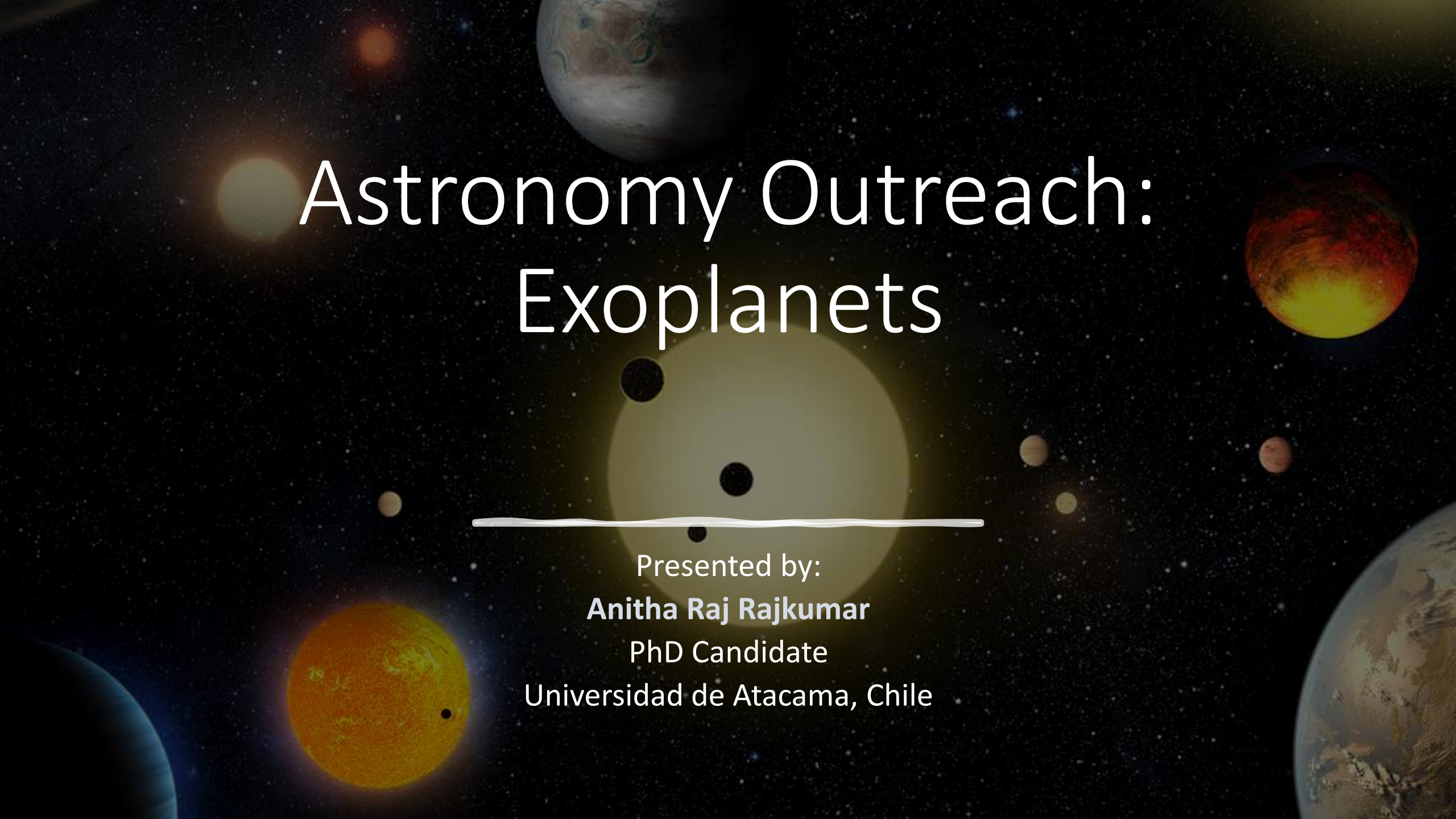


Astronomy Outreach: Exoplanets

Presented by:
Anitha Raj Rajkumar
PhD Candidate
Universidad de Atacama, Chile

Contents:

- How big the space is..
- Introduction to exoplanets
- Detection methods
- Characterize the atmosphere

Space outside the Earth

Is big.. Very big indeed!

Comparison of the stellar objects in solar system and other stellar objects.

