Mysterious isolated object investigated by astronomers

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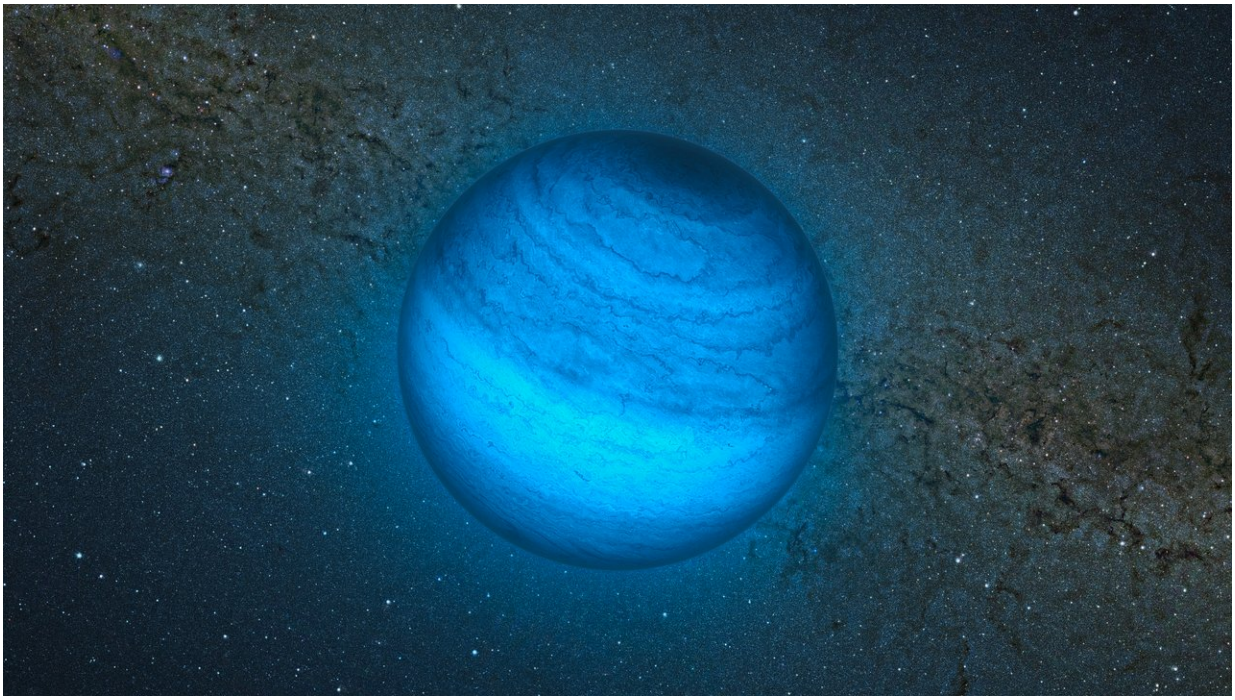

This artist's impression shows the free-floating planet CFBDSIR J214947.2-040308.9. Credit: ESO/L. Calçada/P. Delorme/R. Saito/VVV Consortium.

(Phys.org)—An international team of astronomers led by Philippe Delorme of the Grenoble Alpes University in France has recently investigated a mysterious object designated CFBDSIR J214947.2-040308.9 (CFBDSIR 2149-0403 for short) in order to reveal

its true nature. The object is assumed to be a young isolated planetary-mass object or a high-metallicity low-mass brown dwarf. The results of new observations published Mar. 2 in a paper on arXiv.org could help distinguish between these two classes.

CFBDSIR 2149-0403 was detected in 2012 by Delorme and his team as a possible member of the AB Doradus moving group. After its discovery, it was classified by the researchers as a unique T-type isolated planetary-mass candidate. However, due to the lack of convincing evidence supporting the hypothesis that CFBDSIR 2149-0403 formed as a planet and was subsequently ejected, the scientific community does not exclude the possibility that it could be a low-mass brown dwarf.

In order to to fully characterize CFBDSIR 2149-0403 and to constrain its nature, the team has conducted multi-instrument, multi-wavelength follow-up observations of this object. The list of instruments used by Delorme and his colleagues includes the Very Large Telescope's (VLT) X-Shooter spectrograph and HAWK-I near-infrared imager, WIRCam imager at the Canada–France–Hawaii Telescope and NASA's Spitzer Space Telescope.

"The X-Shooter data enabled a detailed study of the physical properties of this object. However, all the data presented in the paper is really necessary for the study, especially the follow-up to obtain the parallax of the object, as well as the Spitzer photometry. Together, they enable us to get the bolometric flux of the object, and hence constraints that are almost independent from atmosphere model assumptions," Delorme told Phys.org.

Besides determining the object's parallax, the follow-up observations also allowed the researchers to derive its six-dimensional position and kinematics. These results indicate that CFBDSIR 2149-0403 is most likely not a member of the AB Doradus moving group, as was claimed in

earlier studies, thereby removing any strong independent constraint on its age.

"We now reject our initial hypothesis that CFBDSIR 2149-0403 would be a member of the AB Doradus moving group. This removes the most robust age constraint we had. Though determining that certainly improved our knowledge of the object it also made it more difficult to study, by adding age as a free parameter," Delorme said.

The most important conclusion in the new study is that CFBDSIR 2149-0403 is most probably either a young (less than 500 million years) isolated planetary-mass (between two and 13 Jupiter masses) object of late-T spectral type, or an older (2 to 3 billion years old), metallicity-enhanced brown dwarf, with a mass ranging from two to 40 Jupiter masses. However, the scientists noted that our theoretical understanding of cool, low-gravity and/or metallicity-enhanced atmospheres is not yet robust enough to decisively conclude which hypothesis is true. This is because these physical parameters have very similar effects on the emergent spectra of such atmospheres.

"CFBDSIR 2149-0403 is an atypical substellar object that is either a 'free-floating planet' or a rare high-metallicity brown dwarf. Or a combination of both," Delorme concluded.

More information: CFBDSIR 2149-0403: young isolated planetary-mass object or high-metallicity low-mass brown dwarf?? arXiv:1703.00843 [astro-ph.SR] arxiv.org/abs/1703.00843

Abstract
We conducted a multi-wavelength, multi-instrument observational characterisation of the candidate free-floating planet CFBDSIR~J214947.2-040308.9, a late T-dwarf with possible low-gravity features, in order to constrain its physical properties. We

analyzed 9 hours of X-Shooter spectroscopy with signal detectable from 0.8—2.3μm, as well as additional photometry in the mid-infrared using the Spitzer Space Telescope. Combined with a VLT/HAWK-I astrometric parallax, this enabled a full characterisation of the absolute flux from the visible to 5μm, encompassing more than 90% of the expected energy emitted by such a cool late T-type object. Our analysis of the spectrum also provided the radial velocity and therefore the determination of its full 3-D kinematics. While our new spectrum confirms the low gravity and/or high metallicity of CFBDSIR2149, the parallax and kinematics safely rule out membership to any known young moving group, including AB~Doradus. We use the equivalent width of the KI doublet at 1.25μm as a promising tool to discriminate the effects of low-gravity from the effects of high-metallicity on the emission spectra of cool atmospheres. In the case of CFBDSIR2149, the observed KI doublet clearly favours the low-gravity solution. CFBDSIR2149 is therefore a peculiar late-T dwarf that is probably a young, planetary-mass object (2—13Mjup,