

NO PLACE IS MORE
EARTH-LIKE THAN ME.
I'VE GOT EARTH-LIKE
GRAVITY!

WELL, I'VE GOT
LIQUID WATER.

THAT MAKES ME
MORE EARTH-LIKE
THAN YOU!

UH,
GUYS?

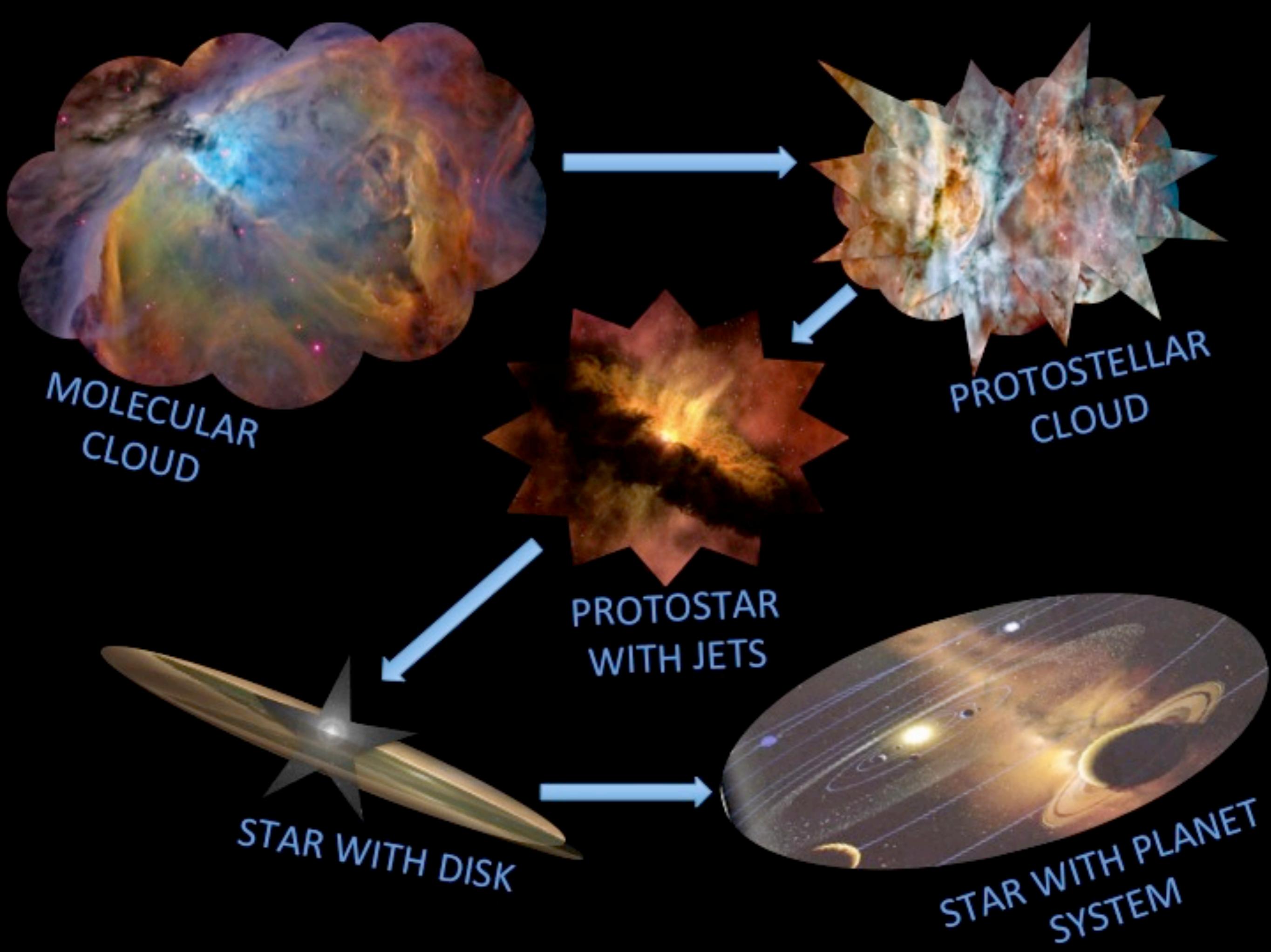
NO, I'M THE MOST
EARTH-LIKE.

I'VE GOT
LIQUID--WELL, LIQUID
SOMETHING--ALL OVER
MY SURFACE!

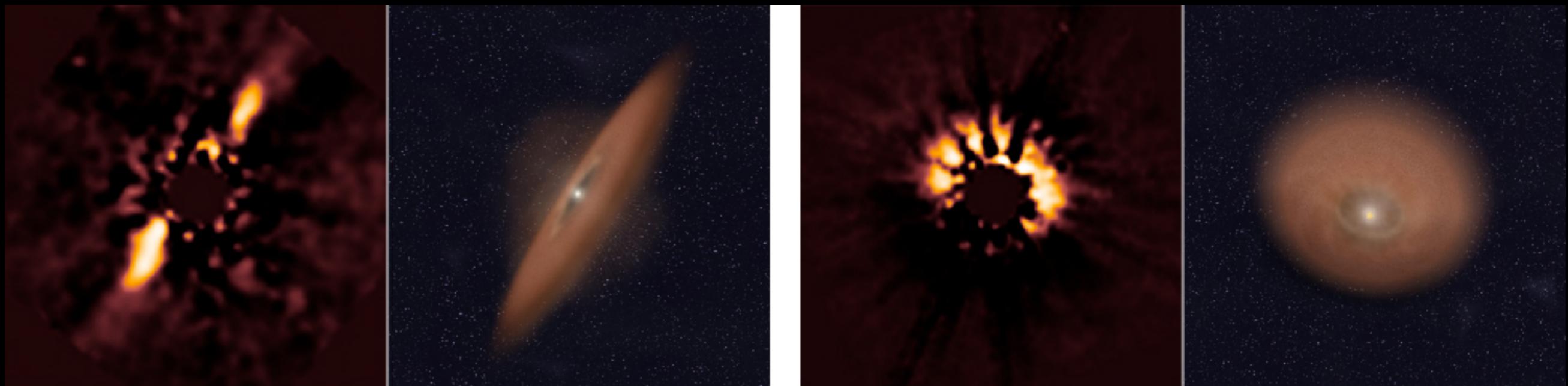
GUYS!

JSP AILLY

Where did all the exoplanets
come from??



