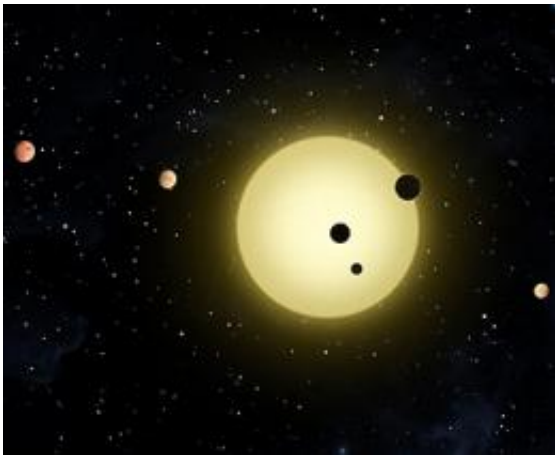


3 Questions: Sara Seager on discovering a trove of new planets

February 4 2011, By David L. Chandler



Kepler-11 is a sun-like star around which six planets orbit. At times, two or more planets pass in front of the star at once, as shown in this artist's conception of a simultaneous transit of three planets observed by NASA's Kepler. Credit: NASA/Tim Pyle

NASA's Kepler -- an orbiting, planet-finding telescope launched in 2009 -- has [dramatically increased the discovery rate](#) of planets around stars other than the sun, known as exoplanets. Before Kepler, there were a total of about 520 known exoplanets, but last year the Kepler team announced 700 new exoplanet "candidates," and this week they unveiled about 500 more. About 60 to 80 percent of these 1,200 Kepler candidates are considered likely to be real planets, and the new trove includes a number of surprising features.

Sara Seager, the Ellen Swallow Richards Professor of Planetary Science and professor of physics at MIT, is a member of the Kepler science team, and MIT News asked her to explain the significance of these new findings.

Q. What was the most interesting new planet or planetary system reported in this recent release of Kepler data?

A. The Kepler team announced what is arguably the most fascinating planetary system ever discovered, called Kepler-11. It has six transiting planets (which have all been confirmed), the most transiting planets of any system yet seen. Moreover, the five inner planets move in the most closely packed planetary orbits yet found. All five inner planets orbit their sun-like star at distances closer than Mercury is to our sun (with complete solar orbits ranging from 10 to 47 days).

Being so close to each other, the five inner planets gravitationally perturb each other's orbits. The level of gravitational interaction is so high that each planet's orbit (or year) is not consistent, but each year varies by 10 to 20 minutes. In comparison, Earth's orbit varies by negligible amounts each year. From the gravitational interactions, each of the planets' masses can actually be determined. This kind of planetary mass determination is so far unique to Kepler — and made possible by Kepler's unparalleled precision measurements of star brightness.

With a planetary radius (determined from the Kepler data) and planetary mass, one can derive a planet's density. Hence we can approximately describe what the inner five Kepler-11 planets are made of. We would have expected the planets to be rocky, like the inner terrestrial planets of our own solar system (Mercury, Venus, Earth and Mars). Yet, surprisingly, the Kepler-11 planets are of too low a density to be purely rock. The planets therefore must have low-density material — such as gas or ice — in layers above any rocky and iron interior, making the

Kepler-11 planets unlike any planet in our own solar system.

Q. This release of data represents a huge increase in the number of known exoplanets, all at once. Is this greatly increased discovery rate changing the way astronomers are approaching the study of exoplanets?

A. Kepler has announced 1,235 planet candidates, potentially tripling the number of known planets in our galaxy. With these planet candidates, Kepler is single-handedly changing the way we do exoplanet science — from studying individual objects to studying the statistics of a large number of planet candidates.

Because of limitations on telescope time and people power, and also the faintness of the stars, most of these planet candidates will not be able to be confirmed as planets. Nonetheless, by statistical analysis of these candidates Kepler will be able reach its main goal: to answer the question, “How common are Earth-like planets in Earth-like orbits about sun-like stars?”

As a second example of science from large planet candidate numbers, Kepler has announced 662 Neptune-size planet candidates. This is incredible, even if 20 to 40 percent are expected not to be bona fide planets. Planetary scientists barely understand how our solar system’s Uranus and Neptune formed, beyond a contrived scenario. Now we need an explanation of why Neptune-size planets are among the most common planets out there.

The sheer numbers of stars with multiple transiting planets and varying orbits is opening up a whole new field in exoplanetary science.

Q. Do these discoveries tell us anything new about the likelihood of discovering life on other planets?

A. Not yet. Kepler will tell us how common it is for Earth-size planets to orbit around sun-like stars in their habitable zones — even though the Kepler planets themselves cannot be followed up for signs of life in their atmospheres because they are too faint and distant to be studied in detail by existing telescopes.

Kepler's finding of 54 planet candidates within their star's habitable zone is tantalizing. The habitable zone is the region around a star with the right temperatures for surface liquid water. All life on Earth requires liquid water, and so the planets that can potentially support life are those orbiting in the star's habitable zone. Most of Kepler's habitable zone planets are large planets, almost certainly with massive gas envelopes that make the planetary surface too hot to support complex molecules needed for life. Out of the half dozen small planet candidates orbiting in their star's [habitable zone](#), five are less than twice the size of Earth and one is even smaller than Earth. These planets orbit small, low-luminosity stars very different from our sun.

We will have to be patient for Kepler to tell us how common Earth-like [planets](#) orbiting in the habitable zones of sun-like stars actually are. We will be ready to act; once informed, we can plan the next step for space telescopes that can search for signs of life in the atmospheres of distant Earths.

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