

Exoplanets And the Search for Habitable Worlds

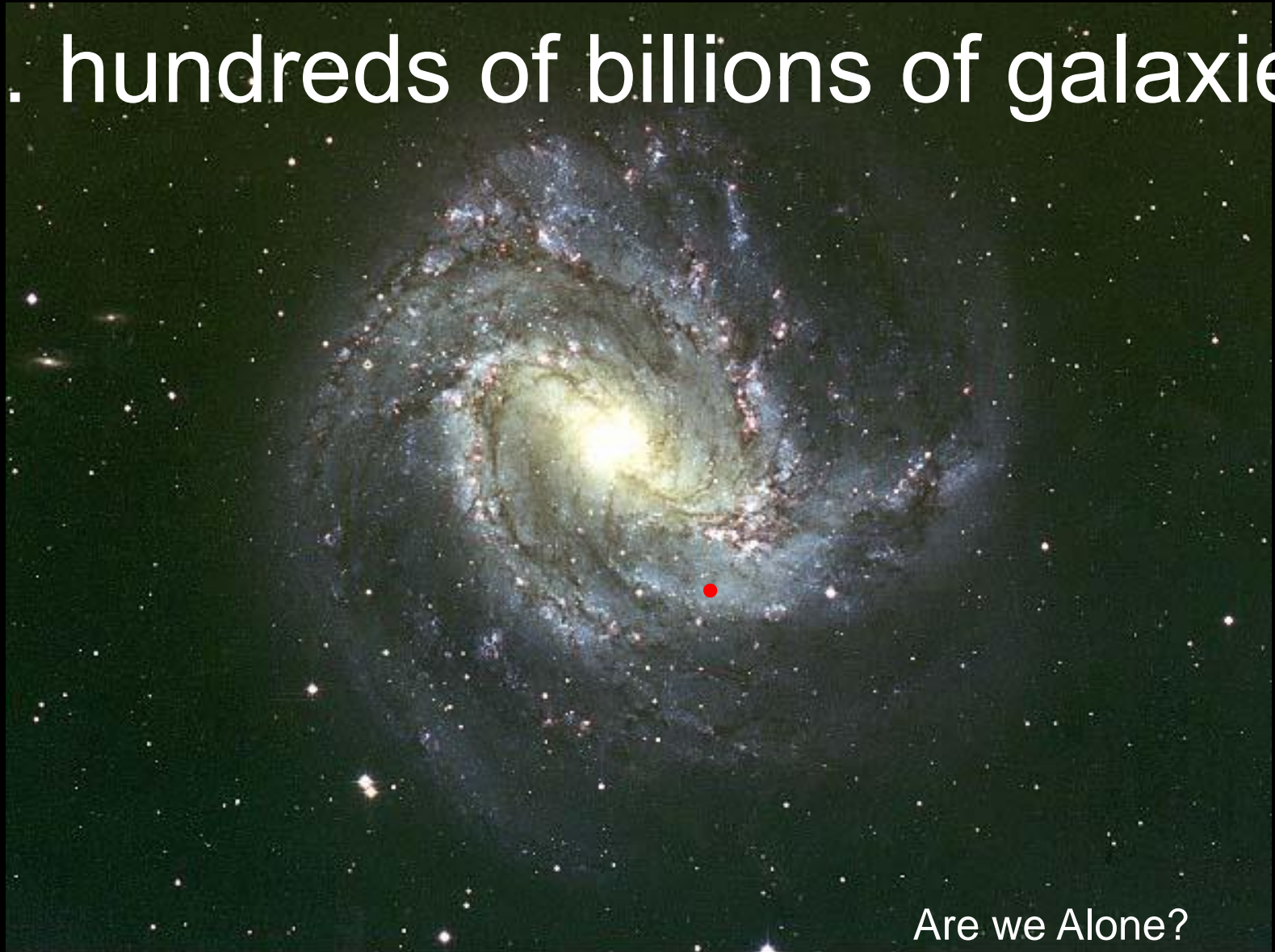
Sara Seager



Massachusetts
Institute of
