3 Questions: Sara Seager on searching for Earth-like planets

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Sara Seager, the Ellen Swallow Richards Associate Professor in the Department of Earth, Atmospheric, and Planetary Sciences. Photo courtesy of Sara Seager

(PhysOrg.com) -- MIT planetary scientist Sara Seager has been studying exoplanets — planets circling stars other than the sun — for many years.

The first such planet was discovered just 15 years ago, and now more than 400 others are known. This week, a paper co-authored by Seager and NASA scientist Drake Deming in the journal *Nature* reviews what we know about exoplanets so far, what we can expect to learn about them in the next decade or so, and the chances for finding a twin of our own planet. She has also just published an online book to answer questions about exoplanets and the lessons they hold.

Q. How far are we from being able to directly detect an Earth-like planet, and what will be required to make it possible?

A. To find and identify a true Earth twin we need to go to space, to get away from the blurring effects of Earth's atmosphere. Finding a true Earth twin is very challenging, not because an Earth is so faint (it’s not fainter than the faintest galaxies ever observed by the Hubble Space Telescope), but because of the adjacent bright star; the sun is 10 billion times brighter than Earth at visible wavelengths. To make a detection possible, we need to develop technology to block out the star light. We have other ways of finding Earth-size and/or Earth-mass planets. But knowing the size and mass of a planet isn't enough to tell if it's really an Earth twin, because we want to know that the temperature on the planet is suitable for life. We also want to know what the atmosphere is made of, to find water vapor (indicative of liquid water oceans) and biosignature gases (those produced by life). Venus and Earth are about the same size, so without the ability to study the planet’s atmosphere we will not know if the planet is habitable.

Q. If we are able to find a transiting super-Earth (an Earth-like rocky planet *with a habitable temperature, but much larger than Earth) that’s not too far away, what kinds of things could we learn from it, and what are the chances we could clearly detect the presence of life if there is any there?*

A. We could learn about the bulk composition of the planet, the planet’s atmospheric temperature, and the planet’s atmospheric composition. We do have a chance to detect signs of life, later in this decade when a new space telescope, the James Webb Space Telescope, is launched in 2014. We also need a very favorable candidate around a star that is not too faint. Mostly we want to take a spectrum and look at features caused by gas molecules in a planet's atmosphere. A planetary atmosphere that is completely out of chemical equilibrium is indicative of life, because under most conditions a planet's atmosphere will be in chemical equilibrium. Earth's atmosphere is composed of 21 percent oxygen by volume due to plants and photosynthetic bacteria. Oxygen is such a reactive gas that it shouldn't be in our atmosphere at all. Oxygen is a key gas we hope to find on exoplanets.

Q. Apart from the presence or absence of life, what lessons might we learn from direct observation and spectroscopy of Earth-like exoplanets?

A. We are already learning so much about hot giant exoplanets. We have learned about bizarre planetary orbits and planets that are too large to be explained. We have learned about huge day-night temperature differences. We have identified molecules on exoplanets. We have learned about the vertical temperature structure of atmospheres. The same kinds of things can be learned about Earth-like planets when they are detected in the future. Of immediate interest is NASA's Kepler Space Telescope, staring at a field of 100,000 sun-like stars looking for Earth-size planets in Earth-like orbits about sun-like stars. Kepler will tell us how common Earth-sized planets are, giving us a jumping off point for planning new discovery space missions.

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