Video Credit: https://www.youtube.com/watch?v=PDMKhmlWwIk&t=52s

Ceres: Dwarf Planet
Callisto: Moon of Jupiter
Kepler-22 b: Exoplanet

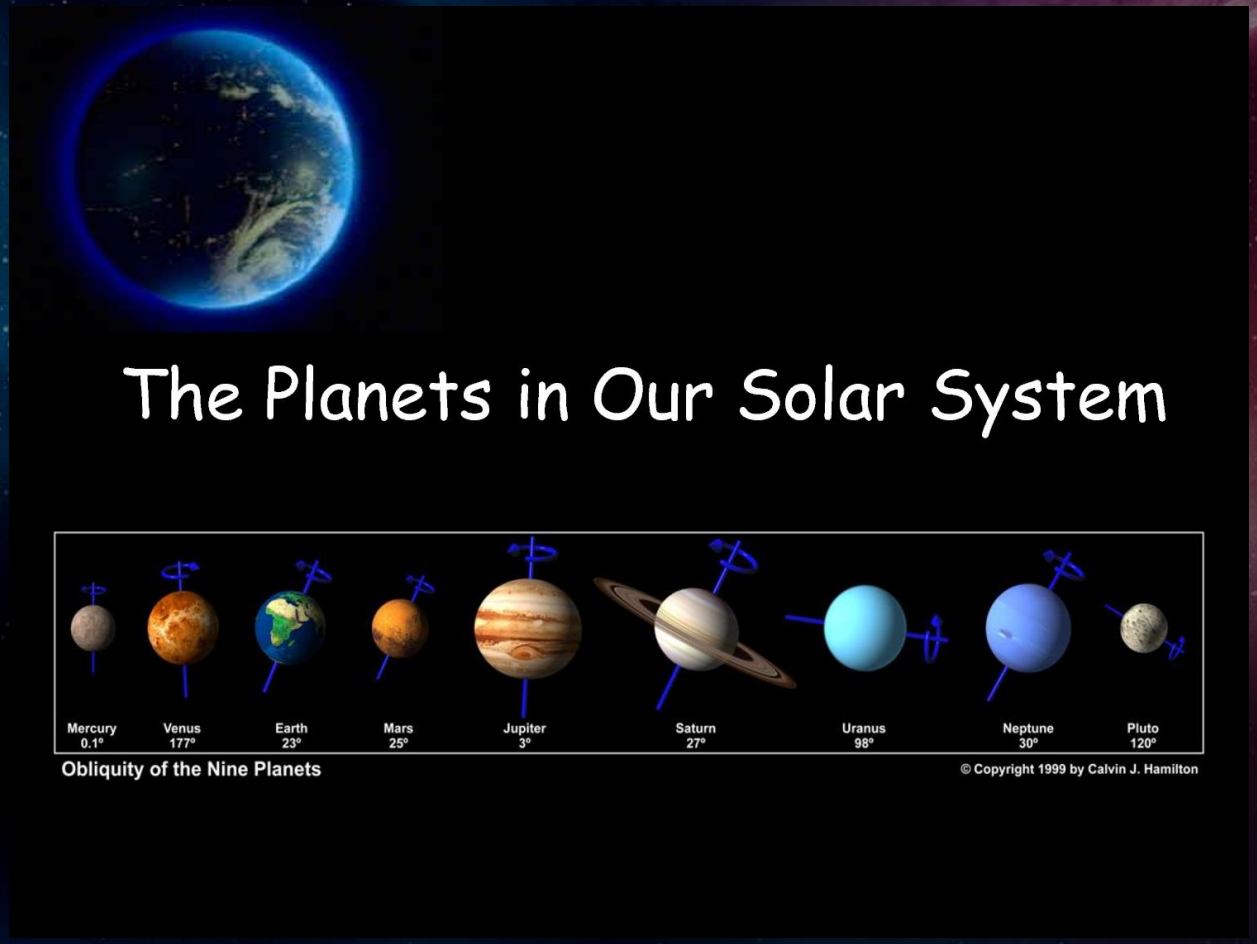
Other solar systems

Now that you have seen how big the stellar objects are, what are the possibilities for the existence of other worlds?

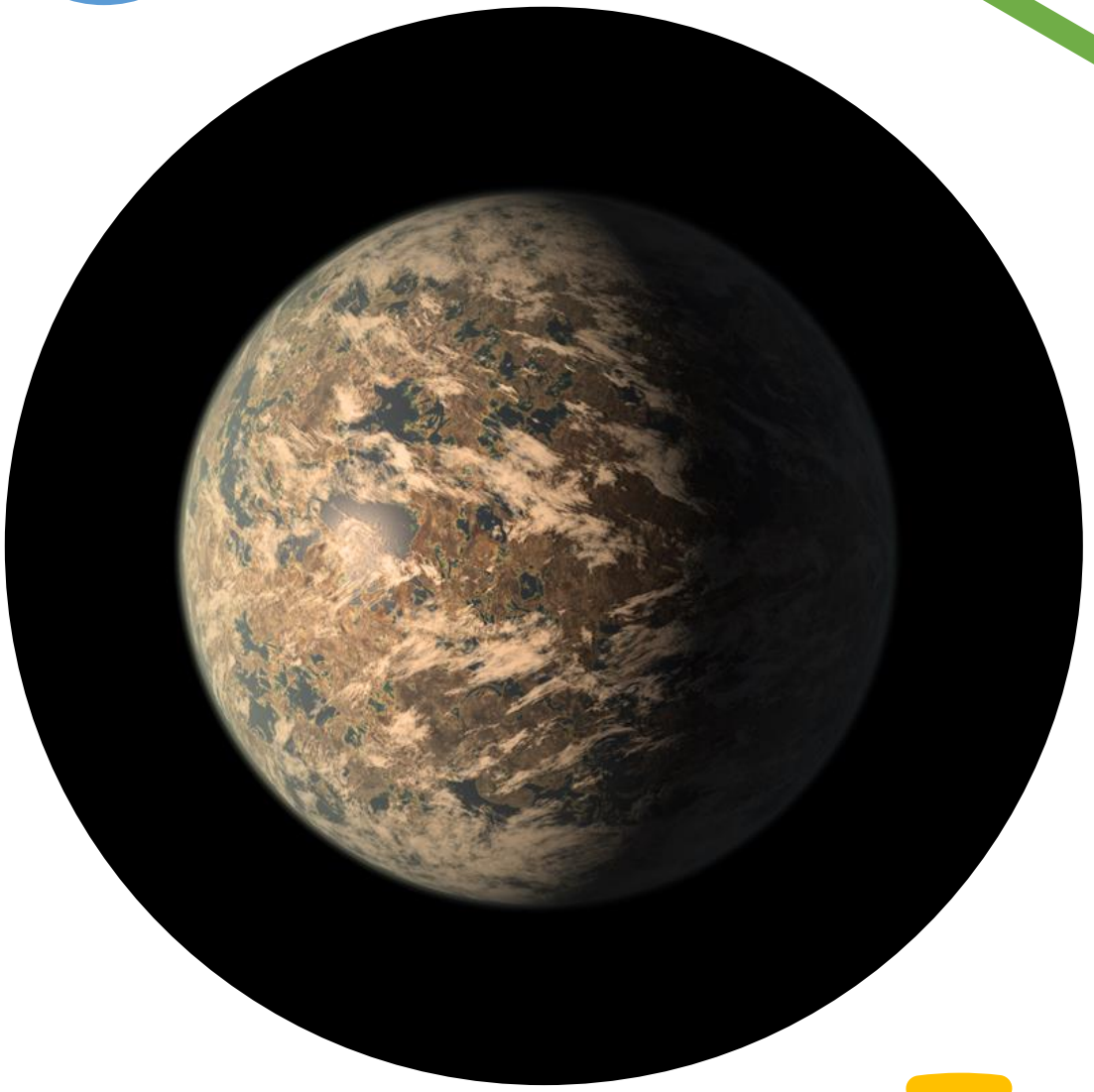
A lot!!!

