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Exoplanets: Our Second Chance?

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EXOPLANETS: Our Second Chance?

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"If we find ourselves with a desire that nothing in this world can satisfy, the most probable explanation is that we were made for another world."

- C.S. Lewis

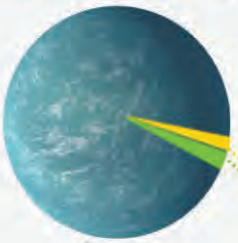
WHAT IS AN EXOPLANET?

A *planet* outside of our solar system

WHAT IS A PLANET?

According to the International Astronomical Union (IAU):

A planet is a celestial body that:
- orbits a star
- has enough gravity to settle it into a round shape
- is large enough to clear objects out of its orbital neighborhood



Since 1992, there have been nearly *2000* exoplanets discovered.*

51 Pegasi b was the first exoplanet to be discovered that orbits a main sequence star.

31 are potentially habitable

10 terran (earth size)
$0.5M_E - 5M_E$ or $0.8R_E - 1.5R_E$
(M_E = mass of the earth; R_E = radius of the earth)

21 superterran (larger than earth)
$5M_E - 10M_E$ or $1.5R_E - 2.5R_E$

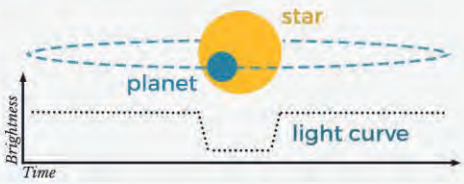
* as of October 2015

EXOPLANET DISCOVERY

TRANSIT METHOD

Over 1,000 exoplanets have been discovered by the Kepler telescope using this method.

When a planet passes in front of a star, it blocks a small portion of the star's light, which reduces its apparent brightness. An instrument detects the brightness of a star, and this brightness is used to estimate the planet's orbital period and size



EXCEPTIONAL EXOPLANETS

OLDEST EXOPLANET
"Methuselah" PSR B1620-26b

13 billion years old! Formed less than a billion years after the galaxy was made. (Planet earth is only *4.5 billion* years old.)

HOTTEST EXOPLANET
HD-149026b

Has a surface temperature of around 3,700°F or 2,000°C!

LIGHTEST EXOPLANET
TrES-4

Almost twice the size of Jupiter, but it weighs as little as a cork! (Also called the *puffy planet* due to its extremely low density)

DENSEST EXOPLANET
55 Cancri e

Only *twice* the size of Earth but 8 times more *massive* and twice as *dense*

DARKEST EXOPLANET
TrES-2b

Only reflects about 1% of light. It is *impossible* to see since it appears only as a pitch black ball of gas.

DAREDEVIL EXOPLANET
Kepler-78b

Orbits *extremely* close to its star, with only 550,000 miles in between! (Mercury orbits about 28.5 *million* miles away from the Sun).

