

March 09, 2020 | By Cynthia Dillon

Astronomers Catch Rare Eclipse of a Double Brown Dwarf System

Astronomers working on “first light” data from a newly commissioned telescope in Chile made a chance discovery that led to the identification of a rare eclipse of two brown dwarfs. The result published today in the journal [Nature Astronomy](#).

Sometimes called “failed stars,” brown dwarfs occupy a grey zone between stars and giant planets. They are unable to sustain the fusion of hydrogen into helium, a process that powers the light from normal stars like the sun; yet they appear to form like stars, only with less mass. They provide a critical link in scientists’ understanding of star and planet formation.

The chance discovery was led by an international team of researchers, including scientists at UC San Diego, working on a project called SPECULOOS (Search for habitable Planets EClipping ULtra-cOOl Stars), which aims to find planets orbiting the smallest stars, including brown dwarfs. SPECULOOS finds planets by detecting periodic dips in a star’s brightness as a planet passes in front of it, an event called a planetary transit. Astronomers predict that the smallest stars and brown dwarfs could host large populations of close-in, potentially habitable rocky planets, like the famous seven-planet system [TRAPPIST-1](#) that was discovered in 2017 by members of the same team.

“This is a great example of scientific serendipity,” explained Adam Burgasser, professor of [physics](#) at UC San Diego and co-leading author on the study. “While searching for planets, we found an eclipsing brown dwarf binary, a system that is uniquely suited for studying the fundamental physics of these faint celestial objects.”

Soon after the construction of the first SPECULOOS telescopes in Chile, and during early testing observations, the team targeted the brown dwarf “2MASSW J1510478-281817,” also known as 2M1510, in the constellation Libra. In this case, the SPECULOOS observations picked up a distinct signal that led the researchers to speculate that 2M1510 might be two brown dwarfs instead of one, in orbit around each other.

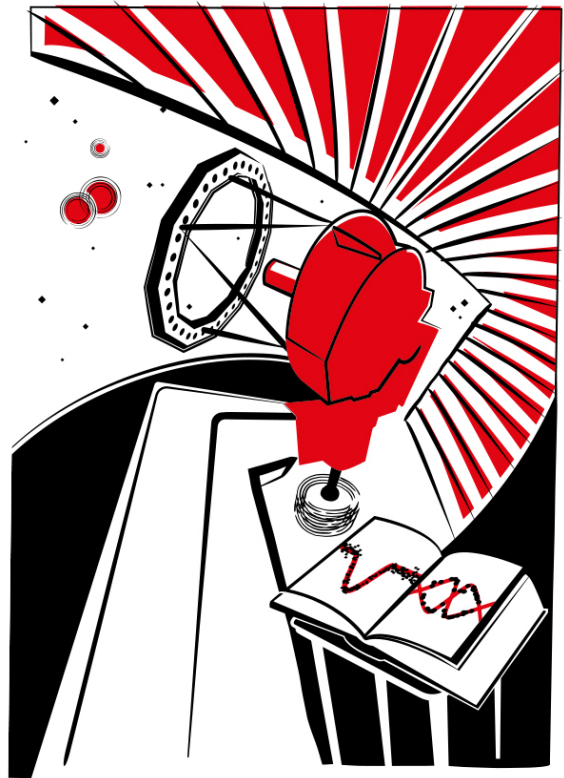
“Among the first test observations we performed, we turned one of our telescopes to a known brown dwarf. But suddenly the object appeared to get dimmer for about 90 minutes, which indicated an eclipse just took place,” reported Michaël Gillon, principal investigator of the SPECULOOS project.

Artem Burdanov, a postdoctoral researcher at Massachusetts Institute of Technology and co-author on the study concurred, adding, “We rapidly realized that we were probably looking at two eclipsing brown dwarfs, one passing in front of the other, a configuration which is much rarer than planetary systems.”

The researchers were able to confirm their hypothesis using two powerful telescopes, W. M. Keck Observatory’s 10-meter Keck II Telescope on Maunakea in Hawaii and the 8-meter Very Large Telescope (VLT) on Cerro Paranal in Chile, the same site as the SPECULOOS telescopes. Keck Observatory and VLT are each equipped with sensitive spectrometers that can measure the velocities of celestial objects. In the case of 2M1510, the astronomers detected the velocities of both brown dwarfs as they orbited one another.

“From the very first spectrum we obtained, we could tell we had an exciting binary discovery,” said Burgasser, who led the spectroscopic analysis with current and former graduate students at UC San Diego’s Cool Star Lab. “It was thrilling to see the absorption lines move back and forth in perfect synchronicity, which allowed us to measure the mass of the binary.”

The detection of an eclipsing brown dwarf binary is extremely rare because the system needs to be precisely aligned with the line-of-sight to move in front of each other. Only one other such system has been identified to date. These systems allow astronomers to measure both the radii and masses of the brown dwarfs directly. 2M1510 is also unique in that it is among the few



An artist's view of one of the SPECULOOS telescopes, with the eclipsing binary brown dwarf in the sky. The third red dot, is a third nearby brown dwarf, which is also part of the same system. The book on the side shows the data that led to the discovery. On the left page is the eclipse captured by SPECULOOS while the right page shows the data from Keck Observatory and the VLT. The illustration's copyright is University of Birmingham / Amanda J. Smith

brown dwarfs that have a known age, due to its membership in a nearby cluster of young stars called the Argus moving group. The eclipsing binary is also part of a brown dwarf triple system—another rarity—with a third component orbiting at a much wider separation.

“Collecting a combination of mass, radius and age is really rare for a star, let alone for a brown dwarf,” explained Amaury Triaud, Birmingham Fellow at the University of Birmingham in the UK who was the primary author of the study. “Usually one or more of these measurements is missing. By drawing all these elements together, we were able to verify theoretical models for how brown dwarfs cool, models which are over 30 years old. We found the models match remarkably well with the observations, a testament to human ingenuity.”

The data that made this discovery possible were obtained by the SPECULOOS-South Observatory, one of the facilities participating in the SPECULOOS project. SPECULOOS is led by the University of Liège, the University of Birmingham, the University of Cambridge, the University of Bern, the Institute of Astrophysics of the Canaries, the Massachusetts Institute of Technology and other partner institutions. SPECULOOS-South is hosted by the European Southern Observatory at its Paranal Observatory in Chile. It is funded by the European Research Council (grant no. 803193/BEBOP); the Leverhulme Trust (grant no.RPG-2018-418); the Science, Technology and Facilities Council (grant no. ST/S00193X/1); the National Science Foundation (award no. AST-1517177); the National Aeronautics and Space Administration (grant no. NNX15AI75G); the Swiss National Science Foundation (PP00P2-163967), as well as the Simons Foundation and the MERAC Foundation. The SPECULOOS project also involves telescopes in Tenerife (Spain) and in San Pedro Martir (Mexico).

The discovery team includes researchers from the University of Birmingham, the University of California San Diego, the University of Liège, the Institute of Astrophysics of the Canaries, the American Museum of Natural History, the University of Cambridge, the University of Bern, the Massachusetts Institute of Technology, the University of Göttingen and the University of Warwick.

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