Introduction to exoplanets

The planets which are outside our solar system are called extrasolar planets or exoplanets



But do they all look the same?



Different kinds of exoplanets

1. Terrestrial

e.g., Trappist-1e

Between half of Earth’s size to twice its radius are considered terrestrial, and others may be even smaller

Current discoveries: 192

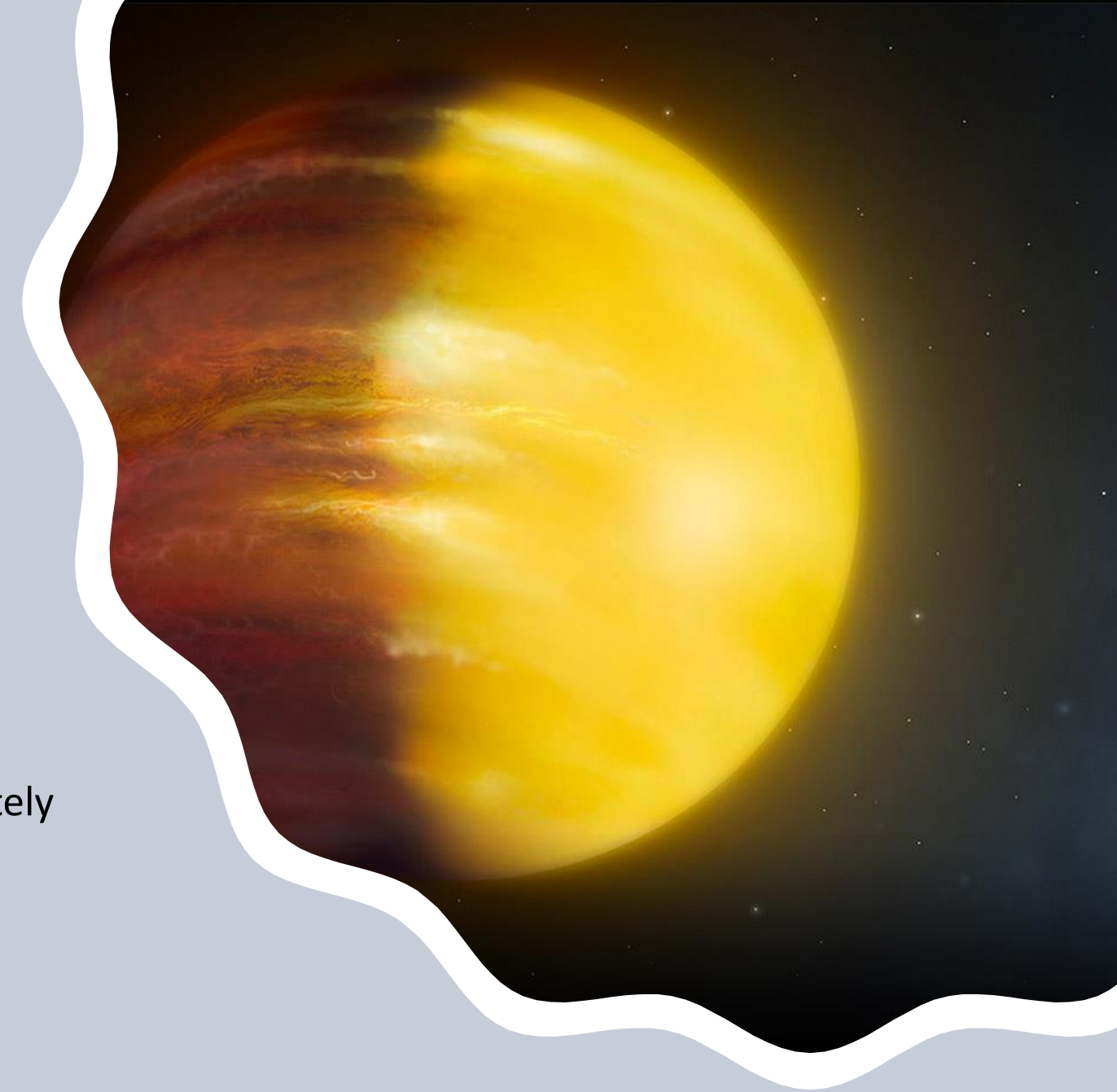