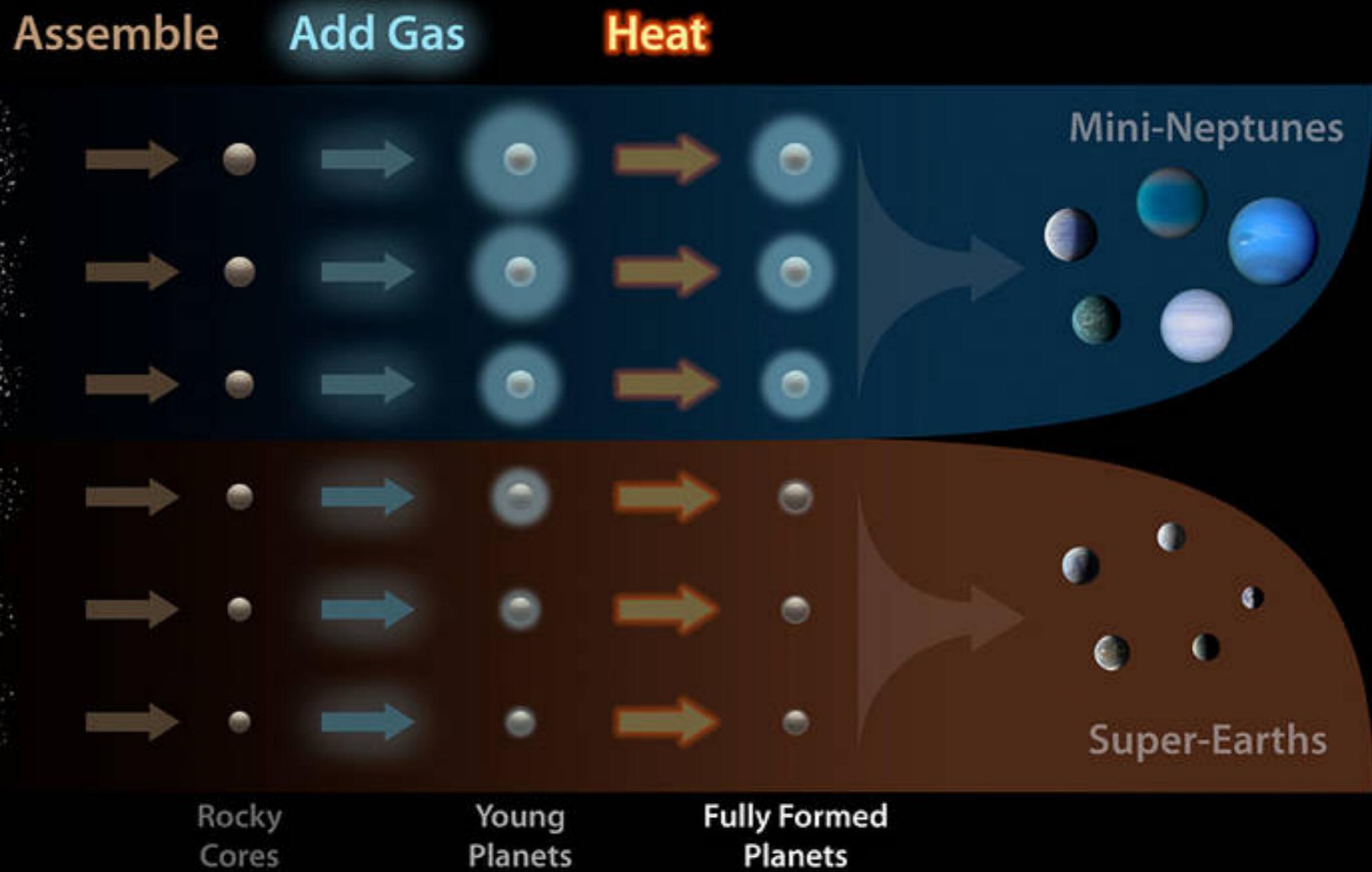
We can see dusty disks around the youngest stars.



