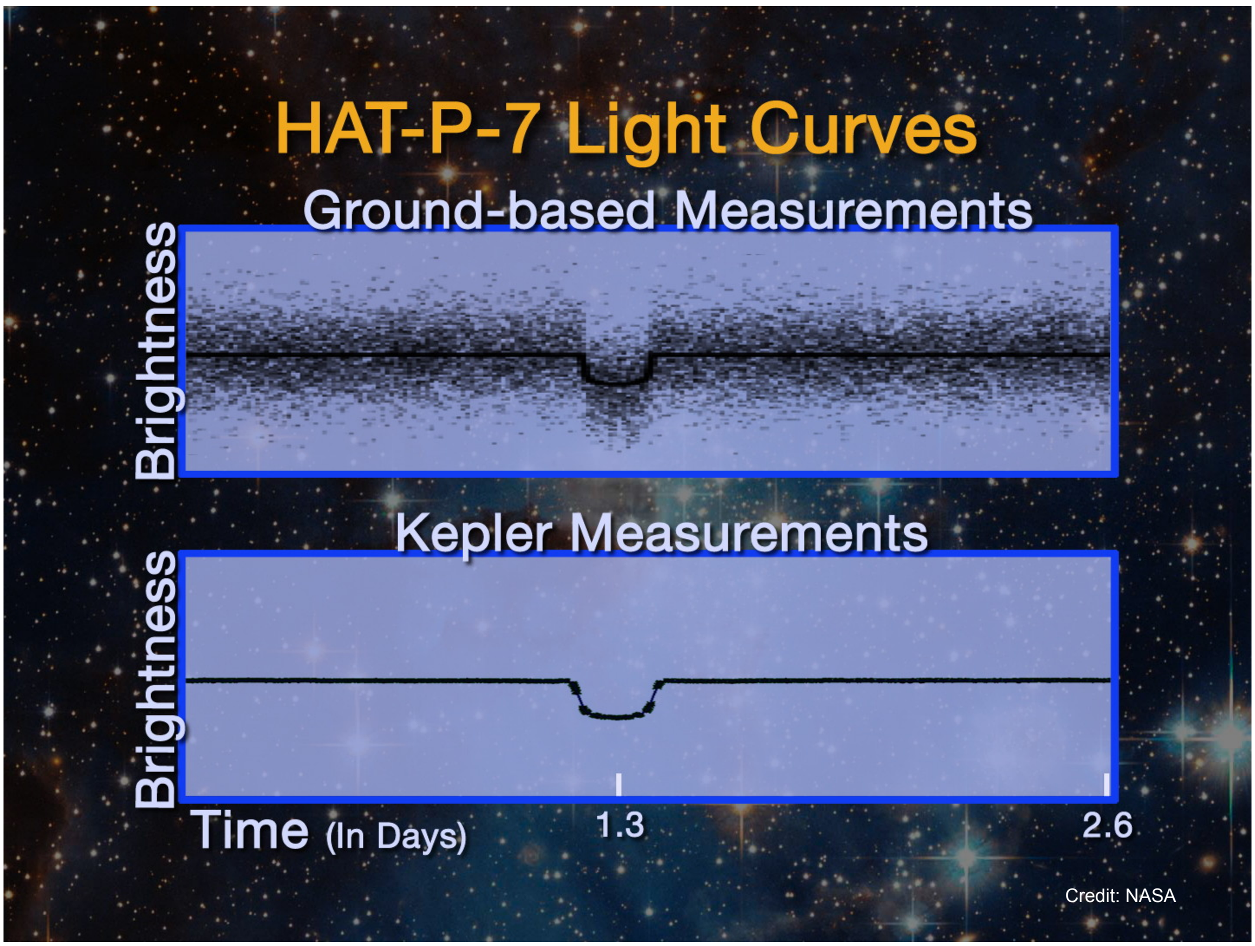
I’d put my money on the sun and solar energy. What a source of power! I hope we don’t have to wait until oil and coal run out before we tackle that.

Thomas Edison, 1931

The Search for Spock's Home

Hello Astronomy 111! In this module we’ll explore the near-future of exoplanets - the hunt for other Earths.

How will we search for Earth-like planets? Note the question is Earth-like, not Earth-sized. Those are related, but different. The first systematic attempts are underway now with the Kepler and COROT missions, which are searching for exoplanets with transit photometry.