2. Gas giant

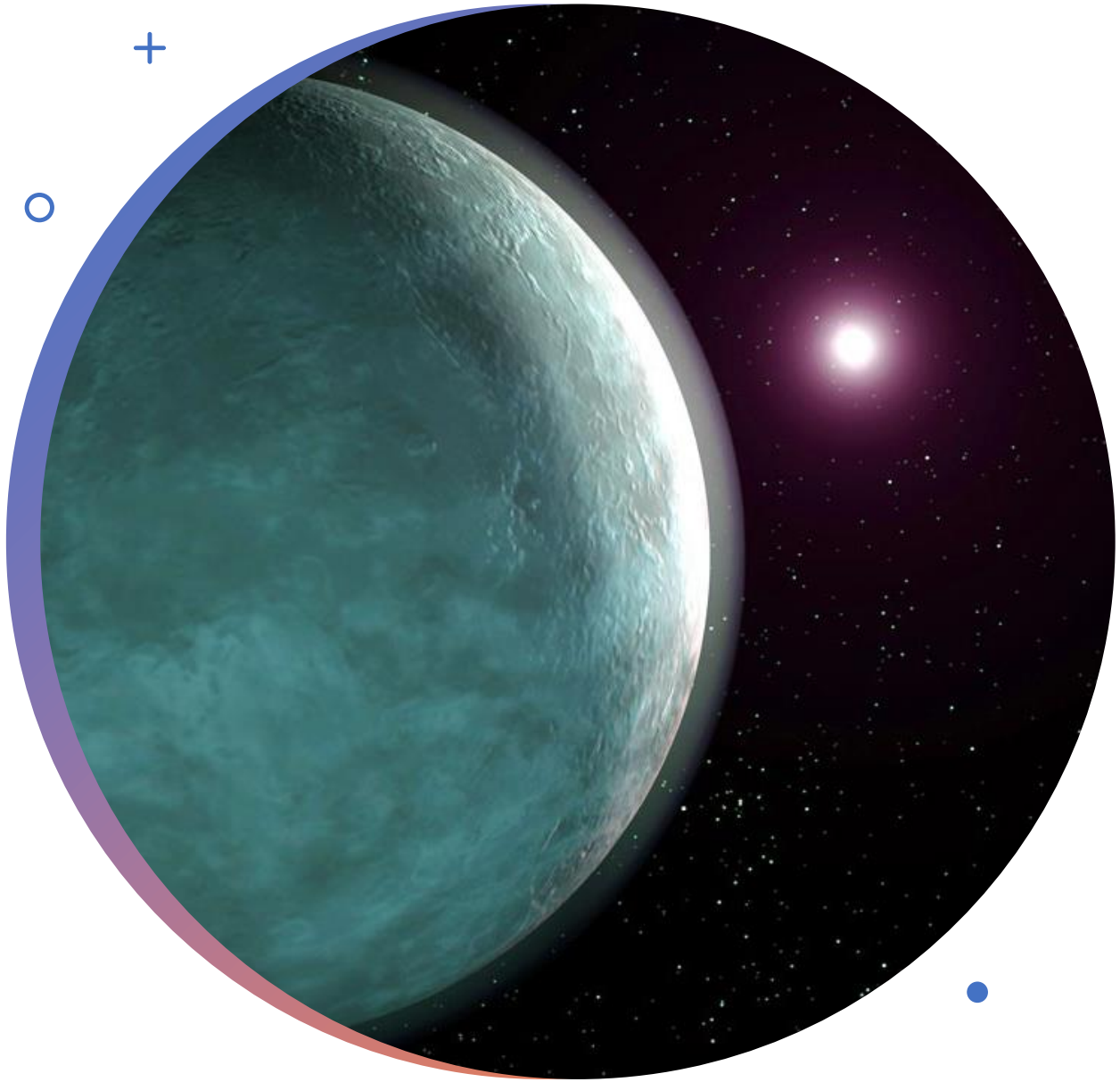
e.g., 51 Pegasi b

Mostly composed of hydrogen and/or helium

Current discoveries: 1,613

They orbit their parent star very close approximately less than 1 au





3. Neptunian

e.g., kepler 1655 b

Neptunian planets typically have hydrogen and helium-dominated atmospheres with cores or rock and heavier metals

