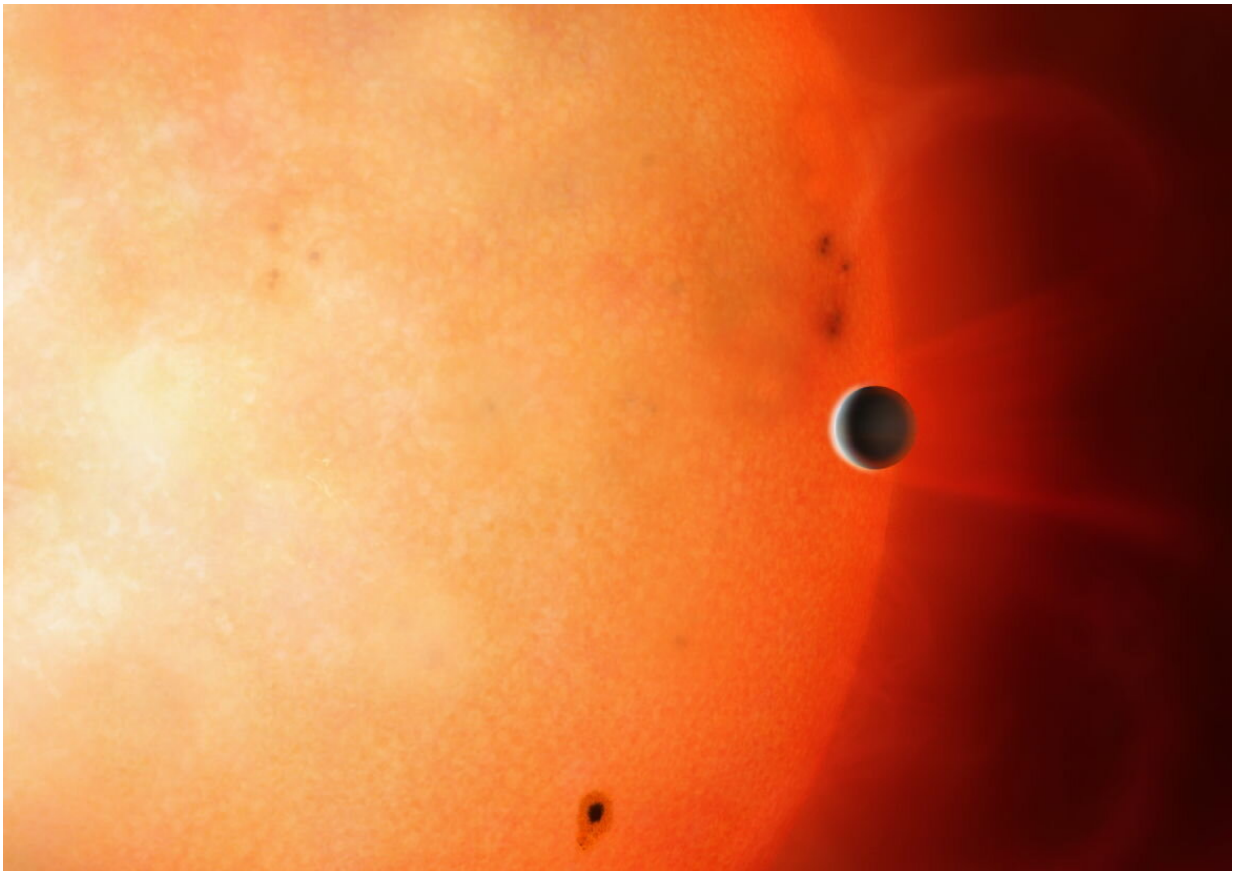


First exposed planetary core discovered allows glimpse inside other worlds

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Artist's impression showing a Neptune-sized planet in the Neptunian Desert. It is extremely rare to find an object of this size and density so close to its star.

Credit: University of Warwick/Mark Garlick

The surviving core of a gas giant has been discovered orbiting a distant

star by University of Warwick astronomers, offering an unprecedented glimpse into the interior of a planet.

