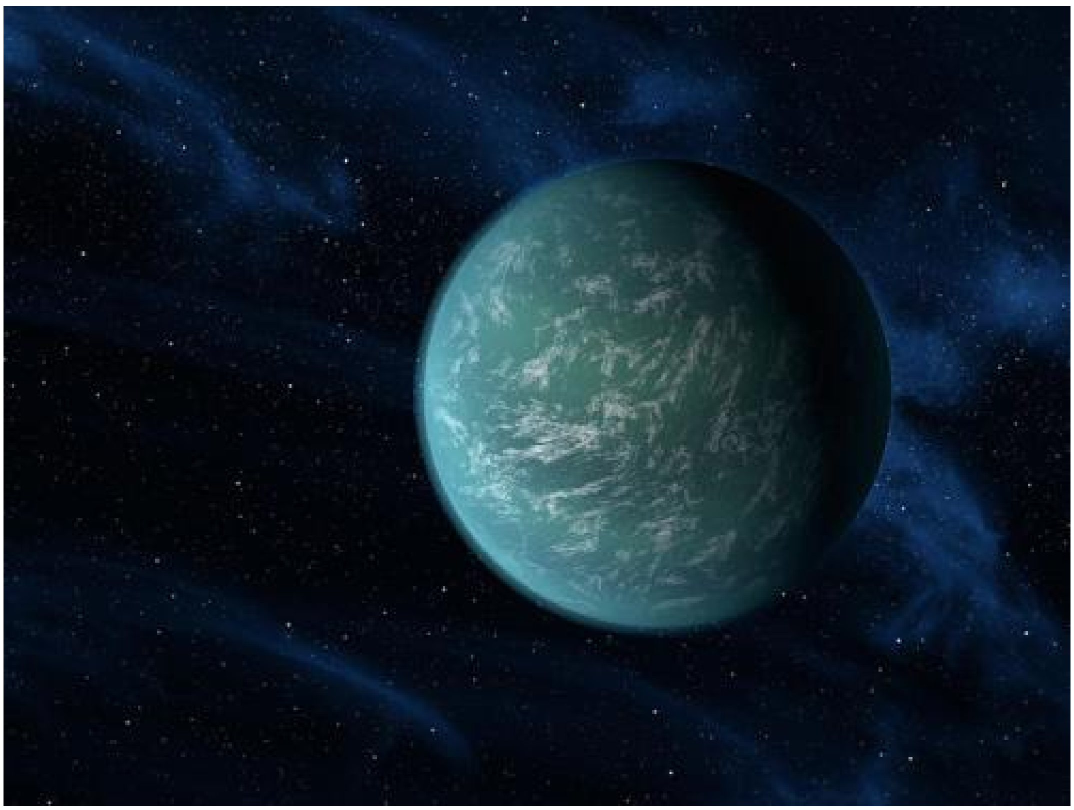
Research trio suggests exomoon atmospheres could cause false-positive signs of life on exoplanets

April 29 2014, by Bob Yirka



This artist's conception illustrates Kepler-22b, a planet known to comfortably circle in the habitable zone of a sun-like star. Credit: NASA/Ames/JPL-Caltech

(Phys.org) —A trio of space scientists has published a paper in *Proceedings of the National Academy of Sciences* in which they suggest that current assumptions regarding using spectral signatures as a means to identify exoplanets that may harbor life, has a major flaw—a false positive could occur if the planet has a moon with an atmosphere that contaminates the spectrum. In their paper, Hanno Rein, Yuka Fujii and David Spiegel of the University of Toronto, the Tokyo Institute of Technology and MIT respectively, point out a major problem with using spectral signatures as a means for finding out if life exists on other planets—moons which can cause the false impression of chemical disequilibrium.

Spectral signatures are found by comparing the light that passes through the atmosphere of an exoplanet with its host star. Doing so allows scientists to discern which gases are in the planet's atmosphere. If there are two gases that exist, that likely wouldn't in the absence of life, than logic suggests there might be life there. An example would be an atmosphere that holds both oxygen and methane. Because they react with one another (causing one to dissipate), the only way an atmosphere could hold both is if the supply of one of them is being continuously replenished—most likely (because of the types of gases involved) by a living creature on the surface below. The logic up to that point, is fine, the researchers suggest, except for that it doesn't take into account what happens if for example, the planet's atmosphere has oxygen and its moon has an atmosphere that holds methane. They're too far apart to react with one another but so close together that to us, they'd appear as one spectral signature, representing a false positive.

The team points out that current telescope technology is not accurate enough to allow for separating out moons with atmospheres from their host planets, and won't be in the near future, thus using spectral signatures as a means for identifying possible life-supporting candidate exoplanets (such as the recently discovered Kepler-186f) cannot be viewed as a viable option. They conclude that because of such a flaw, it might be beyond our current abilities to identify the existence of life on other planets, unless it can be identified in some other way, such as the detection of "intelligent" radio signals.

More information: Some inconvenient truths about biosignatures involving two chemical species on Earth-like exoplanets, Hanno Rein, *PNAS*, 2014. DOI: 10.1073/pnas.1401816111

Abstract
The detection of strong thermochemical disequilibrium in the atmosphere of an extrasolar planet is thought to be a potential biosignature. In this article we present a previously unidentified kind of false positive that can mimic a disequilibrium or any other biosignature that involves two chemical species. We consider a scenario where the exoplanet hosts a moon that has its own atmosphere and neither of the atmospheres is in chemical disequilibrium. Our results show that the integrated spectrum of the planet and the moon closely resembles that of a single object in strong chemical disequilibrium. We derive a firm limit on the maximum spectral resolution that can be obtained for both directly imaged and transiting planets. The spectral resolution of even idealized space-based spectrographs that might be achievable in the next several decades is in general insufficient to break the degeneracy. Both chemical species can only be definitively confirmed in the same object if absorption features of both chemicals can be unambiguously identified and their combined depth exceeds 100%.

— Press release

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