Technology



Hundreds of billions of stars ...
... hundreds of billions of galaxies

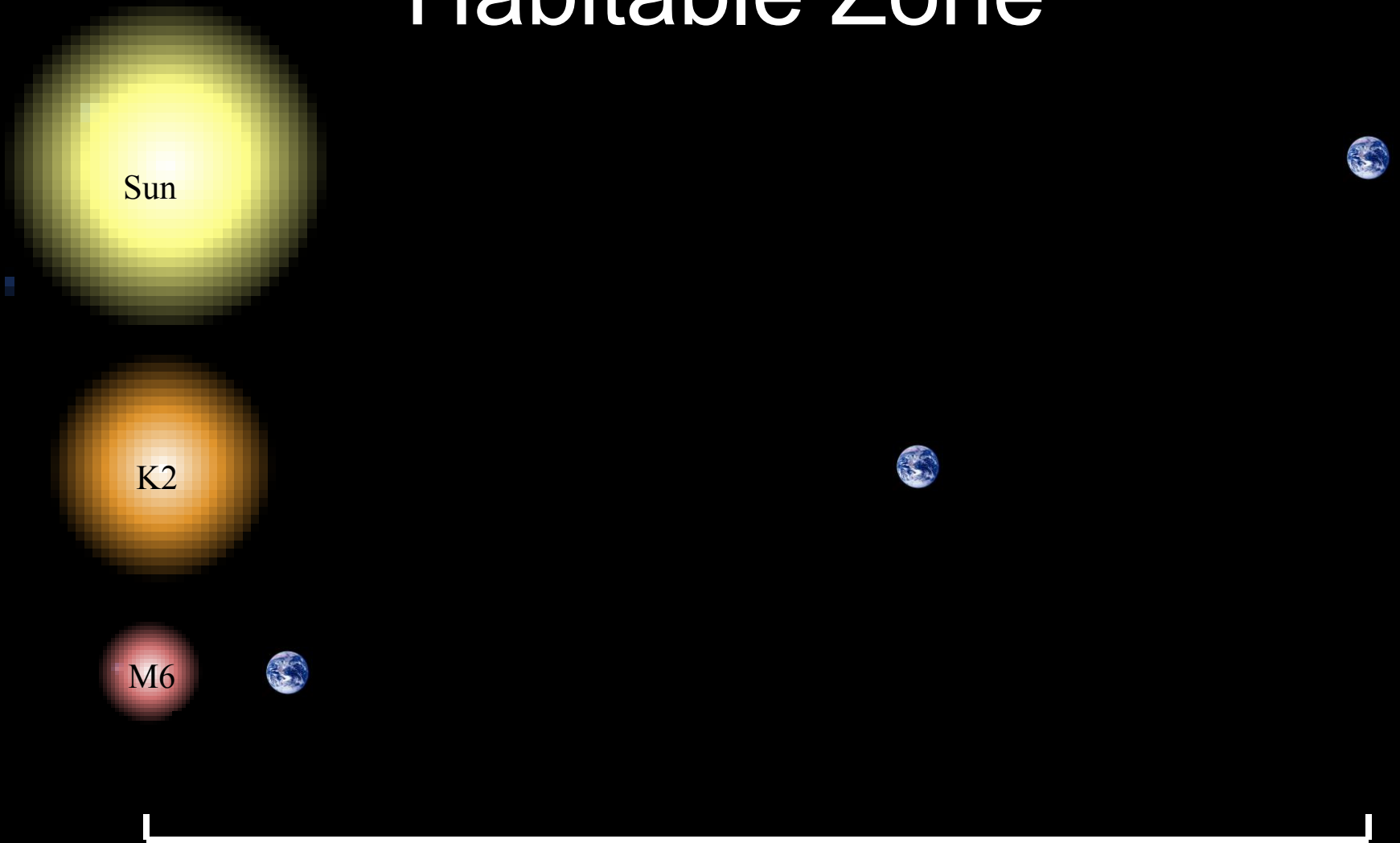


Are we Alone?