Current discoveries: 1,808

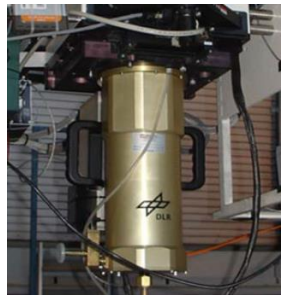
4. Super-Earths

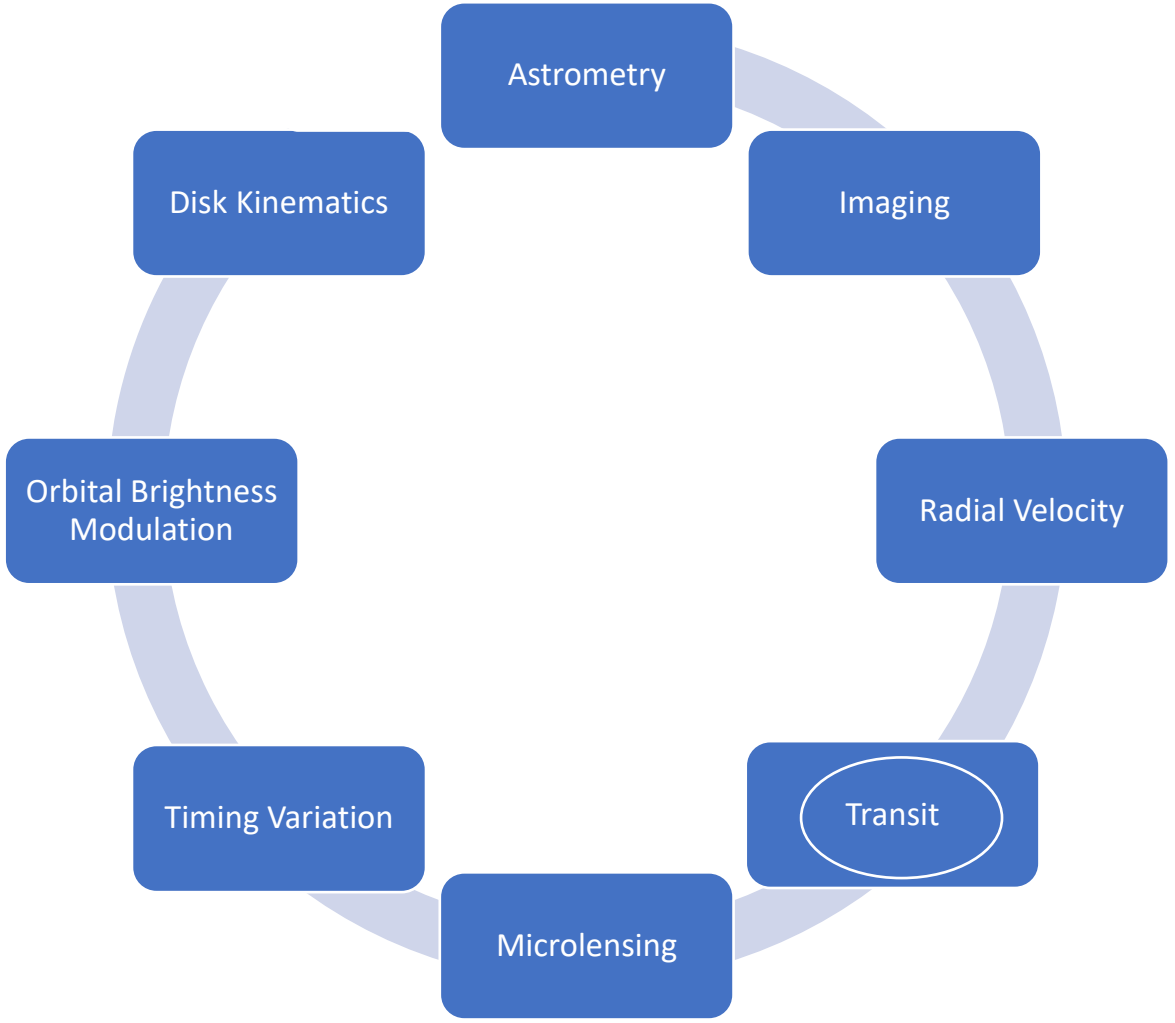
e.g., Barnard’s Star b

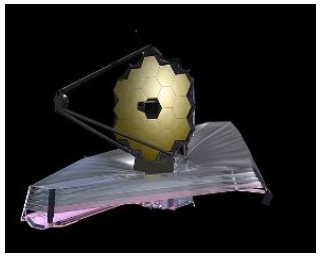
They are between twice the size of Earth and up to 10 times its mass