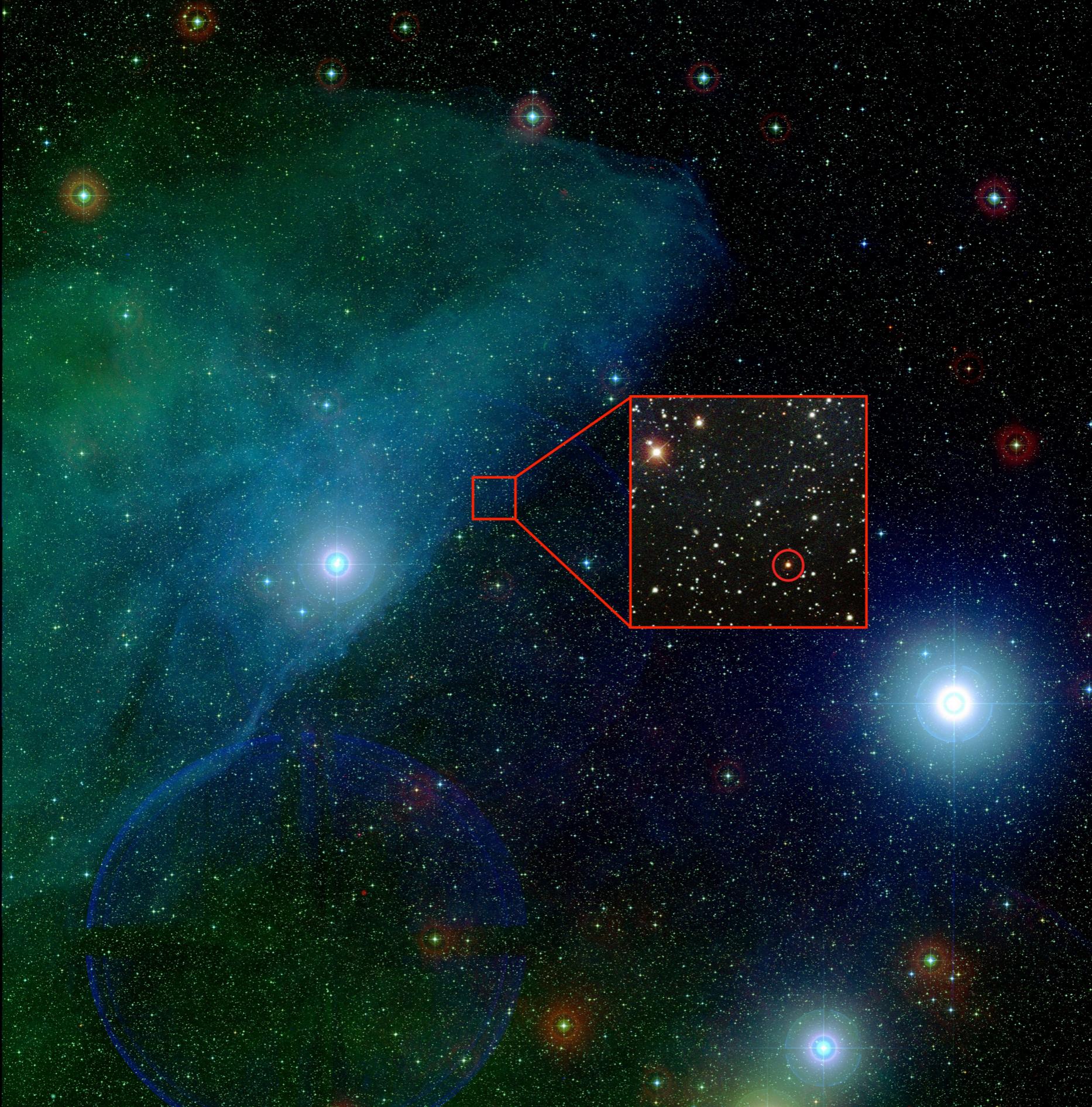
HD 141943

HD 191089

Assembly Line of Planets

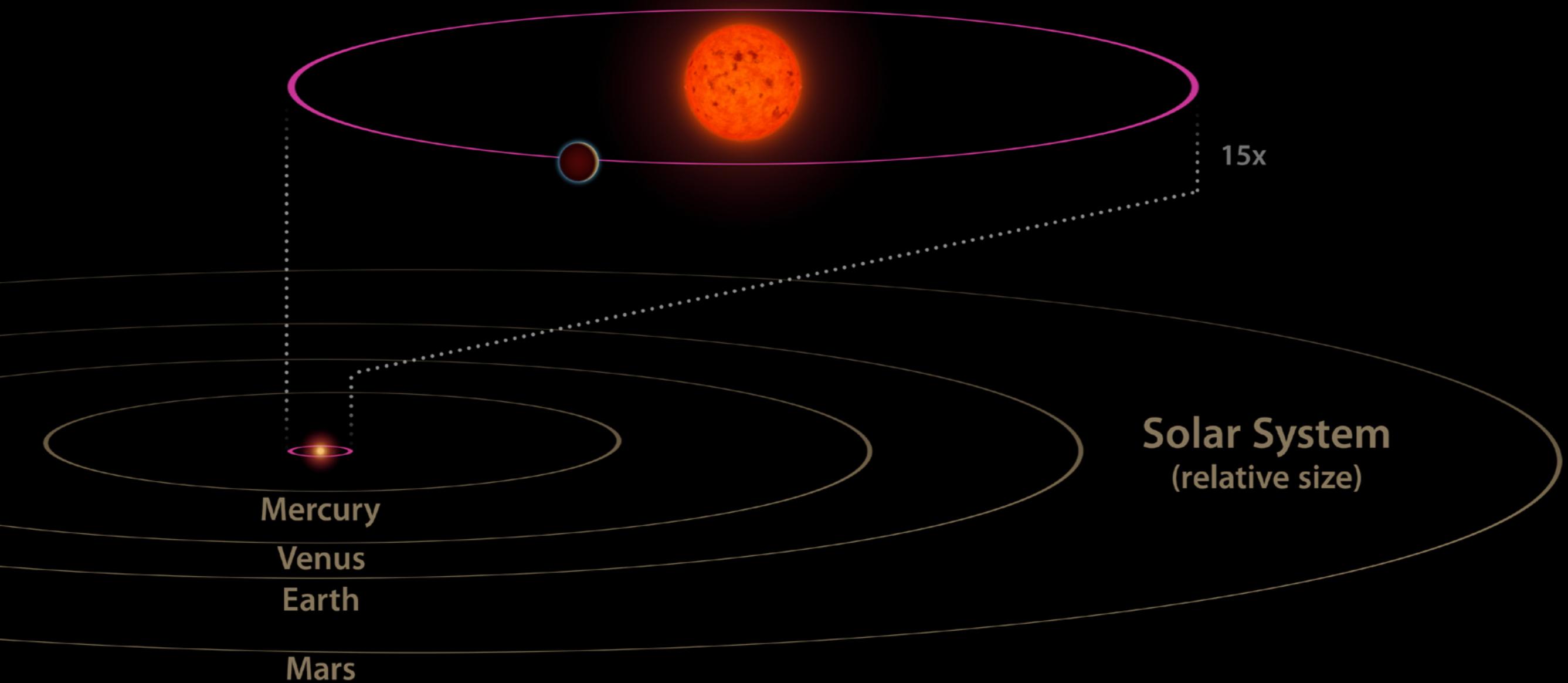


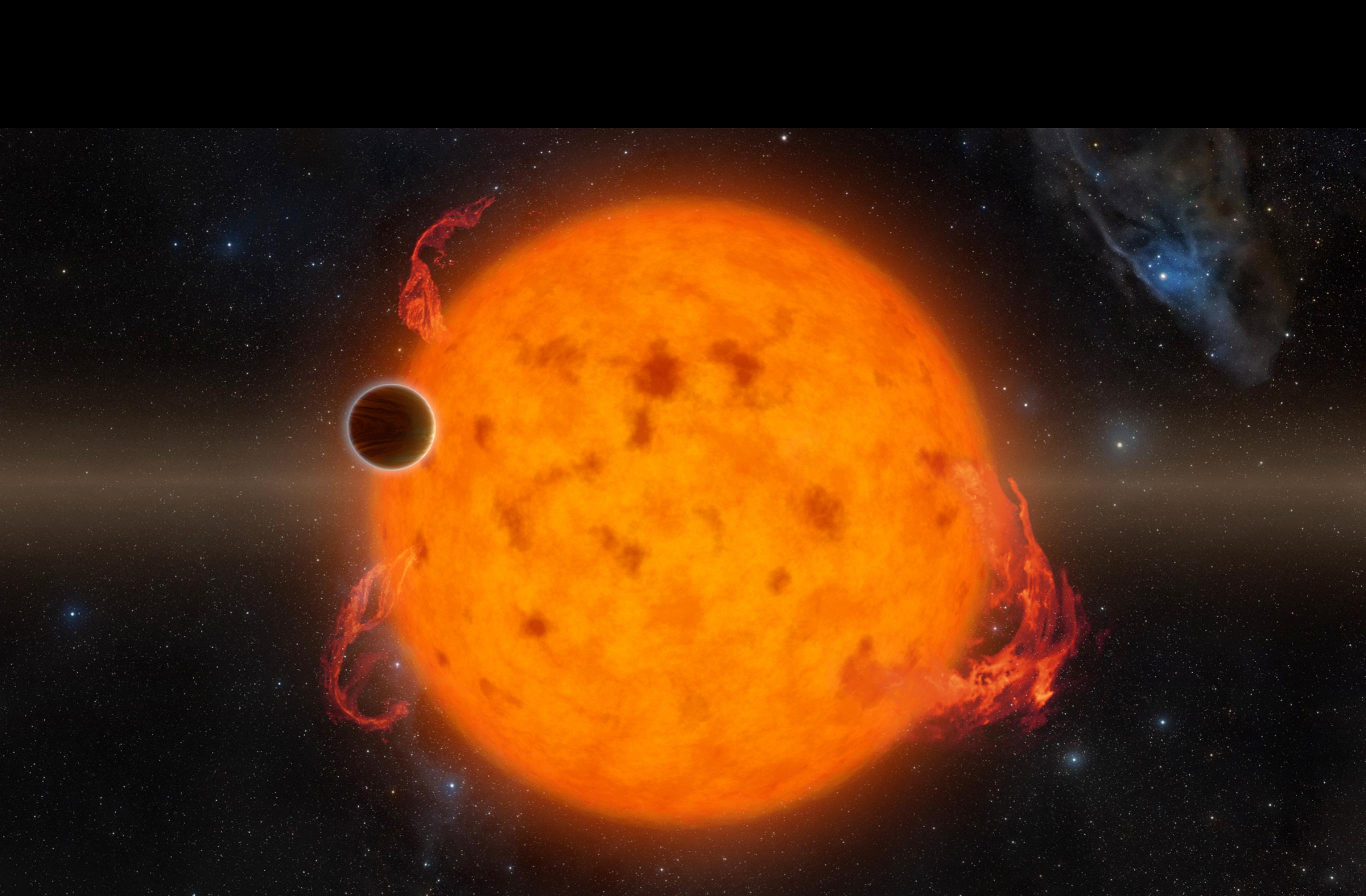
K2-33: A young star in Upper Scorpius



K2-33 System

Star diameter & orbit to scale
K2-33 b planet size exaggerated

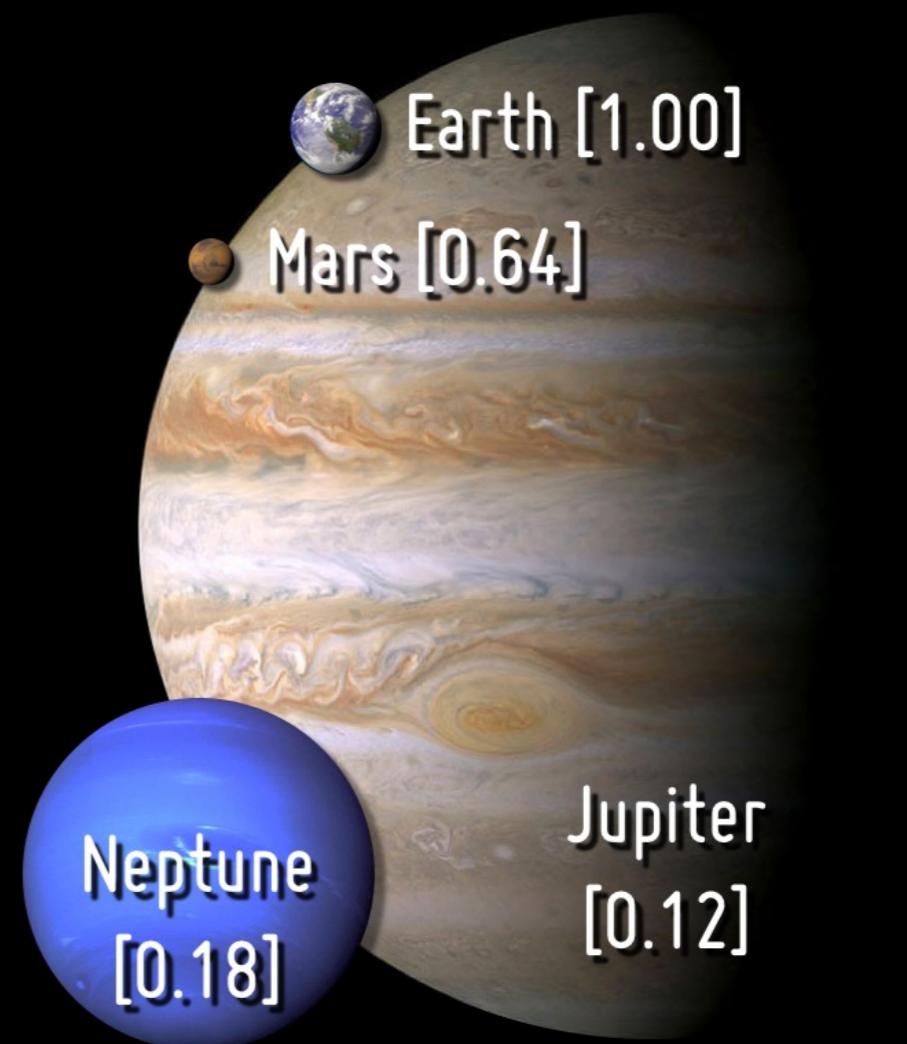




Q: What does it mean to be a
“habitable” planet??

