First Y brown dwarf binary system discovered

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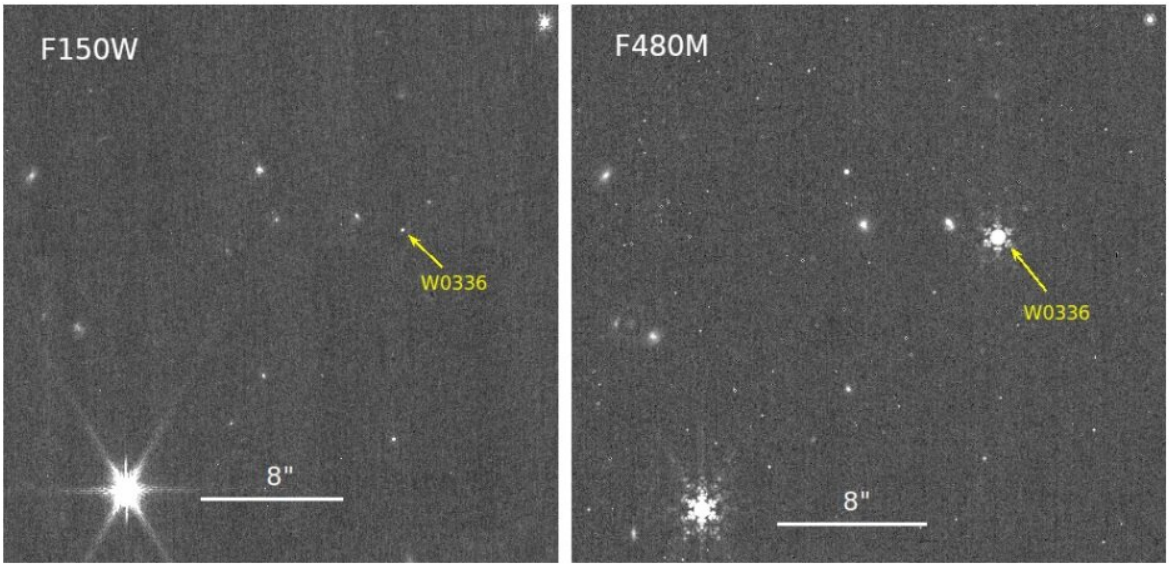

JWST/NIRCam images showing the aligned and scaled images of the target W0336 in each observed filter. North is up and East is to the left in the images. Credit: Calissendorf et al, 2023

Using the Near Infrared Camera (NIRCam) onboard the James Webb Space Telescope (JWST), an international team of astronomers has discovered the first known binary system composed of two Y-type brown dwarfs. The finding was reported in a research paper published March 29 on the *arXiv* pre-print repository.

Brown dwarfs are intermediate substellar objects between planets and stars with masses below the hydrogen burning limit—about 80 Jupiter masses. One subclass of brown dwarfs (with effective temperatures lower than 500 K) is known as Y dwarfs, and represents the coolest and least luminous substellar objects so far detected.

WISE J033605.05−014350.4 (or W0336 for short) is a nearby brown dwarf of spectral type Y0 detected in 2012 with NASA's Wide-field Infrared Survey Explorer (WISE). The object is located some 32.7 light years away in the constellation Eridanus and has an effective temperature of about 460 K.

Now, new observations conducted by a group of astronomers led by Per Calissendorf of the University of Michigan in Ann Arbor, unveiled the presence of a companion object to W0336. The brown dwarf was observed in September 2022 as part of a JWST Cycle 1 GO program—a survey of 20 Y dwarfs.

"We report the discovery of the first brown dwarf binary system with a Y dwarf primary, WISE J033605.05−014350.4, observed with NIRCam on JWST with the F150W and F480M filters. We employed an empirical point spread function binary model to identify the companion, located at a projected separation of 0.″084, position angle of 295 degrees, and with contrast of 2.8 and 1.8 magnitudes in F150W and F480M, respectively," the researchers wrote in the paper.

The observations detected a faint companion to W0336, at a physical separation of approximately 0.97 AU from it. The newfound object has a mass between five and 11.5 Jupiter masses, and its effective temperature is estimated to be 325 K. Therefore, the companion was classified as a Y-type brown dwarf.

The primary brown dwarf is estimated to be between 8.5 to 18 times

more massive than Jupiter, while its effective temperature is about 415 K. The system has an orbital period of seven years and its age is assumed to be 1–3 billion years. However, the evolutionary models suggest that the binary W0336 may be even older than 5 billion years.

The researchers noted that W0336 is a tightly bound system with a relatively low mass-ratio (of about 0.61)—what is in contrast to other known binaries containing a Y-type brown dwarf. Hence, it is still difficult to conclude whether such systems represent the true binary population of ultracool dwarfs or can be considered as peculiar systems.

The authors of the paper propose follow-up spectroscopic and photometric observations of W0336 over a wide wavelength range in order to shed more light on the properties of both Y dwarfs.

More information: Per Calissendorff et al, JWST/NIRCam discovery of the first Y+Y brown dwarf binary: WISE J033605.05$-$014350.4, *arXiv* (2023). DOI: 10.48550/arxiv.2303.16923