Earth: The Pale Blue Dot



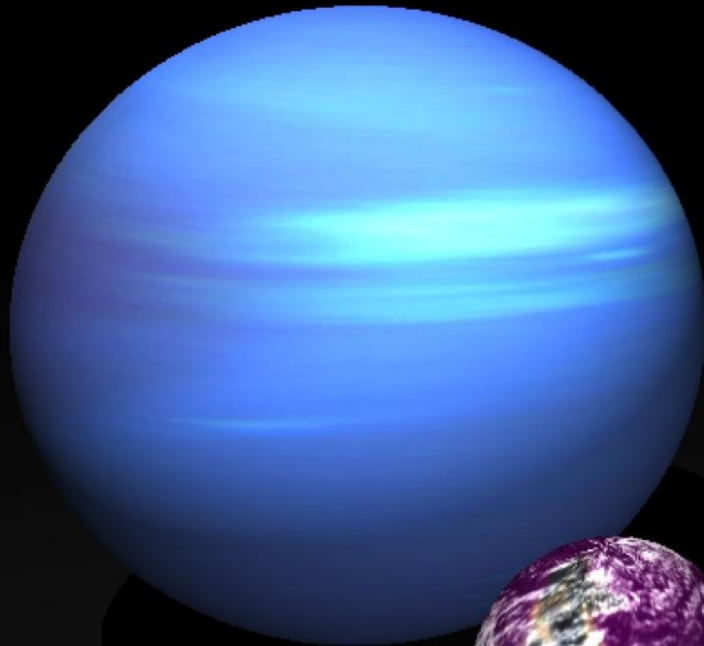
The “Goldilocks Zone” or “Habitable Zone”



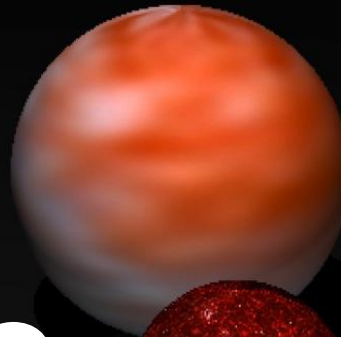
Gliese 581 Planetary System

Gliese 581 is a red dwarf star located 20.3 light years from Earth in the constellation Libra. It has a mass of one third of the Sun and at least six planets. The fourth planet from the star, Gliese 581g, is the first Earth-like planet detected around a star.

