Super-Earth or mini-Neptune? Planetary researcher uses SOFIA to observe exoplanet transit

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Scientists at the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) have used the SOFIA stratospheric observatory to observe a planet outside of the Solar System. Studying its atmosphere will enable them to determine whether this exoplanet is a super-Earth or a mini-Neptune. Claudia Dreyer was DLR's first Principal Investigator on board the research aircraft.

The exoplanet, which is 40 light years from Earth, is referred to as GJ 1214b. At the time of its discovery in 2009, it was the second most Earth-like planet after CoRoT-7b. However, its average density, which has been determined from independent measurements of its mass and radius, indicates that it might be a Neptune-like planet. Scientists in the Extrasolar Planets and Atmospheres Section at the DLR Institute of Planetary Research used instruments on the SOFIA observatory to observe a transit of the planet at multiple wavelengths, in order to determine the composition of its atmosphere. This offers the researchers the best opportunity of observing exoplanets with greater accuracy at various wavelengths and ultimately of determining the composition of their atmosphere. SOFIA enables observations to be made at wavelengths that can otherwise only be reached using space telescopes, as they are absorbed by the Earth's atmosphere. Also, the stratospheric observatory returns to the ground every day, so instruments and filters can be replaced.

Super-Earth or mini-Neptune?

GJ 1214b was discovered using the transit method. A 'transit' occurs when a planet passes in front of its host star, causing a reduction in the observed light intensity. This method enables the radius of the planet to be determined – GJ 1214b is 2.7-times the size of Earth. In addition, the 'radial velocity' method has been used to determine that its mass is 6.5-times greater than that of our home planet. These two pieces of data in turn enable the density of the body to be determined, from which conclusions can be drawn as to the possible composition of the planet; for example, is it a rocky or a gaseous planet? According to the data, the exoplanet might be a rocky planet with an extended atmosphere that has the density of water.

More precise determination of the composition of the planet requires investigation of its atmosphere. "If the atmosphere predominantly consists of water vapour, it will indicate that this is an oceanic planet; that is, a planet whose surface is largely covered with water," says project leader Claudia Dreyer. "There is no comparable planet in the Solar System, although the water coverage might be comparable to that of the Earth, hence, super-Earth," Dreyer adds. On the other hand, if there is evidence of a hydrogen-rich atmosphere with clouds, it might be a planet similar to Neptune. However, it would be lighter than Neptune and might therefore be called a 'mini-Neptune'.

Currently, research results cannot exclude either theory and a full assessment of the available data is needed. The Berlin-based planetary researchers are now analysing the data from the most recent observations. Until now, the theories have been based on observations either just in the infrared or just in the visible part of the spectrum. "The SOFIA investigations have enabled us to take measurements in both these parts of the spectrum at the same time. Furthermore, we have added a wavelength which has not previously been studied," says Dreyer. The advantage of this method is that the data is captured under identical stellar conditions, preventing fluctuations in the brightness of the star leading to varying results.

Dreyer used SOFIA to observe the transit for 52 minutes. "Full assessment of the data will take some time. We are confident that we will be able to contribute to the debate as to what kind of planet GJ 1214b is," says Dreyer, describing the work to be conducted in the coming weeks.

About SOFIA

SOFIA, the Stratospheric Observatory For Infrared Astronomy, is a joint project operated by the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR;) and the National Aeronautics and Space Administration (NASA). The German contribution to the project is managed by DLR, using funds provided by the Federal Ministry for Economics and Technology (Bundesministerium für Wirtschaft und Energie), in accordance with a decision made by the German Federal Parliament (Bundestag), and funds from the State of Baden-Württemberg and the University of Stuttgart. The scientific operations are coordinated by the German SOFIA Institute (Deutsche SOFIA Institut; DSI) on the German side, and by the Universities Space Research Association (USRA) on the American side. Development of the German instruments is financed using funds from the Max Planck Society (Max-Planck-Gesellschaft; MPG) and the German Research Foundation (Deutsche Forschungsgemeinschaft; DFG).