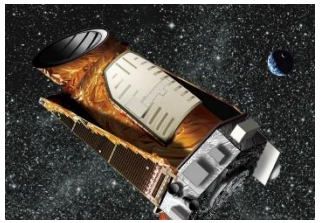
Current discoveries: 1,593

Methods to Detect an Exoplanet

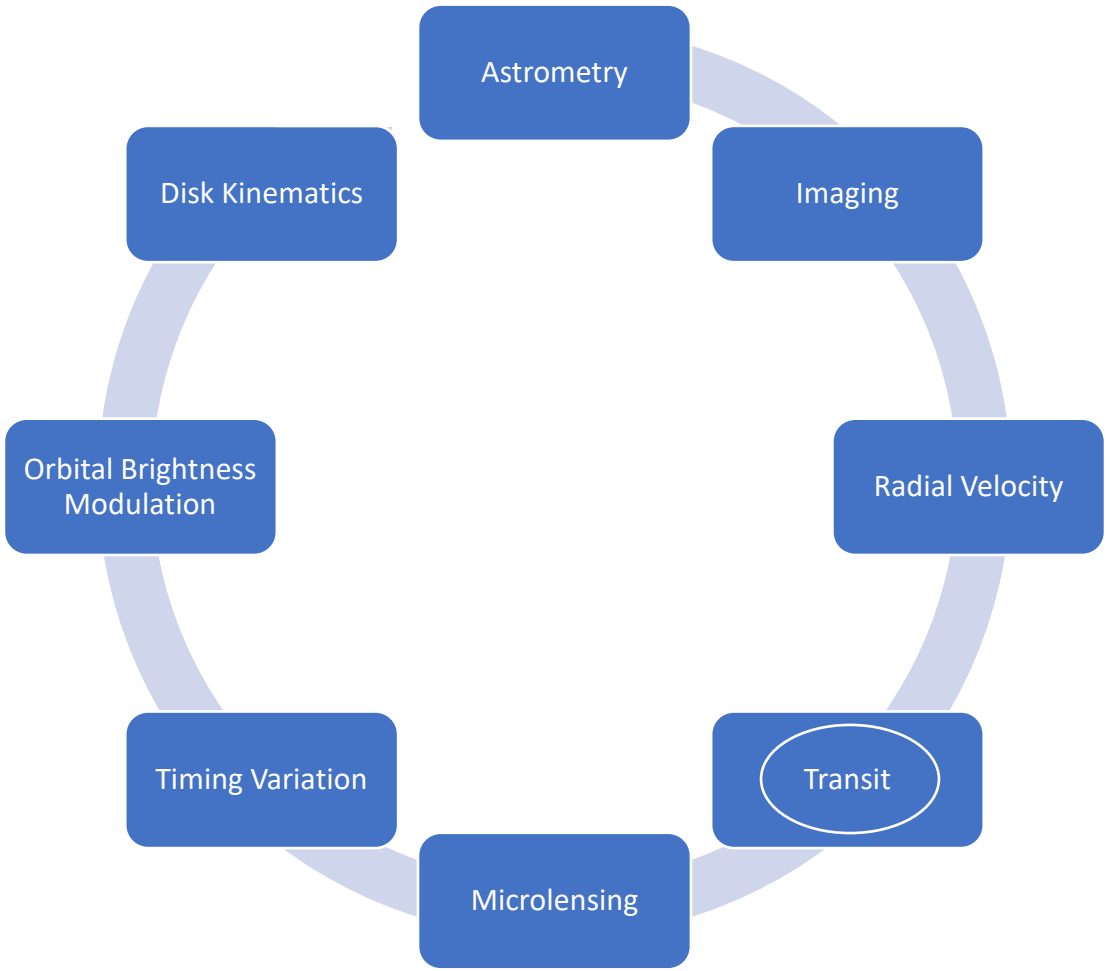








Methods to Detect an Exoplanet

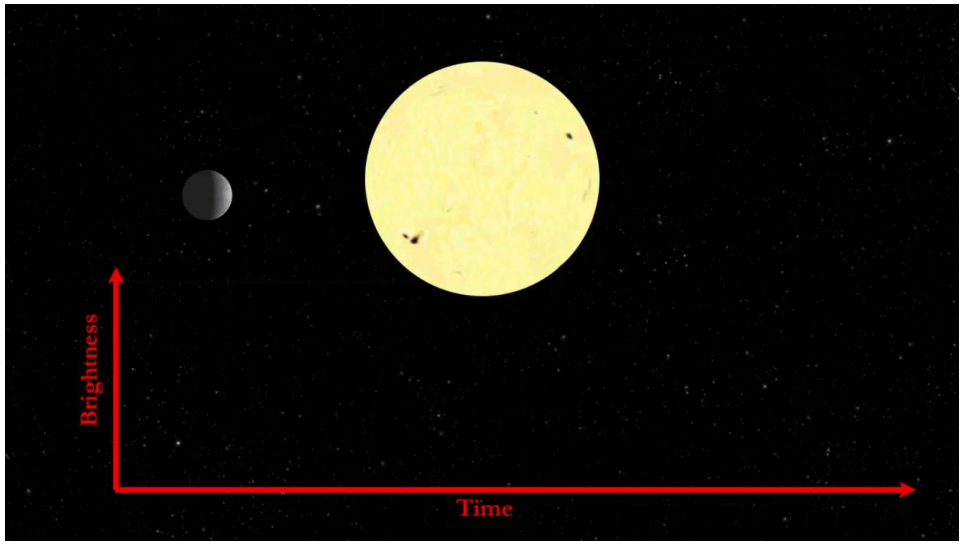


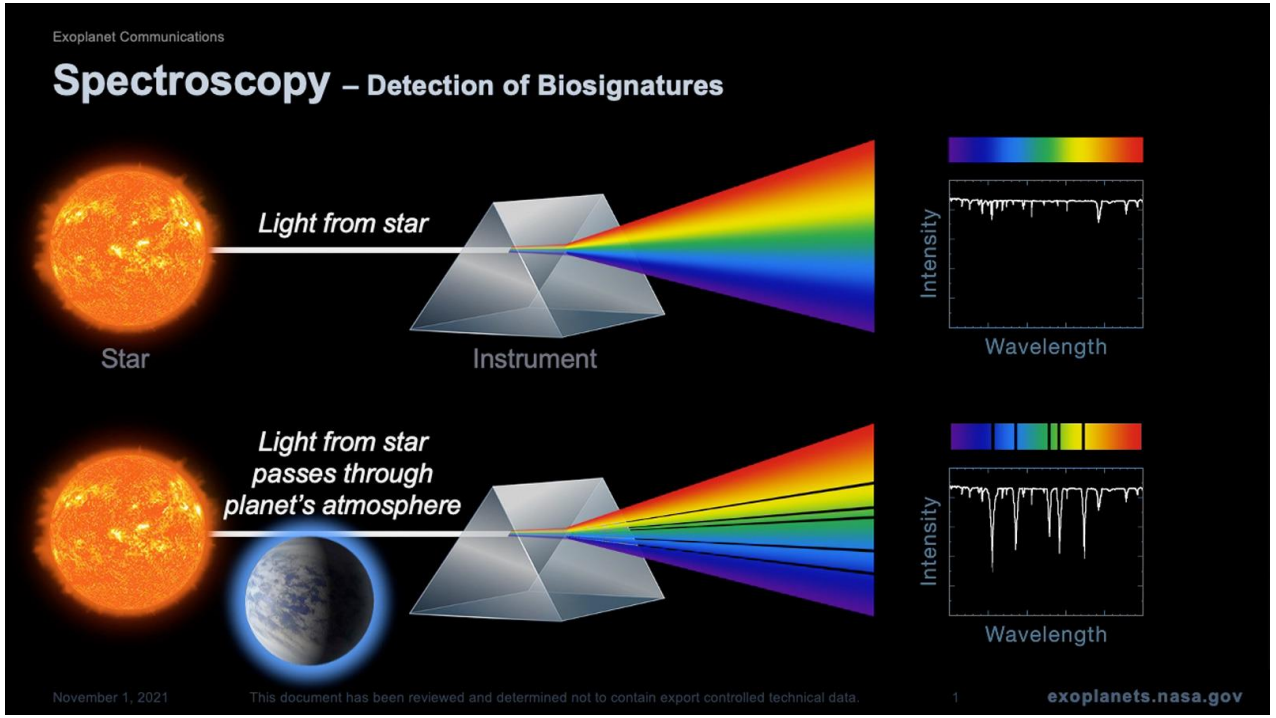
Transit Method

- It provides accurate constraints on planetary and stellar radii, orbital inclination, transit timing measurements and Stellar density.
