# Astronomers detect a massive brown dwarf orbiting the star TOI-5375

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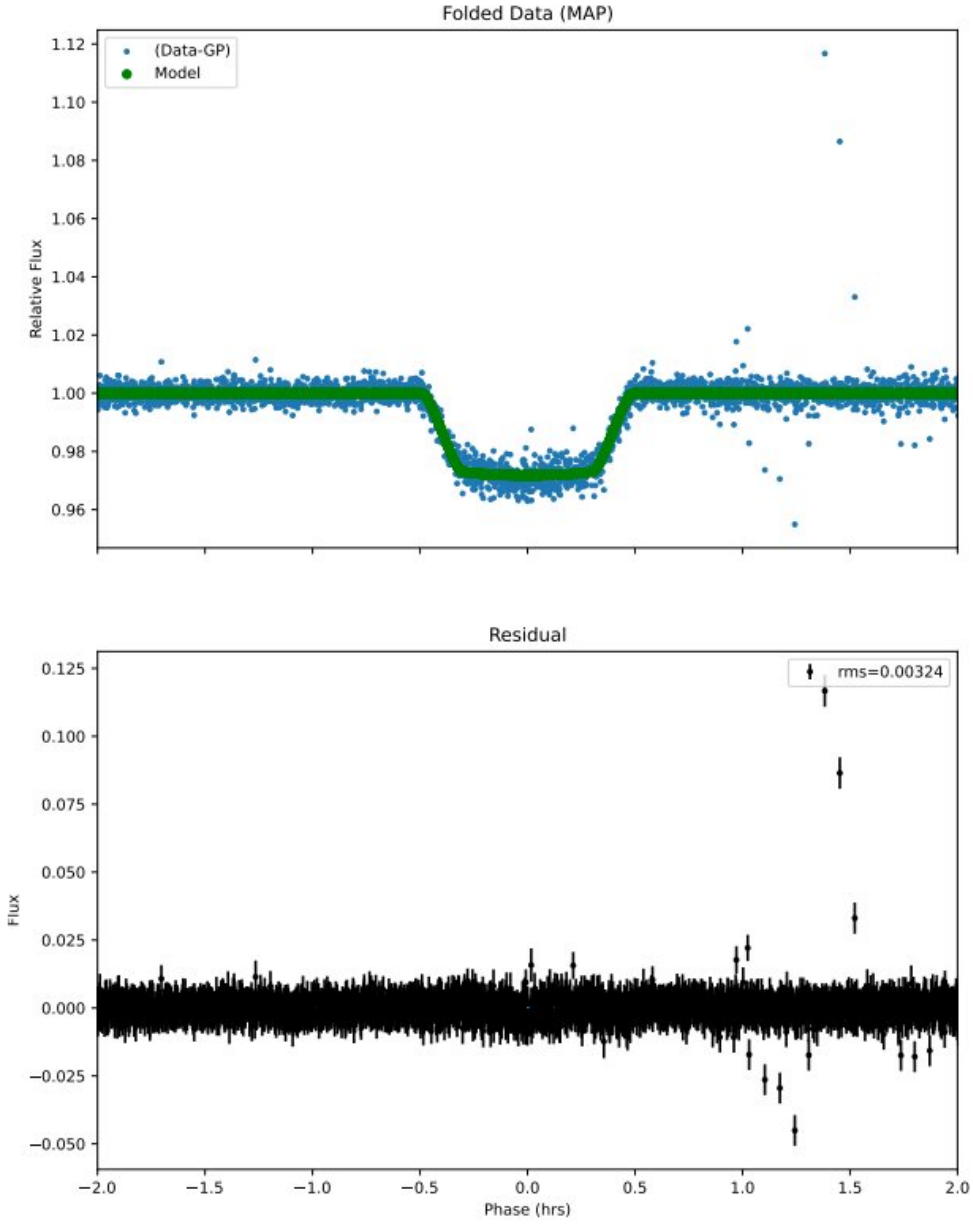

Photometric modelling of TOI-5375. Top: Folded transits in the light curve after the subtraction of the stellar activity signal. The green line shows the best model fit of the transits. Bottom: Residuals of the light curve after the subtraction of the companion transit model. Credit: Maldonado et al, 2023

Using NASA's Transiting Exoplanet Survey Satellite (TESS), astronomers have discovered a new massive brown dwarf. The newfound object is nearly 80 times more massive than Jupiter and orbits an M-dwarf star known as TOI-5375. The finding was presented in a paper published April 10 on the *arXiv* pre-print server.

Brown dwarfs (BDs) are intermediate objects between planets and stars, occupying the mass range between 13 and 80 Jupiter masses (0.012 and 0.076 solar masses). Although many brown dwarfs have been detected to date, such objects orbiting other stars are a rare find.

Recently, a transit signal has been observed with TESS in the light curve of TOI-5375 (also known as TIC 71268730)—an active M dwarf located some 400 light years away. A team of astronomers led by Jesus Maldonado of the Palermo Astronomical Observatory in Italy, has found that this signal is caused by a massive substellar object using space-based photometric observations from TESS combined with high-precision radial velocities from ground-based facilities.

"We reveal the presence of a companion in the brown dwarf/very-low-mass star boundary orbiting around the star TOI-5375," the researchers wrote in the paper.

The newfound companion received designation TOI-5375 b. The object is the size of Jupiter and its mass is estimated to be 77 Jupiter masses,

which yields a density at a level of 98 g/cm$^3$. It orbits the star every 1.72 days, at a distance of 0.025 AU from it. The equilibrium temperature of TOI-5375 b is assumed to be within the range of 931–1,107 K.

Based on its derived properties, Maldonado's team classified TOI-5375 b as a massive brown dwarf. The researchers noted that the newly detected object in the boundary between the brown dwarfs and the very-low-mass stars. The discovery of TOI-5375 b is important for astronomers investigating the brown dwarf/star boundary as massive substellar companions orbiting around M dwarfs are rarely found.

The host star has a spectral type M0.5, and is about 37% smaller and less massive than the sun. The star has a rotational period of approximately 1.97 days and its effective temperature was calculated to be about 3,800 K.

Based on the star's rotational period, the authors of the paper concluded that the orbit of TOI-5375 b decays relatively quickly. They assume that the system should be in the phase in which the star is very close to synchronizing its rotation with the orbital period of the companion.

Summing up the results, the researchers propose further observations of the system using space observatories like the James Webb Space Telescope (JWST). Such studies could improve our knowledge regarding the atmospheres of massive brown dwarfs and low-mass stars.

**More information:** J. Maldonado et al, The GAPS programme at TNG XLV. A massive brown dwarf orbiting the active M dwarf TOI-5375, *arXiv* (2023). DOI: 10.48550/arxiv.2304.04477