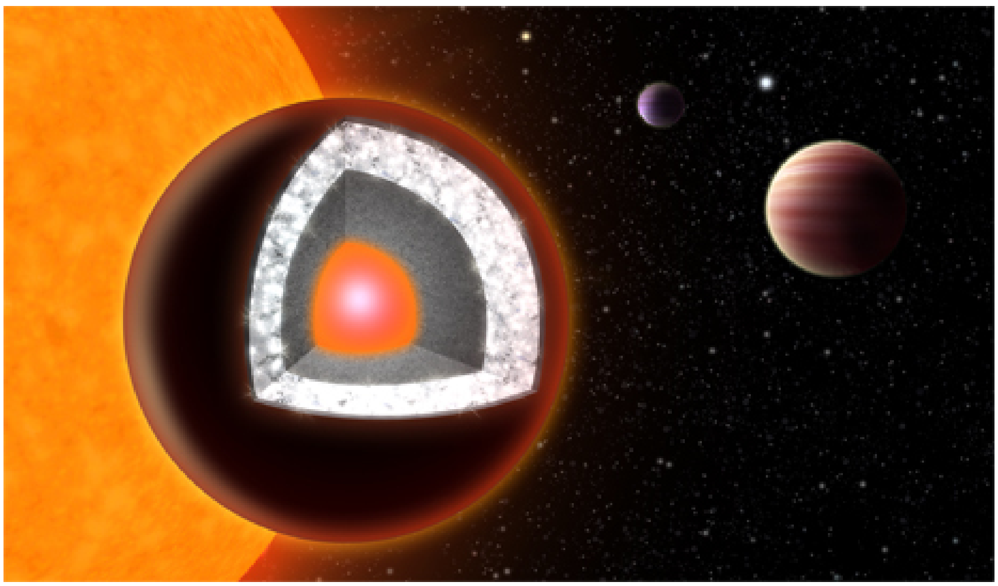
Diamond 'super-Earth' may not be quite as precious, graduate student finds

October 8 2013, by Daniel Stolte



In the sky with diamonds? A so-called Super-Earth, planet 55 Cancri e was believed to be the first known planet to consist largely of diamond, due in part to the high carbon-to-oxygen ratio of its host star. Credit: Haven Giguere/Yale University

(Phys.org) —An alien world reported to be the first known planet to consist largely of diamond appears less likely to be of such precious nature, according to a new analysis led by UA graduate student Johanna Teske.

A planet 40 light years from our solar system, believed to be the firstever discovered planet to consist largely of diamond, may in fact be of less exquisite nature, according to new research led by University of Arizona astronomy graduate student Johanna Teske.

Revisiting public data from previous telescope observations, Teske's team analyzed the available data in more detail and concluded that carbon – the chemical element diamonds are made of – appears to be less abundant in relation to oxygen in the planet's host star – and by extension, perhaps the planet – than was suggested by a study of the host star published in 2010.

"The 2010 paper found that '55 Cancri,' a star that hosts five planets, has a carbon-to-oxygen ratio greater than one," Teske said. "This observation helped motivate a paper last year about the innermost planet of the system, the 'super-Earth' 55 Cancri e. Using observations of the planet's mass and radius to create models of its interior that assumed the same carbon-to-oxygen ratio of the star, the 2012 paper suggested the planet contains more carbon than oxygen."

"However, our analysis makes this seem less likely because the host star doesn't appear as carbon-rich as previously thought," Teske said.