- This method can allow for a planet's atmosphere to be investigated through transmission spectroscopy

Transmission Spectroscopy

As light from the star passes through the planet's atmosphere, the resulting spectra can provide clues to the existing chemical composition of the atmosphere.






What's Next?

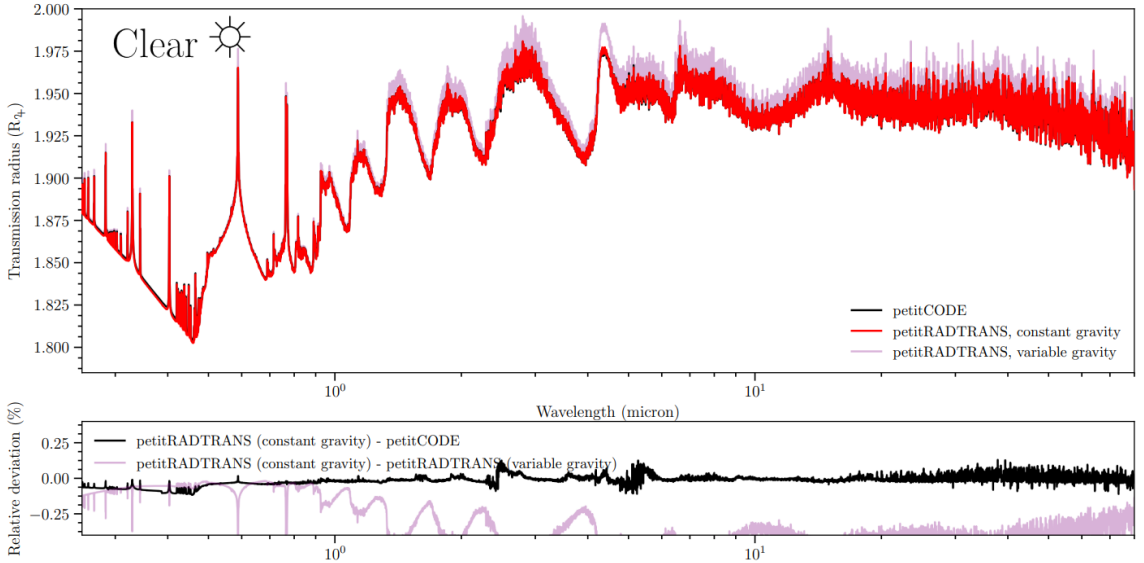
Characterizing the exoplanetary atmosphere

Why is it important to characterize the atmosphere?