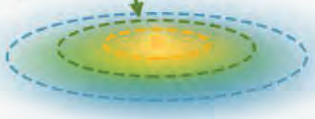
POTENTIAL HABITABILITY

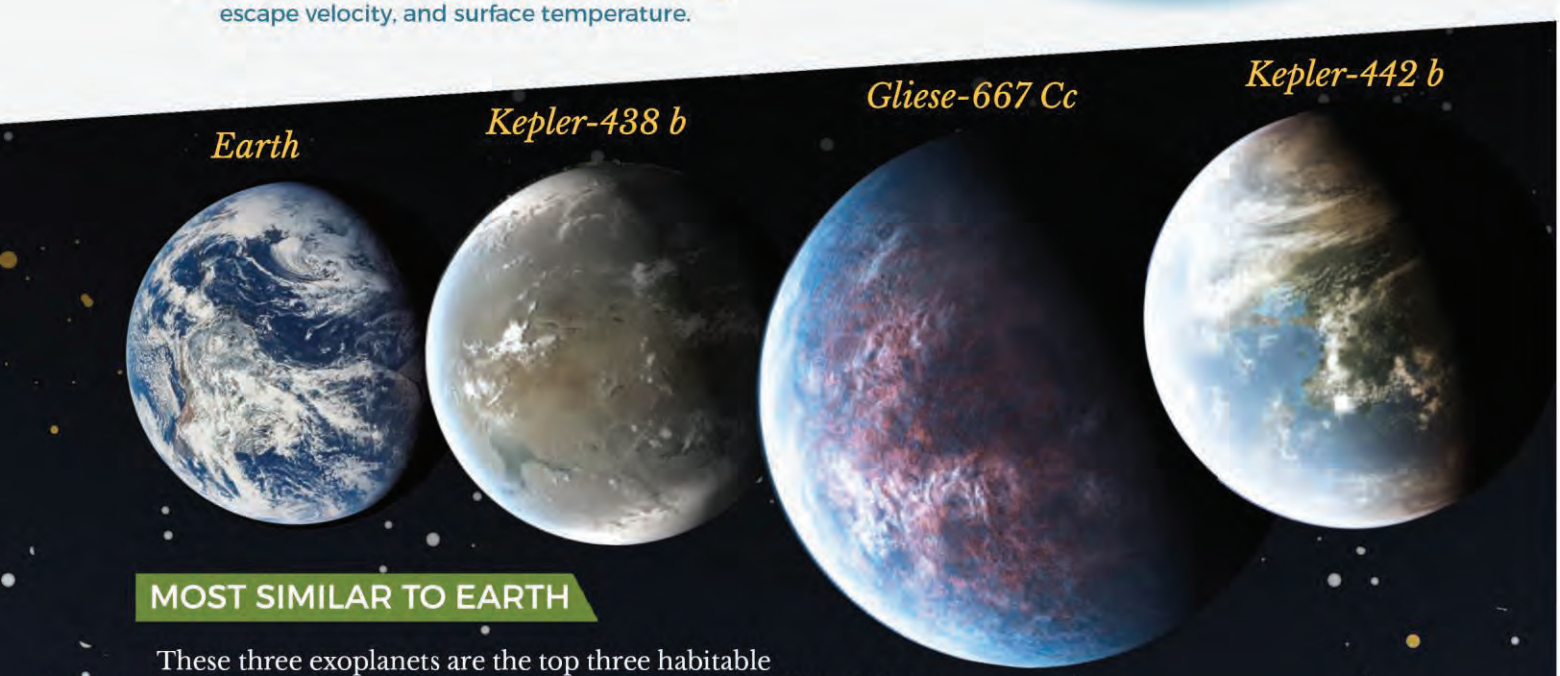
Exoplanets are ranked by how physically similar they are to Earth using the **Earth Similarity Index (ESI)**. The ESI scale goes from *zero* (no similarity to Earth) to *one* (identical to Earth).

$$ESI = \prod_{i=1}^{n} \left(1 - \left|\frac{x_i - x_{i_0}}{x_i + x_{i_0}}\right|\right)^{\frac{w_i}{n}}$$

ESI accounts for the planet's radius, bulk density, escape velocity, and surface temperature.

A vital factor considered when determining an exoplanet's habitability is its ability to support liquid water. A planet has to be a certain distance from its star to have ideal temperatures in order for liquid water to exist. This range of distance is called the **"GOLDILOCKS ZONE"** (the temperature is not too hot or too cold.)





MOST SIMILAR TO EARTH

These three exoplanets are the top three habitable exoplanets discovered so far. They are all in the Goldilocks zone.

ESI	0.88	0.84	0.84
Light Years from Earth	470	22	1200
Days in One Year	35	28	112
Radius Compared to Earth	1.12 times larger	1.8 times larger	1.34 times larger
Average Temperature (°C)	0 - 60 °C	27 °C	-40 °C
Stellar Flux (radiant energy emitted from sun per unit time)	1.38× greater	0.875× greater	0.66× greater
Star system	Single	Triple	Single
Parent Star	Red dwarf, smaller and cooler than Sun	M class dwarf	K-type orange dwarf

TRANSPORT METHODS

THE SOLAR SAIL

The solar sail spacecraft operates by harnessing the sun's energy for propulsion. Photons traveling as a packet of light have energy and momentum, so when they hit the solar sail, their momentum is transferred to the sail. This continuous acceleration allows a spacecraft to reach very high speeds over time!

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