Potentially Habitable Exoplanets

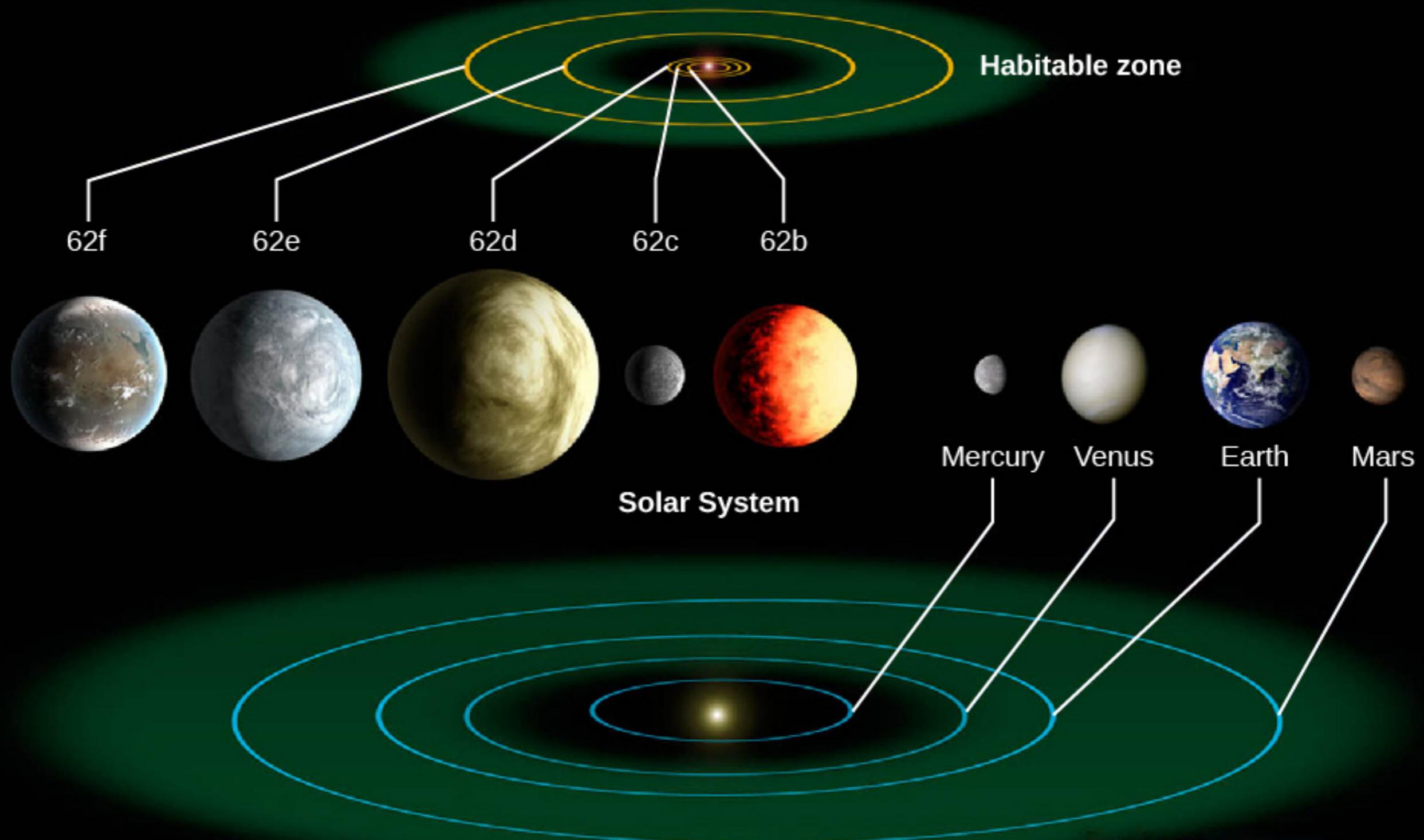
Ranked by the Earth Similarity Index (ESI)



Artistic representations. Earth, Mars, Jupiter, and Neptune for scale. ESI measures similarity to Earth size and insolation.

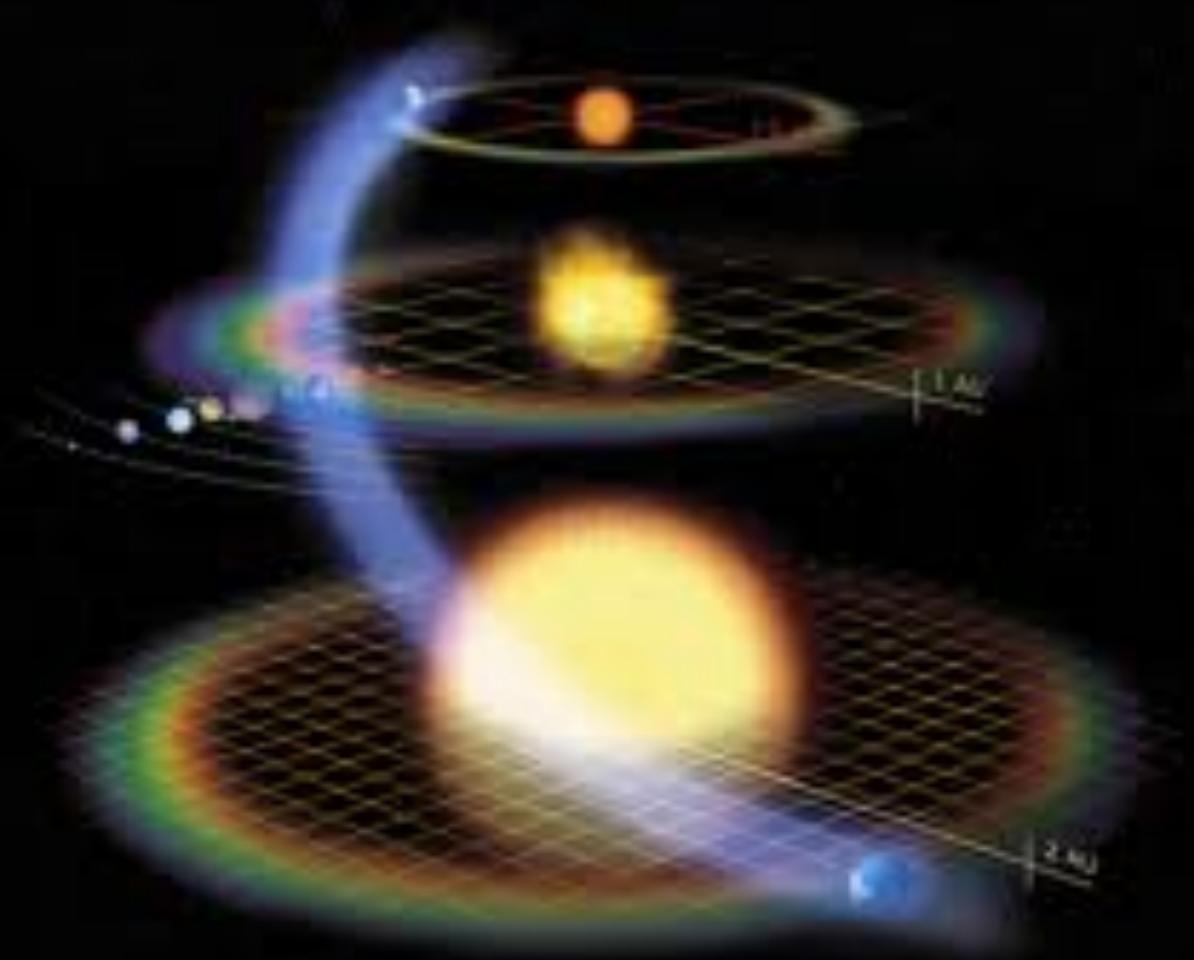
CREDIT: PHL @ UPR Arecibo (phl.upr.edu) Jun 18, 2019

Kepler-62 system



The area around a star where liquid water can exist is called the **habitable zone**

The location depends on the temperature of the star - the hotter the star the further out the zone



We assume liquid water the key to life

Q: How does the habitable zone compare to that of the Earth when its around a star much hotter than the Sun?