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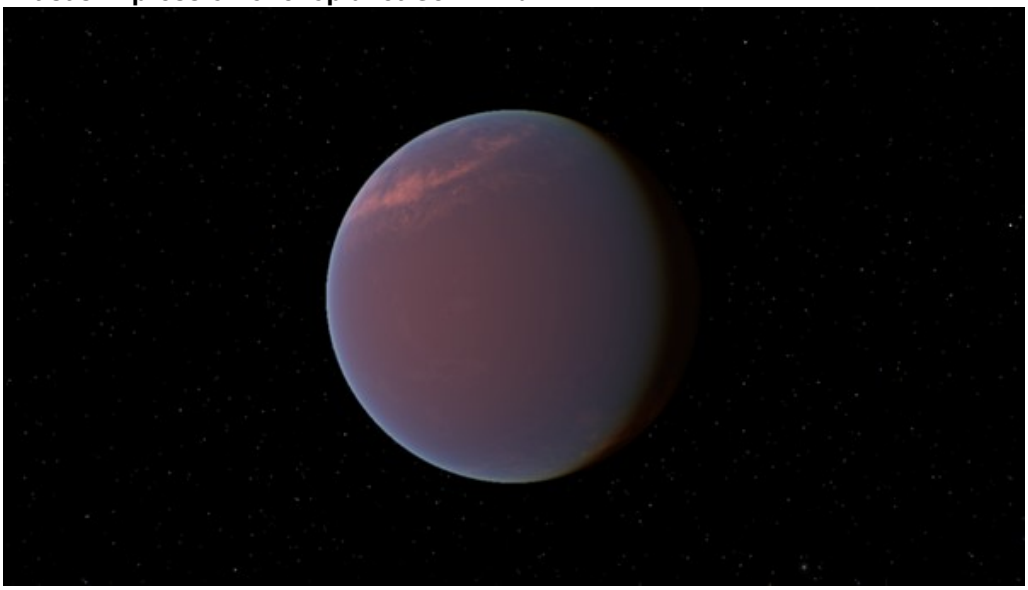
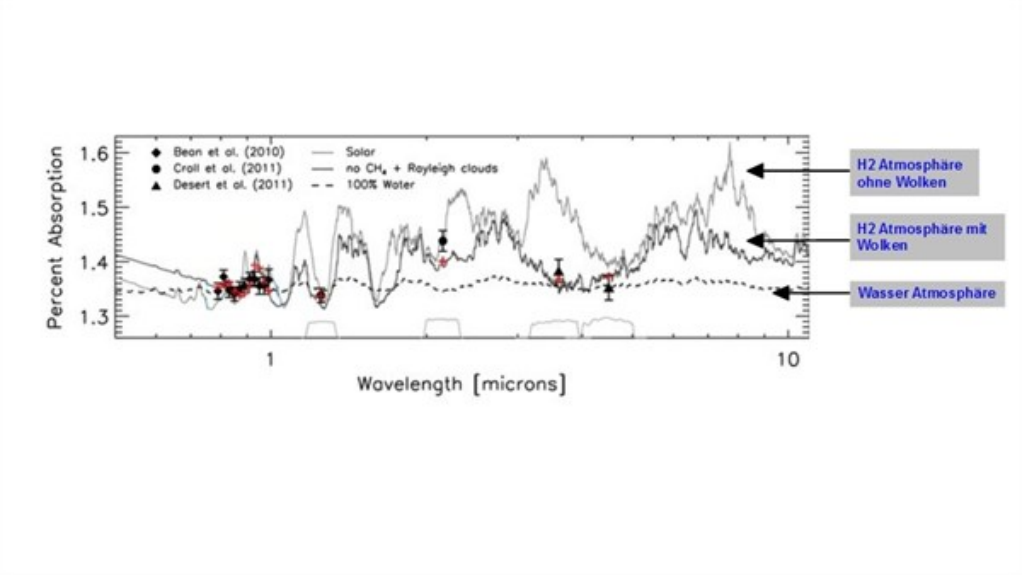
Artist's impression of exoplanet GJ 1214b



GJ 1214b is 40 light years from Earth. DLR researchers are investigating whether this exoplanet is a rocky planet with an extended atmosphere that has the density of water.

Transmission spectrum of GJ 1214b



Transmission spectrum of GJ 1214b with three model spectra: hydrogen atmosphere with no clouds [H2 Atmosphäre ohne Wolken], hydrogen atmosphere with Rayleigh clouds [H2 Atmosphäre met Wolken] and water vapour atmosphere [Wasser Atmosphäre]. The illustration is taken from Kempton et al., 2012 and labels have been added.

Credit: DLR (CC-BY 3.0).

SOFIA airborne observatory

SOFIA provides researchers with the best opportunities to observe exoplanets more accurately at different wavelengths in order to determine the composition of their atmospheres.

Credit: NASA/C. Thomas.

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