The [core](#), which is the same size as Neptune in our own solar system, is believed to be a gas giant that was either stripped of its gaseous atmosphere or that failed to form one in its early life.

The team from the University of Warwick's Department of Physics reports the discovery today in the journal *Nature*, and is thought to be the first time the exposed core of a planet has been observed.

It offers the unique opportunity to peer inside the interior of a planet and learn about its composition.

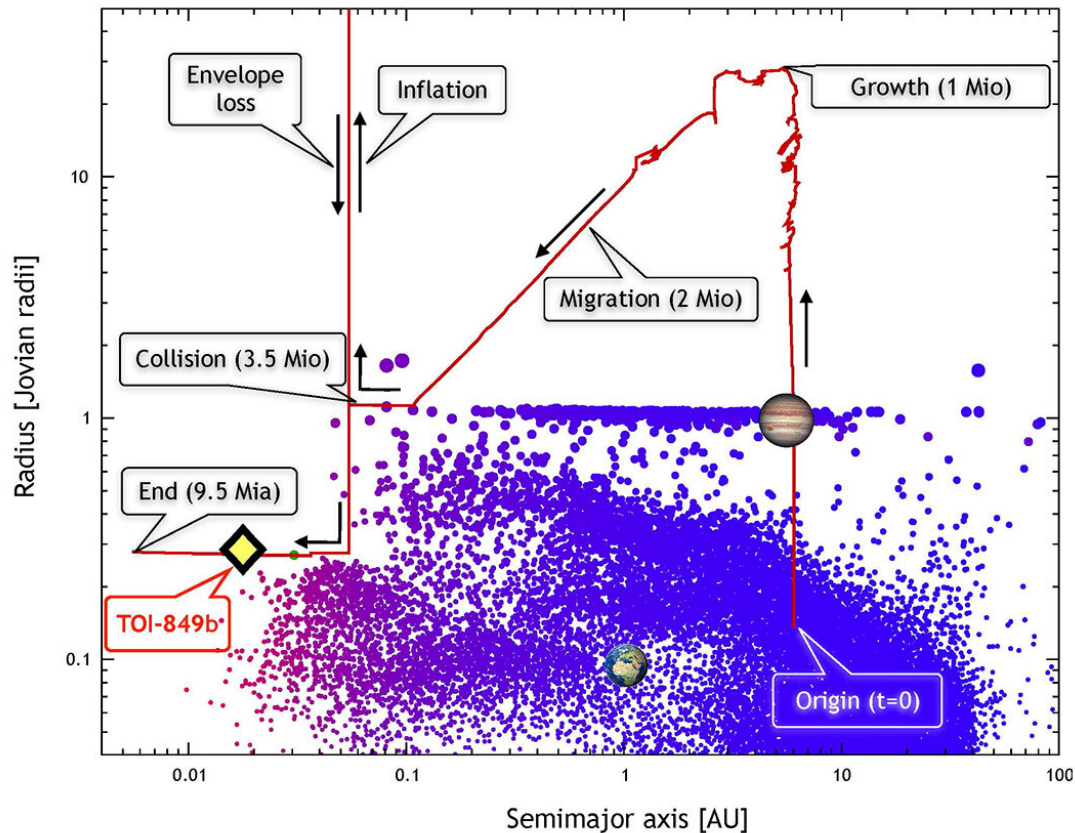
Located around a star much like our own approximately 730 [light years](#) away, the core, named TOI 849 b orbits so close to its [host star](#) that a year is a mere 18 hours and its surface temperature is around 1800K.

TOI 849 b was found in a survey of [stars](#) by NASA's Transiting Exoplanet Survey Satellite (TESS), using the transit method: observing stars for the tell-tale dip in brightness that indicates that a planet has passed in front of them. It was located in the 'Neptunian desert' - a term used by astronomers for a region close to stars where we rarely see planets of Neptune's mass or larger.