- A) Its at the same location of ~1AU
- B) Its further away from the star
- C) Its closer to the star

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Q: If you were on a planet in the habitable zone around a cool, red star like Proxima Centauri, about how long would a year be?

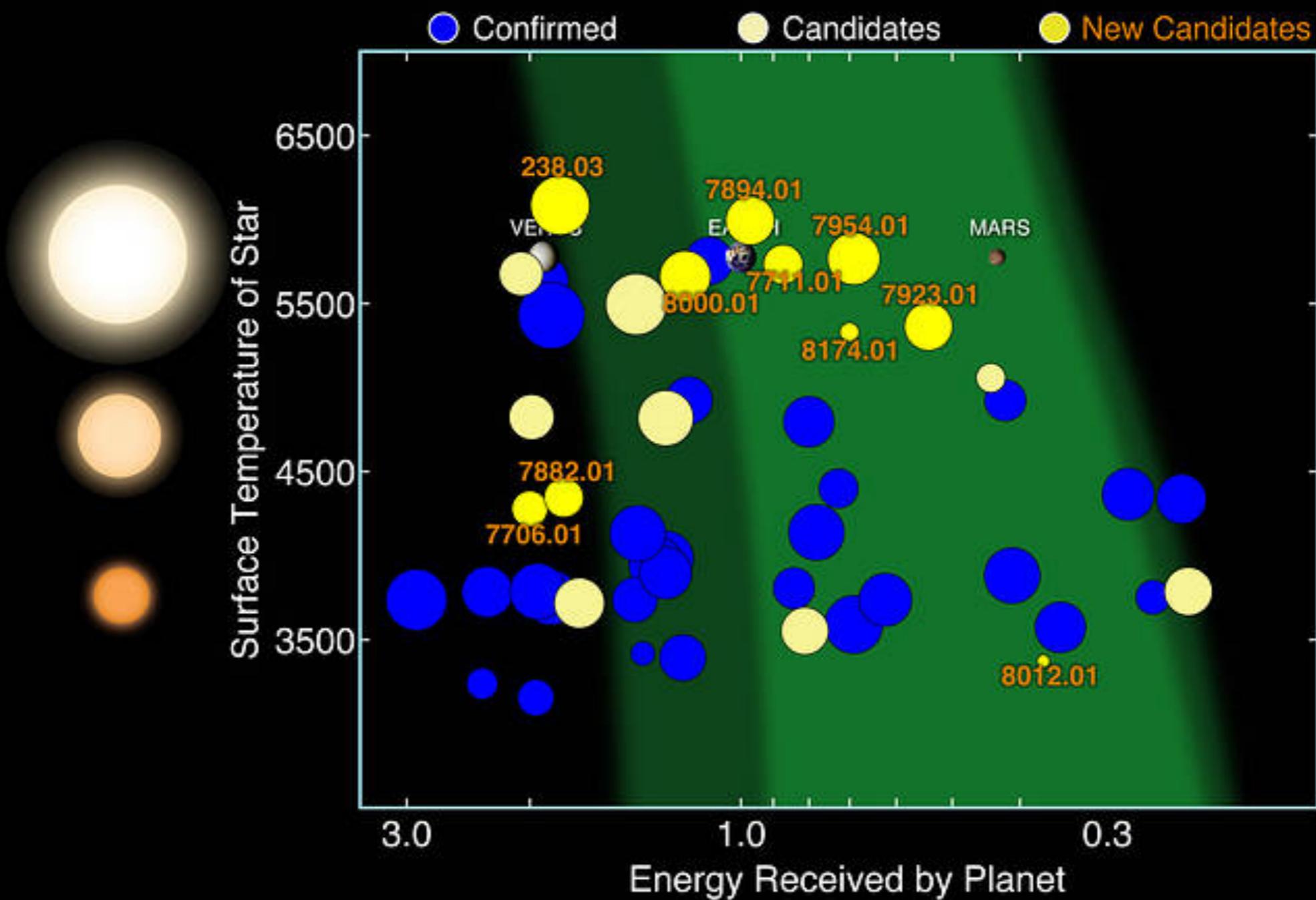
- A) A year
- B) A few years
- C) A month
- D) A week
- E) Less than a week

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Kepler Habitable Zone Planets

As of June 2017



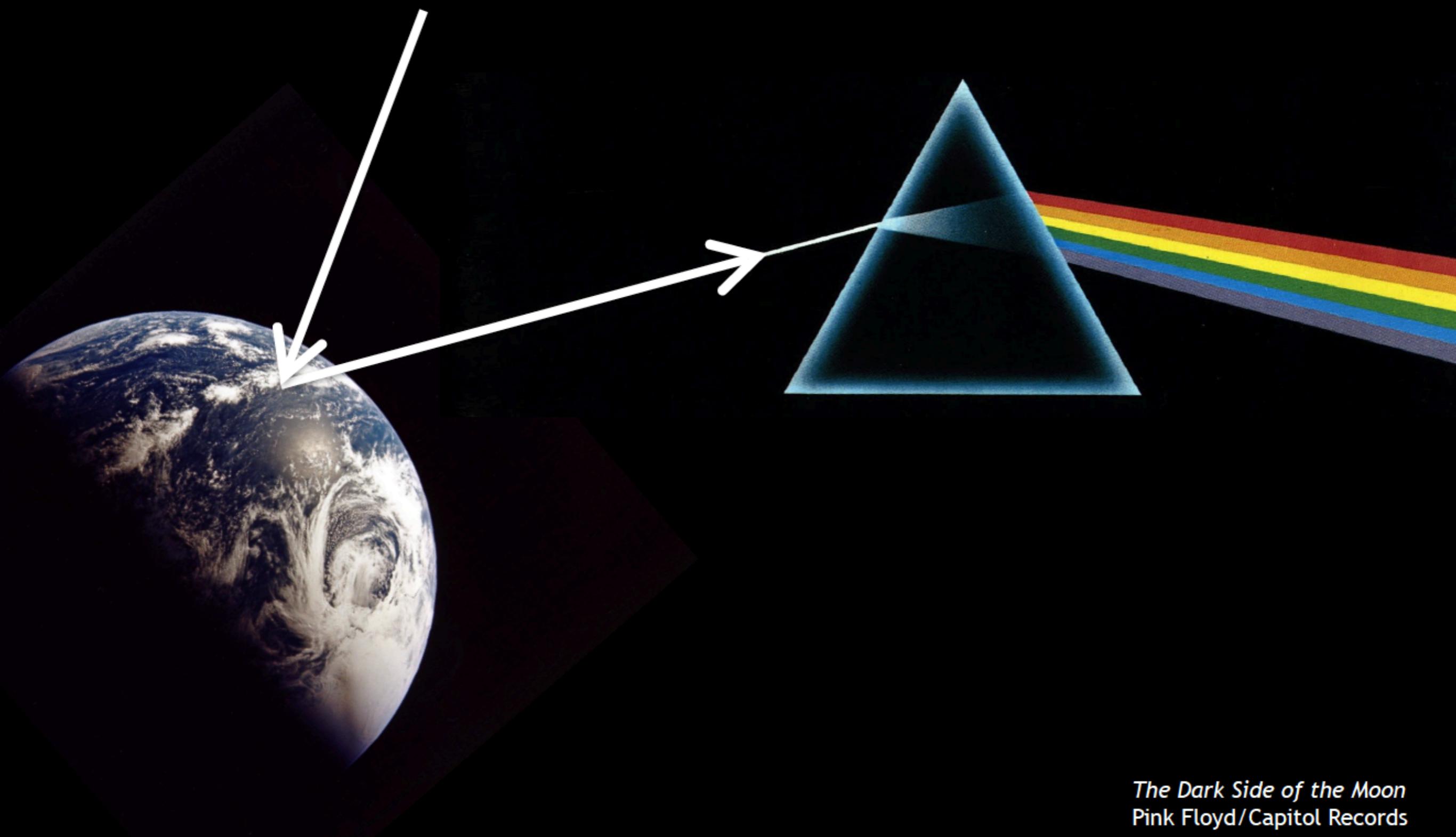
Q: Doesn't the atmosphere (or lack thereof) also contribute to habitability?