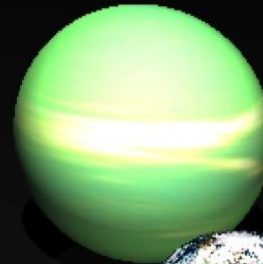
Gliese 581b



Gliese 581f



Gliese 581c

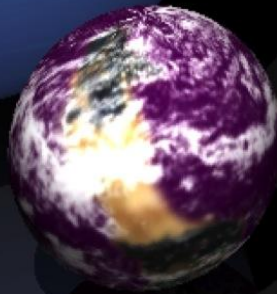


Gliese 581d

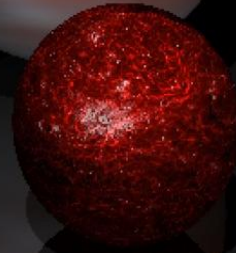


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Gliese 581g



Gliese 581e



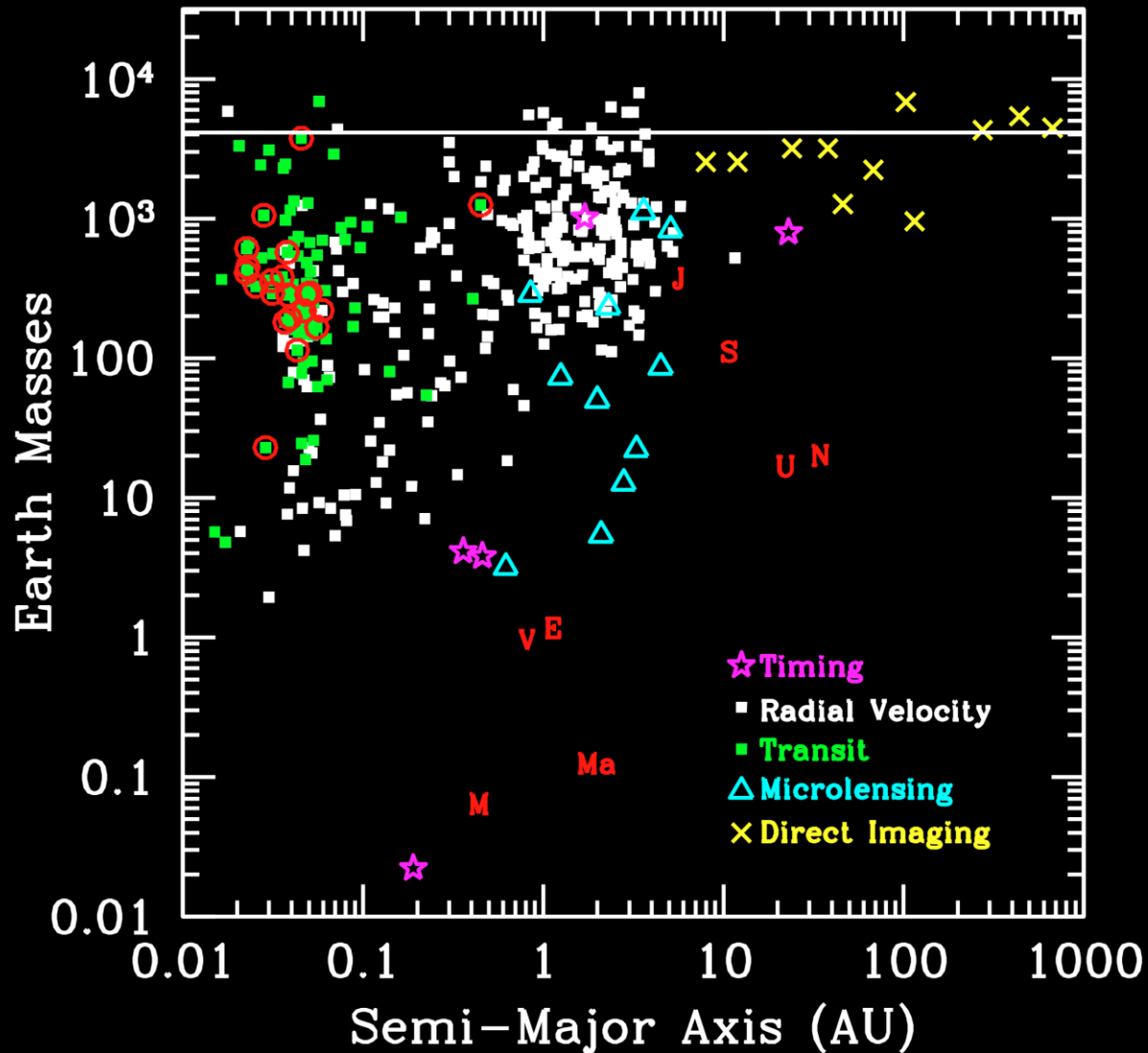
Earth





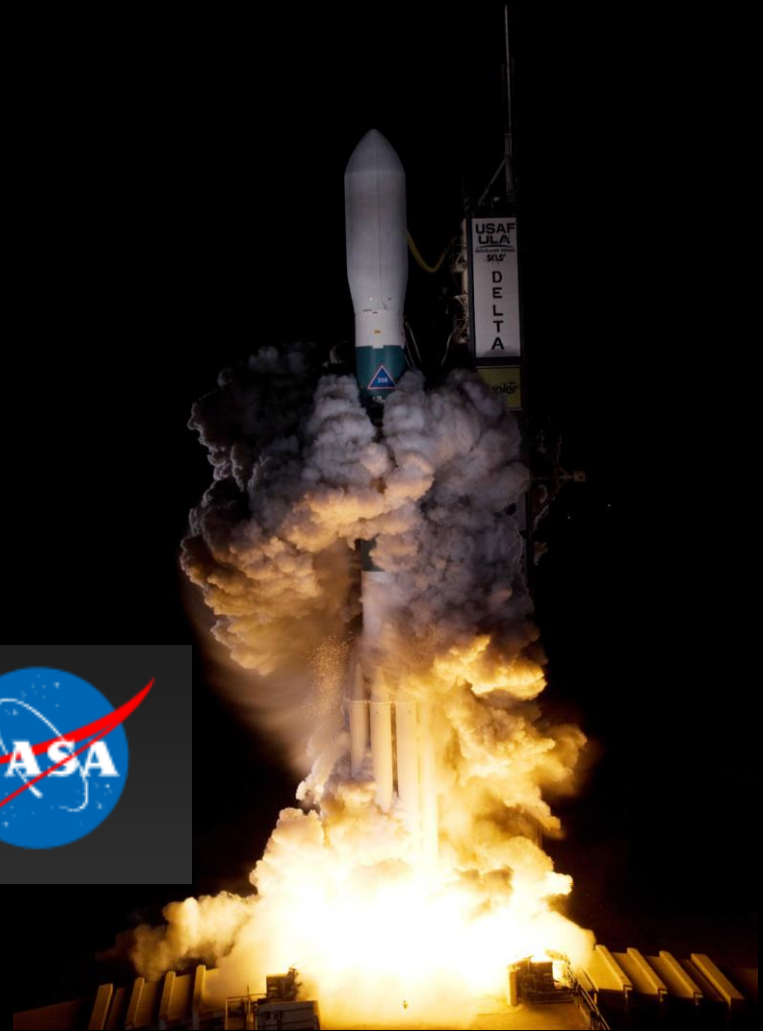
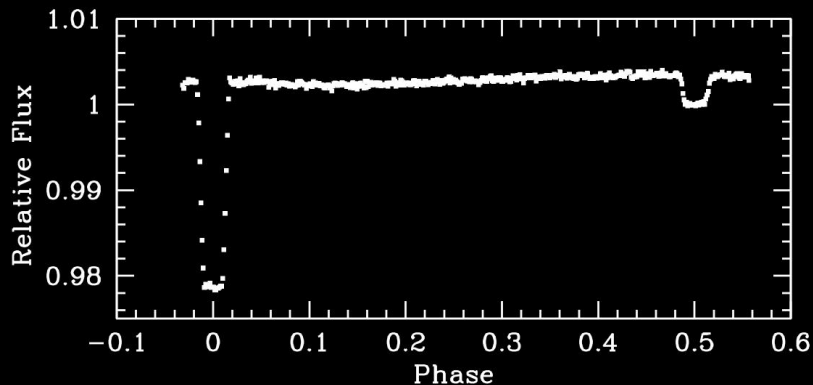