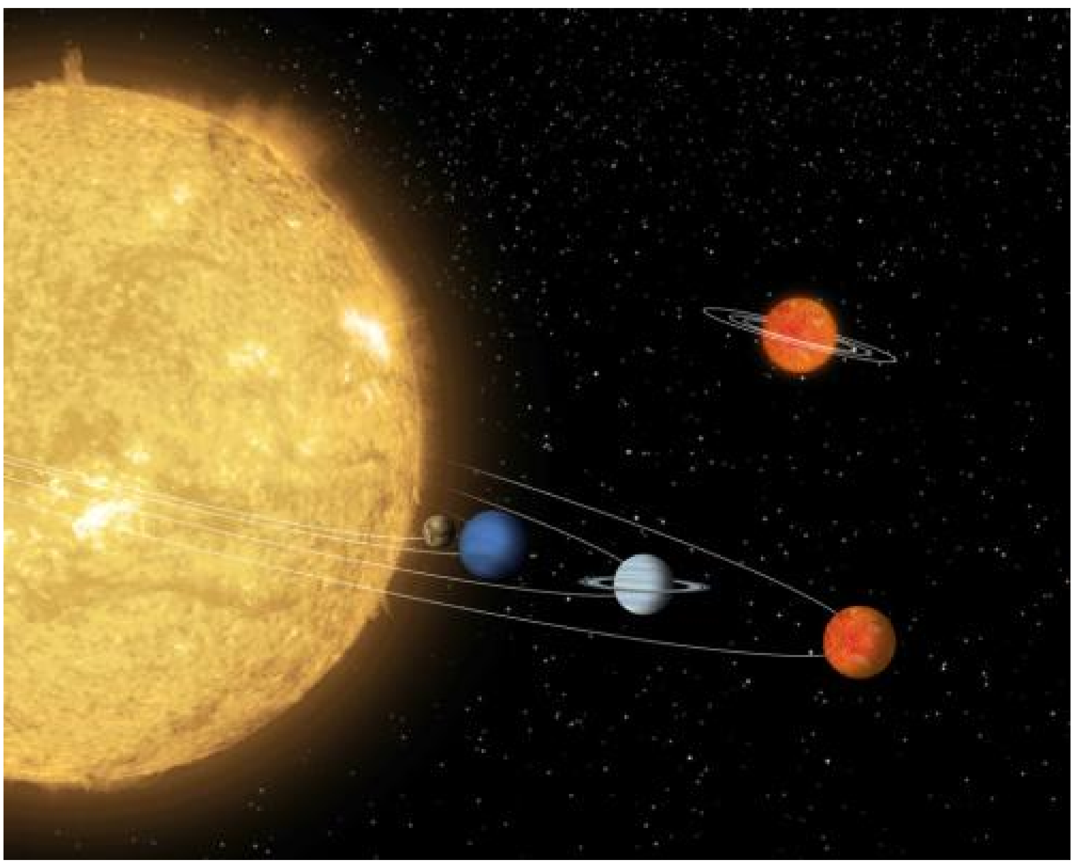
Observations obtained in 2010, together with simulations astronomers use to model a planet's interior based on data like radius, mass and orbital velocity, had yielded a carbon to oxygen ratio greater than one, in other words, an alien world based on carbon instead of oxygen as most planets are in our solar system, including Earth.

"The sun only has about half as much carbon as oxygen, so a star or a planet with a higher ratio between the two elements, particularly a planet with more carbon than oxygen, is interesting and different from what we have in our solar system," explained Teske, who is graduating this spring with a doctorate from the UA's Department of Astronomy and Steward

Observatory.

Based on the previous results, it was suggested that the "diamond planet" is a rocky world with a surface of graphite surrounding a thick layer of diamond instead of water and granite like Earth.

The new research by Teske and collaborators, to be published in the *Astrophysical Journal* and available online, calls this conclusion in question, making it less likely a hypothetical space probe sent to sample the planet's innards would dig up anything sparkling.



The smallest of several planets in the 55 Cancri system, the former 'diamond planet' is seen orbiting its host star at very close range in this artist's impression. A nearby brown dwarf with its own 'miniature' planetary system is pictured as well. Credit: NASA/JPL-Caltech

Teske's group found that the planet's host star contains almost 25 percent more oxygen than carbon, about mid way between the Sun and what the previous study suggested.

"In theory, 55 Cancri e could still have a high carbon to oxygen ratio and be a diamond planet, but the host star does not have such a high ratio," Teske said. "So in terms of the two building blocks of information used for the initial 'diamond-planet' proposal – the measurements of the exoplanet and the measurements of the star – the measurements of the star no longer verify that."

A so-called super-Earth boasting about twice the Earth's diameter and eight times Earth's mass, the "diamond planet," whose official designation is 55 Cancri e, is the smallest member of a five-planet system located in the constellation Cancer. 55 Cancri e races around its host star at such close distance that one year lasts only 18 hours and its surface temperature is more than 3,000 degrees Fahrenheit.