A: YES! But... atmospheres are hard to detect around distant planets, at least so far.

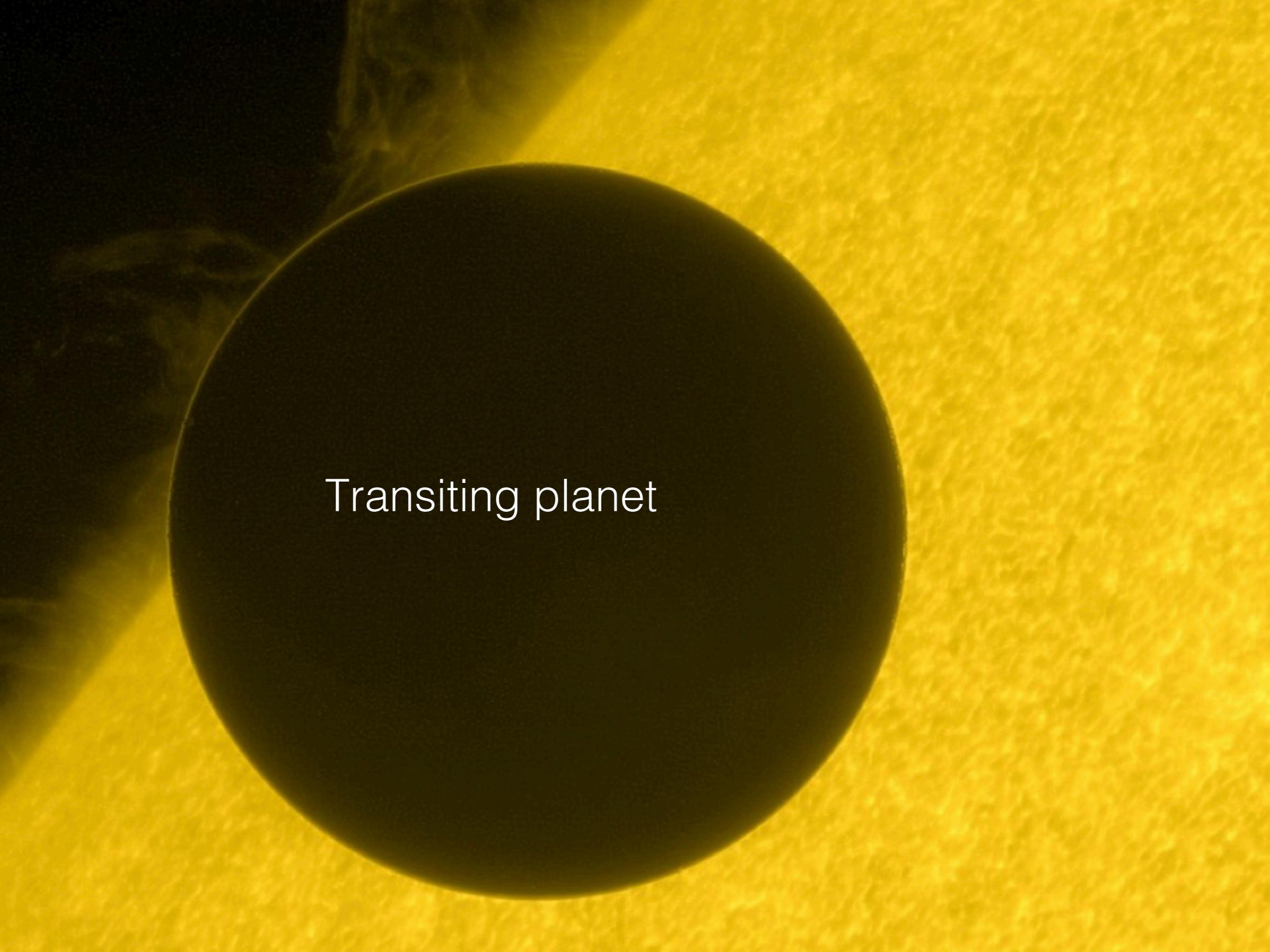
How can we study the atmospheres of transiting planets?



Light from Star

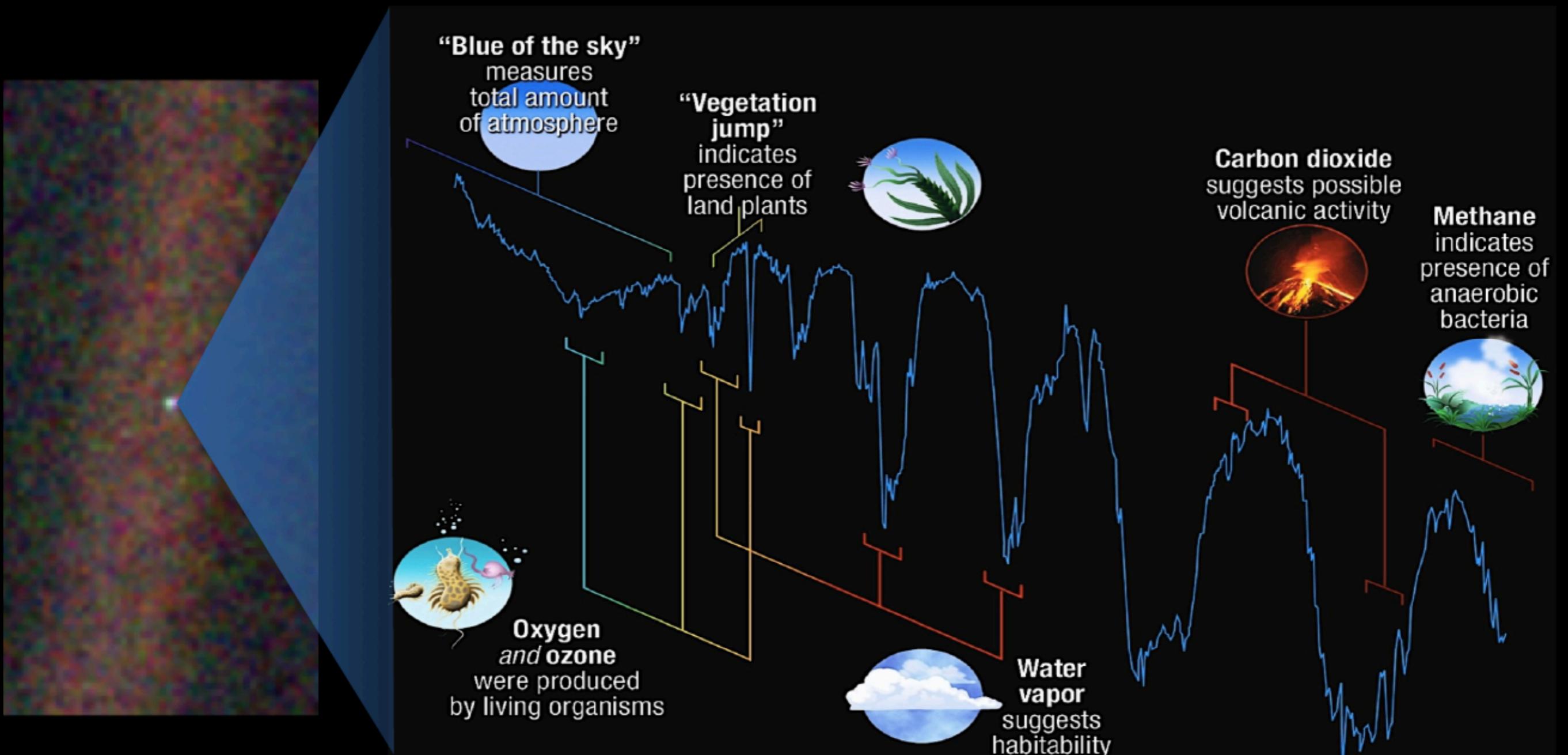


The Dark Side of the Moon
Pink Floyd/Capitol Records

A large, solid black circle is positioned in the center-left of the frame, partially obscuring a bright yellow background that resembles a star or sun. The black circle has a thin, dark outline. The yellow background shows some subtle radial texture and a slight gradient.

