American Museum of Natural History

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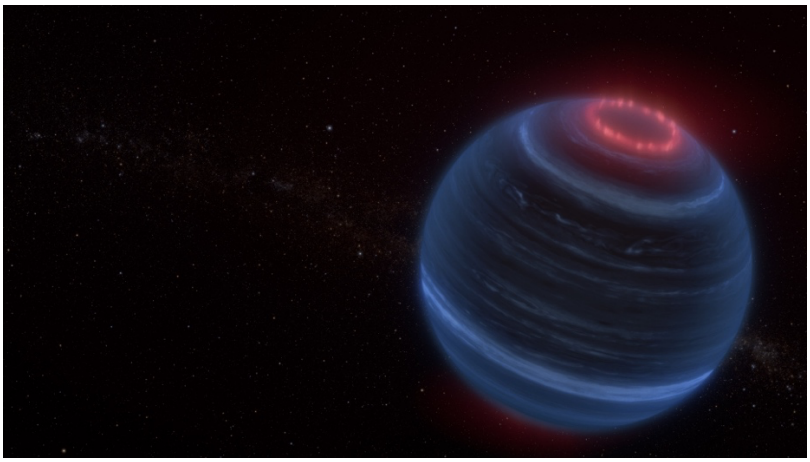
Museum Astronomers Present New Brown Dwarf Findings at American Astronomical Society Press Briefing

Studies investigate brown dwarf cloud cover and aurorae, and how citizen scientists are helping to uncover new worlds



Three astrophysicists from the American Museum of Natural History have been chosen to present their findings about exoplanets and brown dwarfs during the press conference for the American Astronomical Society's 243rd Meeting, which will be held in person in New Orleans and streamed online from January 8-11. Jackie Faherty, a senior research scientist and senior education manager at the Museum, will reveal the discovery of methane emission on a brown dwarf; postdoctoral fellow Genaro Suárez will discuss how cloud cover can change the infrared color of brown dwarfs and exoplanets; and Austin Rothermich, a graduate student at the City University of New York (CUNY) Graduate Center and the Museum, will discuss how scientists are using citizen science to identify new brown dwarfs. All three researchers will present at 11:15 am Eastern Standard Time/10:15 am Central Standard Time on Tuesday, January 9.

A brown dwarf with an aurora

More massive than planets but lighter than stars, thousands of brown dwarfs have been identified in our solar neighborhood. One such object is called W1935—a cold brown dwarf 47 light years away that was discovered through the Backyard Worlds: Planet 9 citizen science project. Using new observations from the James Webb Space Telescope (JWST), Faherty and her colleagues uncovered something in the data from W1935 that has never been seen before on a brown dwarf: the emission of methane. Methane is abundant in brown dwarfs but it is usually being absorbed, not emitted.

“We knew the JWST data would give us exciting insights into the atmospheres of extrasolar worlds, but I was not expecting to see any emission out of such a cold object,” Faherty said. “We figured there had to be extra energy in the atmosphere to get it to happen but were quite puzzled over how and why at first.”

Turning to the solar system, the team realized that cold giant planets like Jupiter and Saturn also have methane emission, and for them, it is linked to aurorae. The auroral process seen on these planets involves both interactions with the solar wind as well as interactions with active moons (Io for Jupiter and Enceleadus for Saturn). Because W1935 has no host star to create solar wind, the research team speculates that an active moon could be contributing to the methane emission. However, more observations are needed, and Faherty’s team plans to continue studying W1935 to uncover more clues about what is driving this process.

“No matter what is causing the methane emission on W1935, this world represents an outstanding laboratory for investigating linked phenomena that are prominent in our own solar system,” Faherty said.

The findings are in press for the journal *Nature*.

Brown dwarfs are cloudier at the equator
Recent studies have found that cloudy skies are common on brown dwarfs. Mostly composed of hot sand or dust, these clouds play a crucial role in shaping how astronomers “see” brown dwarfs by picking up the spectra of light these worlds emit.