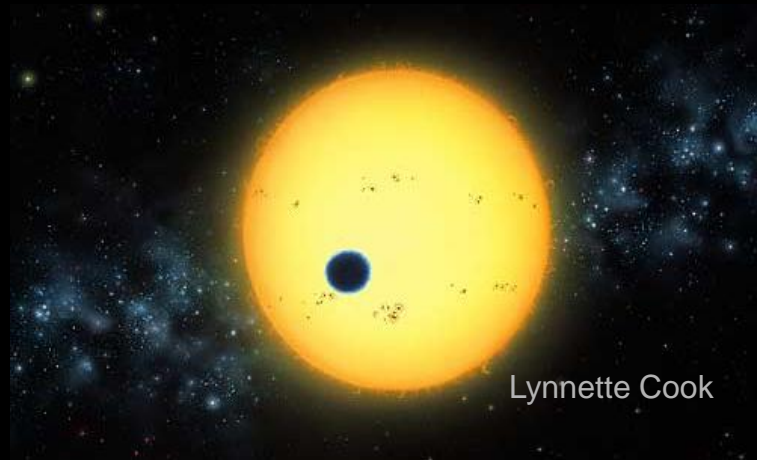
John E. Kauffman

Known Planets 2010



Based on data compiled by J. Schneider

Kepler: How Common are Earths?



Goal: to find transiting Earth-size planets in the habitable zones



Search

for other earths

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Search

for other earths

Direct imaging: 10^{-10}
Transiting Earth: 10^{-4}
Transiting super Earth
around a small star: 10^{-3}