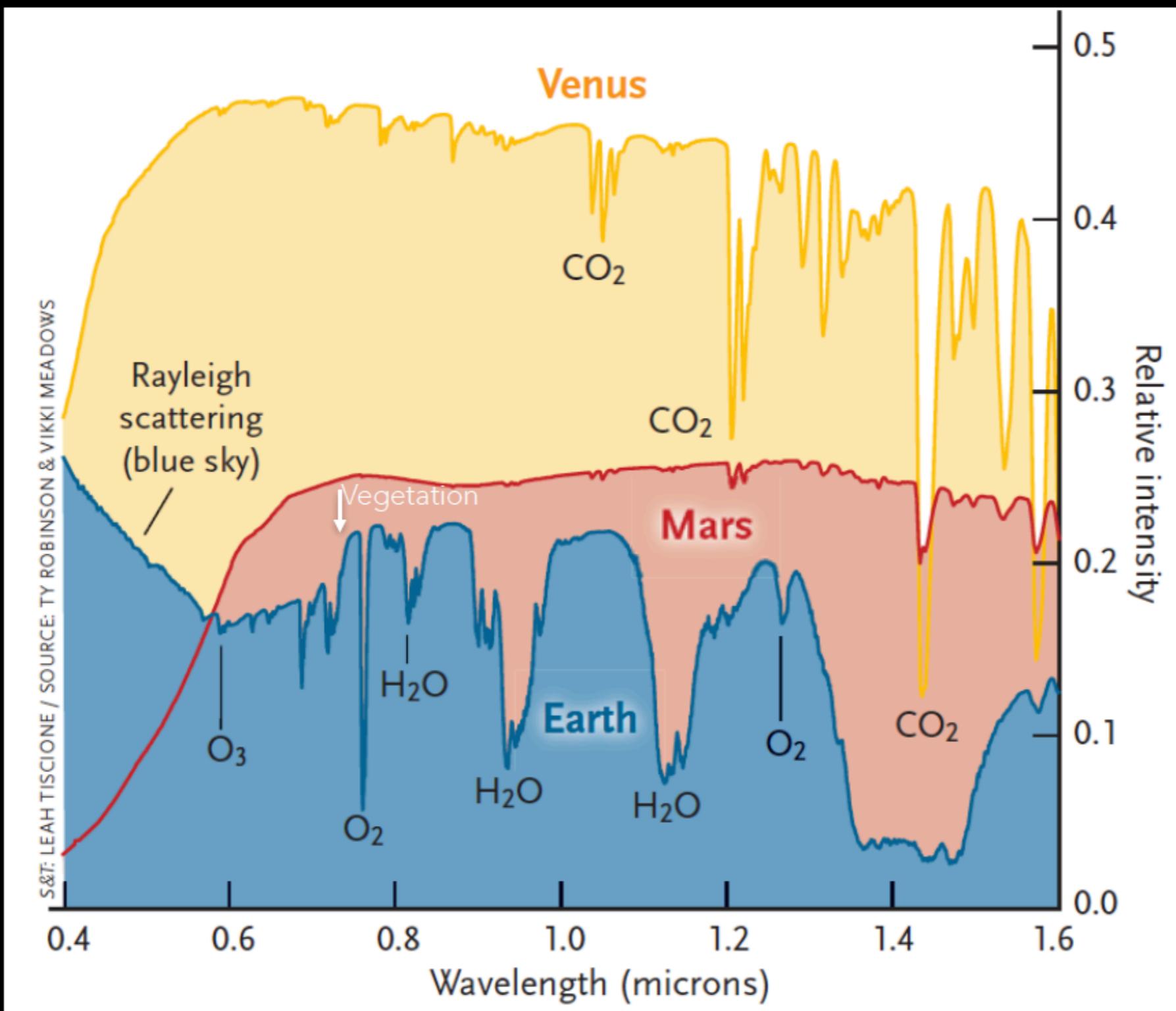
Transiting planet

Voyager's picture of Earth, the Pale Blue Dot



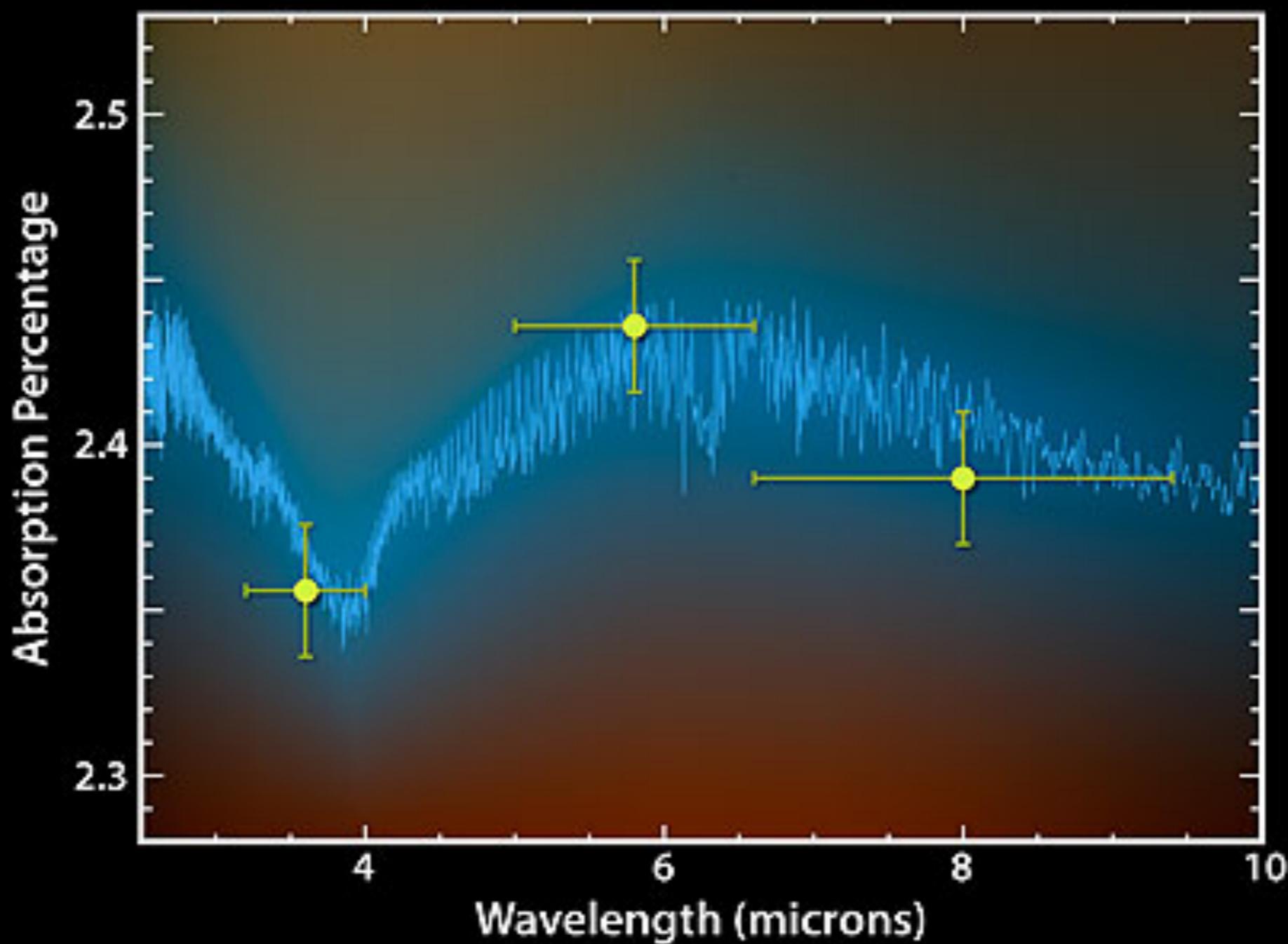
Spectrum of the reflected light reveals a living world.