The object was then analyzed using the HARPS instrument, on a program led by the University of Warwick, at the European Southern Observatory's La Silla Observatory in Chile. This utilizes the Doppler effect to measure the mass of exoplanets by measuring their 'wobble' - small movements towards and away from us that register as tiny shifts in the star's spectrum of light.

The team determined that the object's mass is 2-3 times higher than

Neptune but it is also incredibly dense, with all the material that makes up that mass squashed into an object the same size.



The red line shows the evolutionary track of a simulated planet that finally has similar properties as the actual planet TOI-849b, as found in the Bern Model of planet formation and evolution. The track is shown in the plane of semimajor axis in astronomical units (AU), that is the orbital distance from the star, on the x-axis, and the radius of the planet in units of jovian radii on the y-axis. The blue-red points show other planets predicted by the model. The Earth and Jupiter are shown at their positions for comparison. The planet starts to form at the initial time $t=0$ years as a small planetary embryo at about 6 AU. The protoplanet grows in mass in the following 1 million year which increases its radius. In this phase, the radius of the planet is still very large, as it is embedded in the protoplanetary

disk in which it forms. The increasing mass of the protoplanet causes it to migrate inwards, towards the star. This reduces again the size of the planet. After 3.5 million years, the planet has migrated to the inner edge of the disk. There, it suffers a very energetic giant impact with another protoplanet in its planetary system. The enormous heat liberated in the collision strongly inflates the gaseous envelope of the planet. The envelope is lost via Roche-lobe overflow, and an exposed planetary core comes into existence. In the following billions of years, the exposed core slowly spirals towards its host star because of tidal interactions. The simulate planet now has properties like a mass, radius, and orbital distance which are very similar the observed properties of TOI-849b that is shown by a black-yellow symbol. In the end, after about 9.5 billion years, the planet falls into its host star. Credit: © University of Bern

Lead author Dr. David Armstrong from the University of Warwick Department of Physics said: "While this is an unusually [massive planet](#), it's a long way from the most massive we know. But it is the most massive we know for its size, and extremely dense for something the size of Neptune, which tells us this planet has a very unusual history. The fact that it's in a strange location for its mass also helps—we don't see planets with this mass at these short orbital periods.

"TOI 849 b is the most massive terrestrial planet—that has an earth like density—discovered. We would expect a planet this massive to have accreted large quantities of hydrogen and helium when it formed, growing into something similar to Jupiter. The fact that we don't see those gases lets us know this is an exposed planetary core.

"This is the first time that we've discovered an intact exposed core of a gas giant around a star."

There are two theories as to why we are seeing the planet's core, rather than a typical gas giant. The first is that it was once similar to Jupiter but

lost nearly all of its outer gas through a variety of methods. These could include tidal disruption, where the planet is ripped apart from orbiting too close to its star, or even a collision with another planet. Large-scale photoevaporation of the atmosphere could also play a role, but can't account for all the gas that has been lost.

Alternatively, it could be a 'failed' gas giant. The scientists believe that once the core of the gas giant formed then something could have gone wrong and it never formed an atmosphere. This could have occurred if there was a gap in the disk of dust that the planet formed from, or if it formed late and the disk ran out of material.

Dr. Armstrong adds: "One way or another, TOI 849 b either used to be a gas giant or is a 'failed' gas giant.

"It's a first, telling us that [planets](#) like this exist and can be found. We have the opportunity to look at the core of a planet in a way that we can't do in our own solar system. There are still big open questions about the nature of Jupiter's core, for example, so strange and unusual exoplanets like this give us a window into planet formation that we have no other way to explore.

"Although we don't have any information on its chemical composition yet, we can follow it up with other telescopes. Because TOI 849 b is so close to the star, any remaining atmosphere around the planet has to be constantly replenished from the core. So if we can measure that atmosphere then we can get an insight into the composition of the core itself."

More information: A remnant planetary core in the hot-Neptune desert, *Nature* (2020). [DOI: 10.1038/s41586-020-2421-7](https://doi.org/10.1038/s41586-020-2421-7) , www.nature.com/articles/s41586-020-2421-7

Provided by University of Warwick

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