalhaut in the November issue.*