Earth's Spectral Fingerprints are Unique



Credit: Sky & Telescope 10/2015; reproduced from Robinson & Meadows

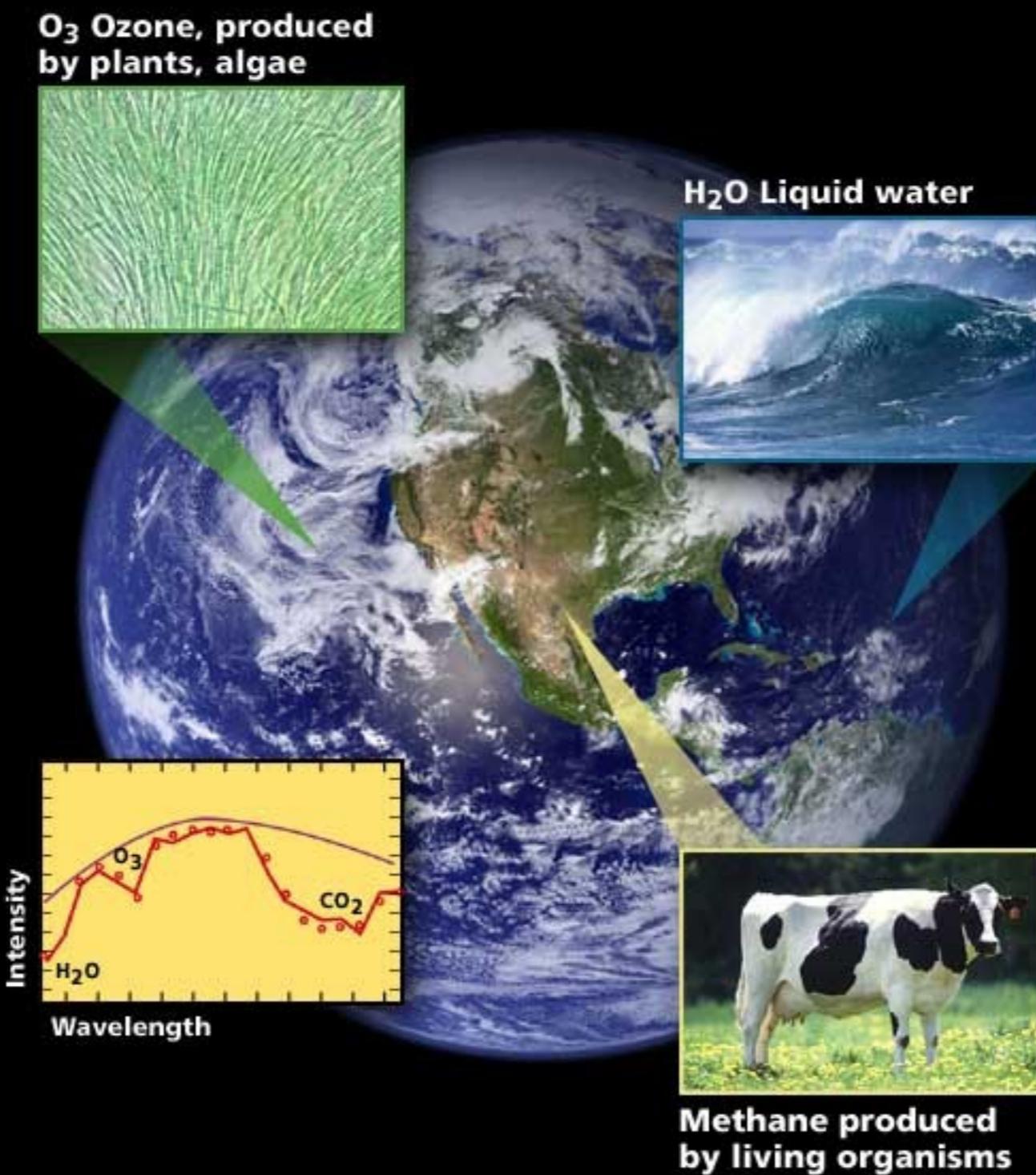
Water Detected in the Atmosphere of a Hot Jupiter!



Water Signatures in Exoplanet HD189733b
NASA / JPL-Caltech / G. Tinetti (Institute d'Astrophysique de Paris)

Spitzer Space Telescope • IRAC
ssc2007-12a

We will look for indirect signs ...



JWST: Launch in March 2021



What are the odds for Life?

Billions of stars ...

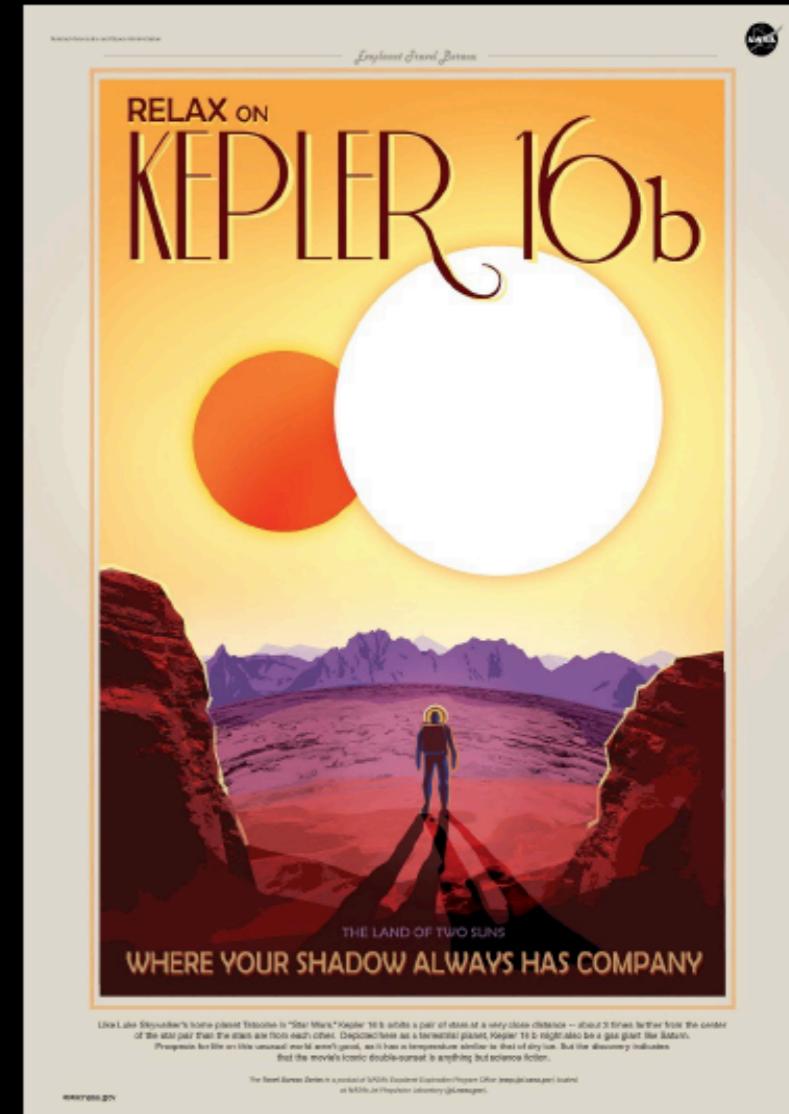
~20% have terrestrial sized
planets?

An estimated 17 billion Earth-
sized planets in the Galaxy!

? How many stars have
habitable planets

0.1°
? How many have life

Where will exploration take us in 100 years? ?



Exoplanet Travel Bureau