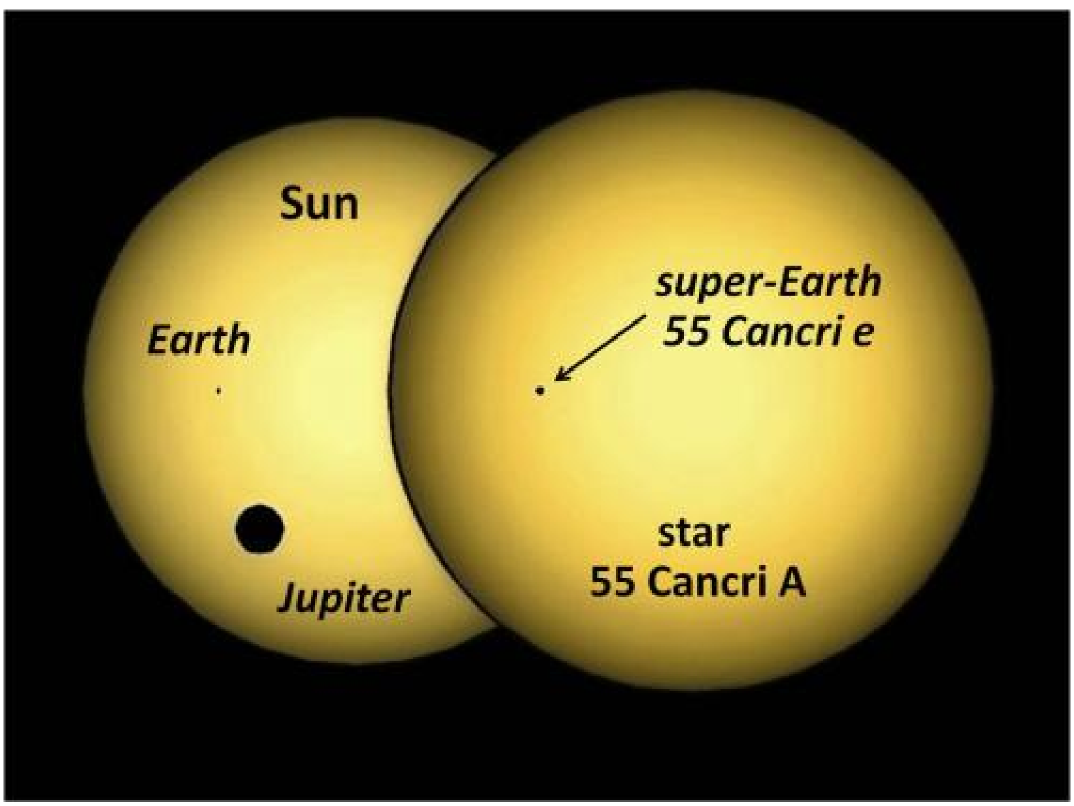
"With rocky worlds like 55 Cancrie, researchers use measurements of a planet's radius, mass and density and basic physical equations governing the internal structure of solid planets to calculate possible compositions of the planet's interior," Teske said.

"This planet is probably rocky or has a large rocky component," she said. "We don't really know if it has an atmosphere."

Since astronomers can't probe the makeups of stars and planets directly, they rely on indirect observational methods such as absorption spectra; each chemical element absorbs light at different wavelengths, in a characteristic pattern that can be used as a fingerprint of that element. By analyzing the absorption spectra of starlight passing through a star's atmosphere, it is possible to deduce what elements are present in the star's atmosphere.

"Instead of using the same absorption lines in the spectrum of the host star as the previous study of 55 Cancri, we looked at more lines of carbon and more lines of oxygen," Teske said. "We find that because this particular host star is cooler than our sun and more metal-rich, the single oxygen line analyzed in the previous study to determine the star's oxygen abundance is more prone to error."

Teske instead relied on several different indicators of the oxygen abundance that were not considered previously. "Averaging all of these measurements together gives us a more complete picture of the oxygen abundance in the star."



A simulation of the silhouette of planet 55 Cancri e passing in front of ("transiting") its parent star, compared to the Earth and Jupiter transiting our Sun, as seen from outside the Solar System. Credit: Jason Rowe/NASA Ames and SETI Institute and Jaymie Matthews/UBC

Teske pointed out that the 'diamond planet' results hinge on the presumption that a star's composition bears some relation to the composition of its planets, a notion grounded in the idea that planets form from the same material as their host stars. However, as astronomers discover more and more extrasolar systems, a one-size-fits-all formula becomes less likely.

"We still don't know whether our solar system is common or uncommon in the universe," Teske said, "because many of the systems that we are finding have giant gas planets closer to the star, unlike our system where rocky planets dominate the inner orbits and gas giants occur further out."

Given there are so many processes – most of which are not fully understood – happening in a planet-forming disk that could influence the composition of planets, Teske said: "At this point, I would honestly be surprised if there was a one-to-one correlation."

"The compositions of planets and stars don't always match," she said, explaining that in a swirling disk of dust and gas giving birth to a star and planets, "you can have pockets where there is a lot of water, meaning an enhancement of oxygen. Or places where water has frozen out, leaving behind carbon species as the dominant gas molecules. So the planets that are accreting gas at those locations in the disk could be more carbon-rich instead of oxygen-rich."

Therefore, room for uncertainty remains, according to the researchers.

"Depending on where 55 Cancri e formed in the protoplanetary disk, its carbon-to-oxygen ratio could differ from that of the host star," Teske said. "It could be higher or lower. But based on what we know at this point, 55 Cancri e is more of a 'diamond in the rough.'"

More information: arxiv.org/abs/1309.6032

Provided by University of Arizona

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