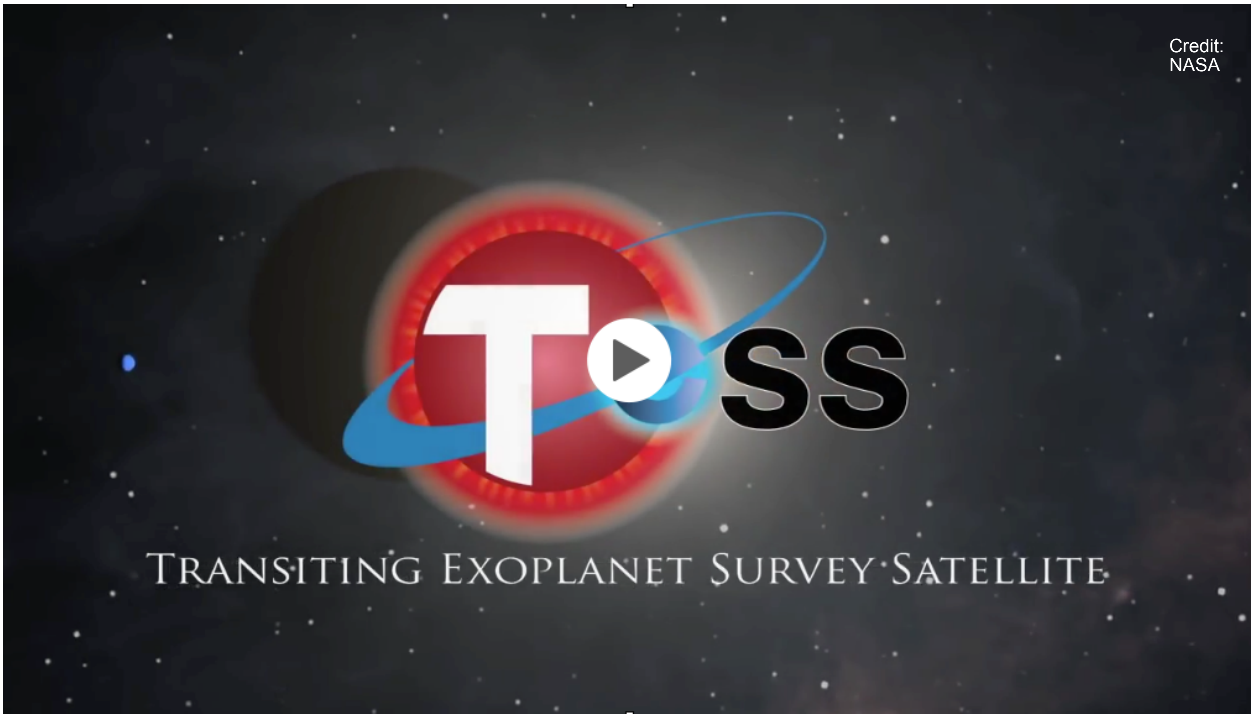
The Kepler mission was launched in 2006, and it's NASA's first mission capable of finding Earth-sized and smaller planets around other stars. The Kepler mission looks continuously at about 100,000 stars in one region of the sky, in the Cygnus and Lyra constellations. The field of view is about the width of your hand at arm's length. For those in the Northern Hemisphere, the field of view is overhead at midnight in the middle of summer, and earlier in the evening in late summer and fall. Recall that only about 1% of solar systems are oriented such that from our perspective their planets will transit across the face of the host star. This is why one need to monitor 100,000 or more stars - to make that 1% pay off.

Kepler uses 42 CCDs similar to those in your smart phone camera. But these are much larger, having a total of 95 megapixels. With these CCDs, Kepler can observe those 100,000 stars all at once, and measuring their brightness to an accuracy of better than 10 parts per million. This like watching a football game from the camera blimp, and detecting every time just one person walks in or out of the stadium.

The image above shows how the brightness of a particular target, HAT-P-7, varies with time. The upper upper is the best one can do with a ground-based telescope. The trend in the data is clear, its a transit allright, but it sure is noisy. The bottom plot shows what it looks like from the Kepler telescope. Much cleaner, much less noise. which yields additional information and more precise information. For HAT-P-7, the transiting Hot Jupiter causes a 0.7% dip in the stars brightness. The error in the Kepler data is smaller than the dots used to draw the curve!

Missions like Kepler help answer the question if Earth-size systems are common, but can't answer if such planets are Earth-like. Upcoming missions, like those shown in the NASA timeline above, will begin to answer if the exoplanets are Earth-like. Do the exoplanets have an atmosphere? Does it have oxygen? Does it have nitrogen? Does it have biosignatures in it? Said another way, we are moving from discovering exoplanets to characterizing exoplanets.

The time line above says a TESS mission is next. Let's look at that a bit. TESS is an acronym for Transiting Exoplanet Survey Satellite. It is schedule to be launched in August 2017. It is designed to search and characterize exoplanets using the transit method. TESS' primary mission is to survey the brightest stars near the Earth for transiting exoplanets over a two-year period. It will have four wide-angle telescopes to survey the entire sky, and of course have CCd's at least as powerful as Kepler's. Approximately half a million stars will be studied, with an expected yield of about 3000 transiting exoplanet candidates, including about 500 Super-Earths and Earth-sized planets.



The image above is a frame from a TESS motivational movie. I hope you enjoy the movie.

Thanks! Bye Bye.