“Understanding the effects of clouds on our observations is crucial for learning about the physics and chemistry of the atmospheres of not only brown dwarfs, but also of exoplanets, which can have similar cloud cover,” Suárez said.

Suárez will present new findings, based on data collected with the Spitzer Space Telescope, showing that there are more clouds near the equator of these worlds than at the poles, and that these clouds change the infrared color of the objects. His study, published in *The Astrophysical Journal Letters* in 2023, finds that brown dwarfs appear redder in color when measurements are taken from near the equator and bluer when taken from close to the poles.

“You can focus on the exact same object but depending on the viewing inclination—whether you’re looking at it near the equator or near the poles—it can be a very different color,” Suárez said. “This helps explain why we see such a diversity of colors among brown dwarfs and exoplanets.”

Using citizen science to identify new worlds
Brown dwarfs are everywhere, but they are very difficult to identify because they are small, cold, and faint. To help in this pursuit, astronomers from the Backyard Worlds: Planet 9 citizen science project, co-founded by the Museum in 2017, tap a worldwide network of more than 100,000 volunteers who inspect infrared images to identify nearby brown dwarfs that move relative to more distant background stars. At the AAS Meeting, Rothermich will announce the identification of 89 new “ultracool dwarfs”—brown dwarfs or very low-mass stars—that were found co-moving with a higher-mass star. All of them were identified as part of the Backyard Worlds citizen science project.

“I started out as a citizen scientist volunteer with Backyard Worlds when I was an undergraduate,” Rothermich said. “It is so exciting to now be a Ph.D. student leading the paper on the discoveries made by my Backyard Worlds colleagues.”

Volunteers with Backyard Worlds search through digital images taken from NASA’s Wide-field Infrared Survey Explorer (WISE) mission to try to identify new worlds inside and outside of our solar system. Objects that are particularly close to Earth will appear to “jump" between images taken with several years apart, similar to an object “moving” in a flipbook. Users then flag these objects for further study by

scientists. In this case, the objects that were marked as movers weren't moving alone: a second object was "jumping" alongside them, indicating that a companion system had been spotted. Scientists including Rothermich obtained follow-up observations at telescopes around the world to confirm and characterize the discoveries. Data taken by the European Space Agency's Gaia telescope anchored the results by providing distances and motions for the stellar hosts.

The 89 new systems are a diverse collection of objects, including 72 systems that have more than 1,000 astronomical units (or roughly 93 billion miles) between the dwarfs and the companion stars, and 37 systems with constrained ages including several very old and several very young systems that are typically hard to locate in the solar neighborhood. The study, which was submitted for peer review to *The Astrophysical Journal*, includes 21 citizen scientists as co-authors.

ABOUT THE AMERICAN MUSEUM OF NATURAL HISTORY (AMNH)

The American Museum of Natural History, founded in 1869 with a dual mission of scientific research and science education, is one of the world's preeminent scientific, educational, and cultural institutions. The Museum encompasses more than 40 permanent exhibition halls, galleries for temporary exhibitions, the Rose Center for Earth and Space including the Hayden Planetarium, and the Richard Gilder Center for Science, Education, and Innovation. The Museum's scientists draw on a world-class permanent collection of more than 34 million specimens and artifacts, some of which are billions of years old, and on one of the largest natural history libraries in the world. Through its Richard Gilder Graduate School, the Museum offers two of the only free-standing, degree-granting programs of their kind at any museum in the U.S.: the Ph.D. program in Comparative Biology and the Master of Arts in Teaching (MAT) Earth Science residency program. Visit amnh.org for more information.

Photo:

This artist concept portrays the brown dwarf W1935, which is located 47 light-years from Earth. Astronomers using NASA's James Webb Space Telescope found infrared emission from methane coming from W1935. This is an unexpected discovery because the brown dwarf is cold and lacks a host star; therefore, there is no obvious source of energy to heat its upper atmosphere and make the methane glow. The team speculates that the methane emission may be due to processes generating aurorae, shown here in red.
Credit: NASA, ESA, CSA, Leah Hustak (Space Telescope Science Institute)

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