Astronomers find first evidence of changing conditions on a super Earth

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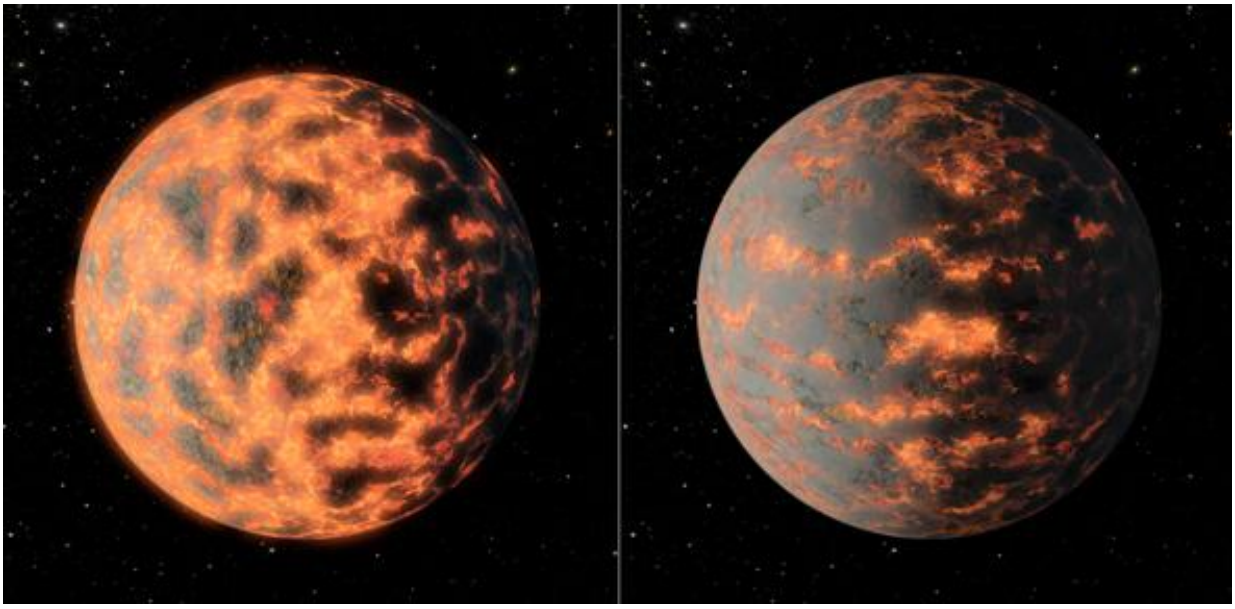

Artist's impression of super-Earth 55 Cancri e, showing a hot partially-molten surface of the planet before and after possible volcanic activity on the day side. Credit: NASA/JPL-Caltech/R. Hurt

Astronomers have detected wildly changing temperatures on a super Earth – the first time any atmospheric variability has been observed on a rocky planet outside the solar system – and believe it could be due to huge amounts of volcanic activity, further adding to the mystery of what had been nicknamed the 'diamond planet'.

For the first time, researchers led by the University of Cambridge have detected atmospheric variability on a rocky planet outside the solar system, and observed a nearly threefold change in temperature over a two year period. Although the researchers are quick to point out that the cause of the variability is still under investigation, they believe the readings could be due to massive amounts of volcanic activity on the surface. The ability to peek into the atmospheres of rocky 'super Earths' and observe conditions on their surfaces marks an important milestone towards identifying habitable planets outside the solar system.

Using NASA's Spitzer Space Telescope, the researchers observed thermal emissions coming from the planet, called 55 Cancri e – orbiting a sun-like star located 40 light years away in the Cancer constellation – and for the first time found rapidly changing conditions, with temperatures on the hot 'day' side of the planet swinging between 1000 and 2700 degrees Celsius.

"This is the first time we've seen such drastic changes in light emitted from an exoplanet, which is particularly remarkable for a super Earth," said Dr Nikku Madhusudhan of Cambridge's Institute of Astronomy, a co-author on the new study. "No signature of thermal emissions or surface activity has ever been detected for any other super Earth to date."

Although the interpretations of the new data are still preliminary, the researchers believe the variability in temperature could be due to huge plumes of gas and dust which occasionally blanket the surface, which may be partially molten. The plumes could be caused by exceptionally high rates of volcanic activity, higher than what has been observed on Io, one of Jupiter's moons and the most geologically active body in the solar system.

"We saw a 300 percent change in the signal coming from this planet,

which is the first time we've seen such a huge level of variability in an exoplanet," said Dr Brice-Olivier Demory of the University's Cavendish Laboratory, lead author of the new study. "While we can't be entirely sure, we think a likely explanation for this variability is large-scale surface activity, possibly volcanism, on the surface is spewing out massive volumes of gas and dust, which sometimes blanket the thermal emission from the planet so it is not seen from Earth."

55 Cancri e is a 'super Earth': a rocky exoplanet about twice the size and eight times the mass of Earth. It is one of five planets orbiting a sun-like star in the Cancer constellation, and resides so close to its parent star that a year lasts just 18 hours. The planet is also tidally locked, meaning that it doesn't rotate like the Earth does – instead there is a permanent 'day' side and a 'night' side. Since it is the nearest super Earth whose atmosphere can be studied, 55 Cancri e is among the best candidates for detailed observations of surface and atmospheric conditions on rocky exoplanets.

Most of the early research on exoplanets has been on gas giants similar to Jupiter and Saturn, since their enormous size makes them easier to find. In recent years, astronomers have been able to map the conditions on many of these gas giants, but it is much more difficult to do so for super Earths: exoplanets with masses between one and ten times the mass of Earth.

Earlier observations of 55 Cancri e pointed to an abundance of carbon, suggesting that the planet was composed of diamond. However, these new results have muddied those earlier observations considerably and opened up new questions.

"When we first identified this planet, the measurements supported a carbon-rich model," said Madhusudhan, who along with Demory is a member of the Cambridge Exoplanet Research Centre. "But now we're

finding that those measurements are changing in time. The planet could still be carbon rich, but now we're not so sure – earlier studies of this planet have even suggested that it could be a water world. The present variability is something we've never seen anywhere else, so there's no robust conventional explanation. But that's the fun in science – clues can come from unexpected quarters. The present observations open a new chapter in our ability to study the conditions on rocky exoplanets using current and upcoming large telescopes."

More information: "Variability in the super-Earth 55 Cnc e." *arXiv*:1505.00269. arxiv.org/abs/1505.00269

Provided by University of Cambridge