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Terrestrial Planet Finder

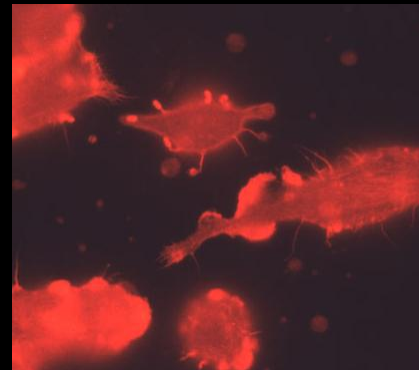
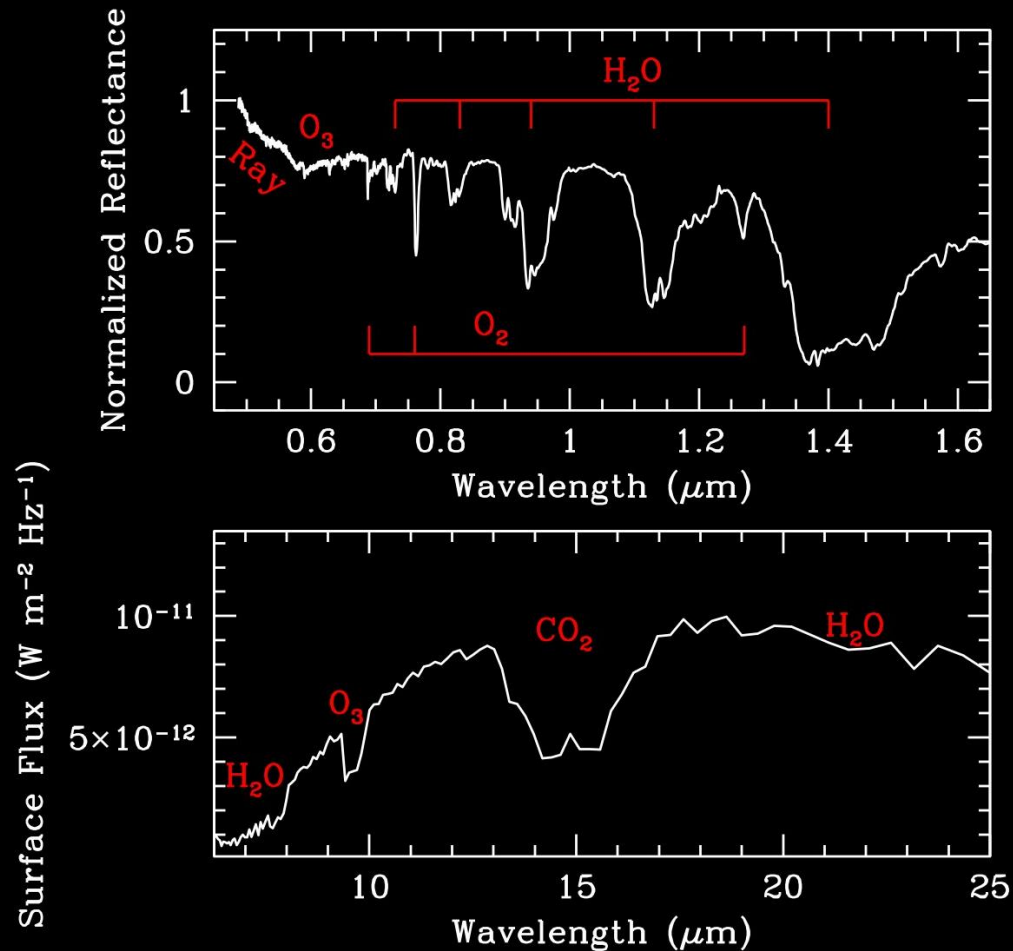
Goal: to find planets in the star's habitable zone and look for biosignatures.

Terrestrial Planet Finder



Northrup Grumman external occulter test bed

Biosignature Gases



Turnbull et al. 2007

Pearl and Christensen 1997

SETI

A photograph of several large, silver, parabolic radio telescope dishes at the Arecibo Observatory. The dishes are mounted on black metal tripods and are arranged in a field. The background shows a clear blue sky and a forested hillside. The text "SETI" is overlaid in the top left corner.

No alien civilization appears to be continuously broadcasting a powerful “beacon” signal from a planet circling any of the nearest 1,000 or so Sunlike stars, at least in the frequency bands searched to date.



LIFE IN THE EXTREMES



HALOPHILES

LIFE IN THE EXTREMES



PSYCHROPHILES

LIFE IN THE EXTREMES



ACIDOPHILES

LIFE IN THE EXTREMES



RADIORESISTANT MICROBES

LIFE IN THE EXTREMES



BAROPHILES

LIFE IN THE EXTREMES



ALKALIPHILES

LIFE IN THE EXTREMES



XEROPHILES

LIFE IN THE EXTREMES



THERMOPHILES

LIFE IN THE EXTREMES



ENDOLITHS

SETI

- No alien civilization appears to be continuously broadcasting a powerful “beacon” signal from a planet circling any of the nearest 1,000 or so Sunlike stars, at least in the frequency bands we’ve searched.”