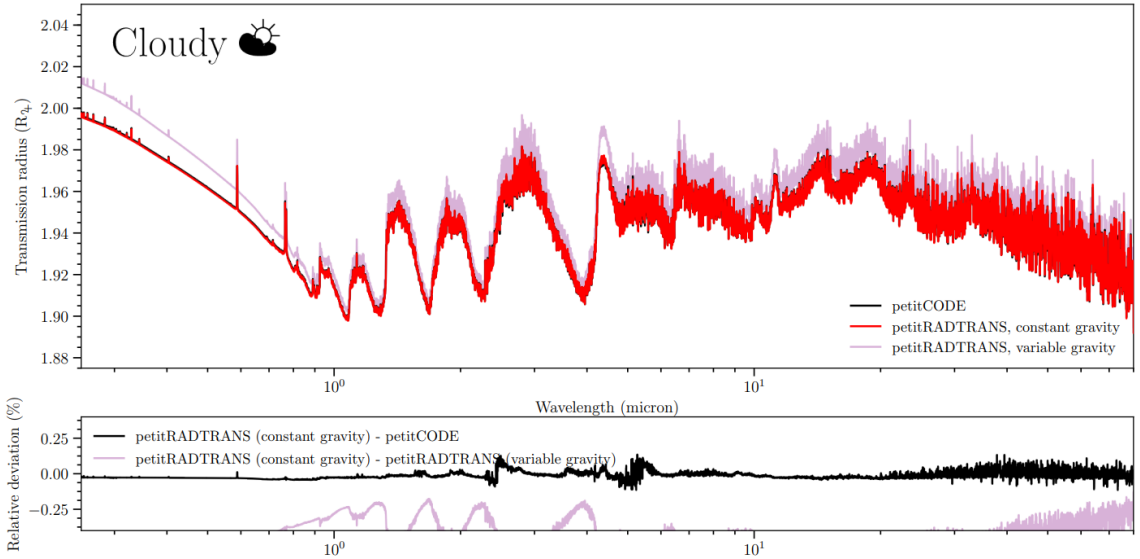
Presence of clouds and hazes

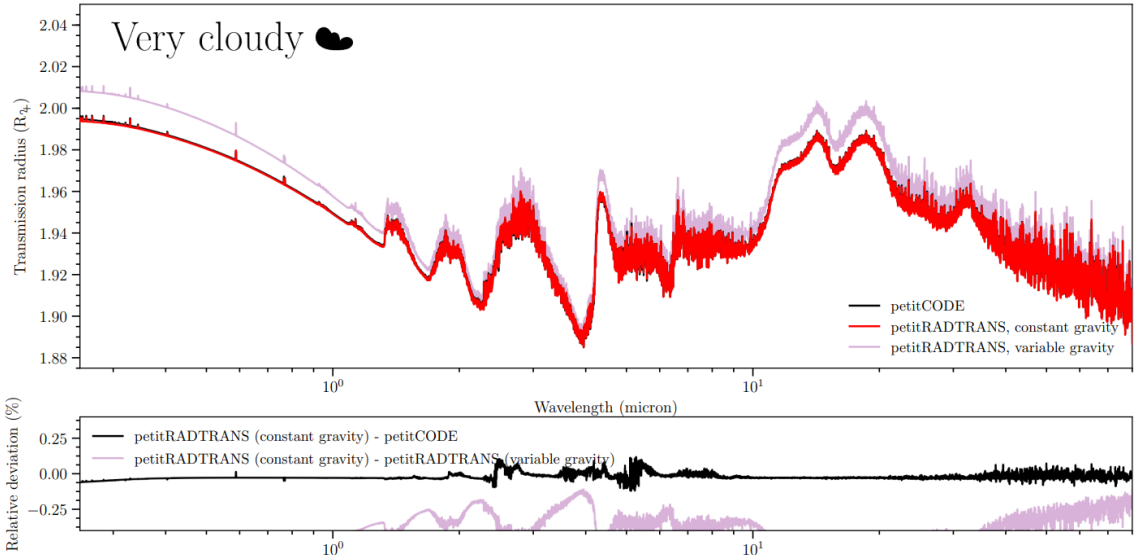
What could it tell us?

Whether the exoplanet can bare life in it or not!



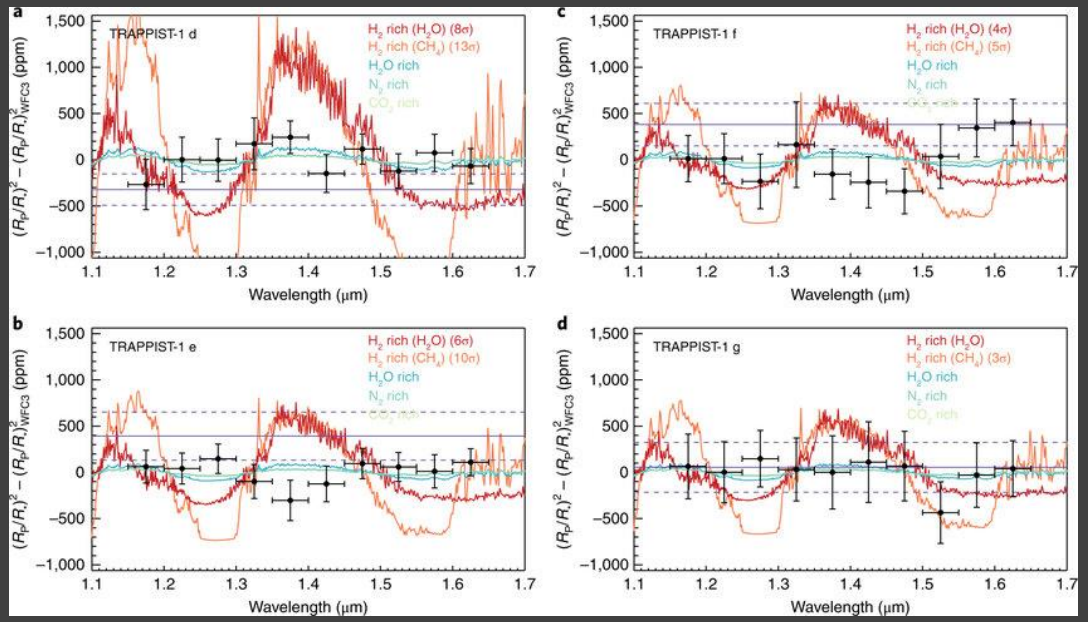
TrES-4 b [Molliere et al. (2019)**]**



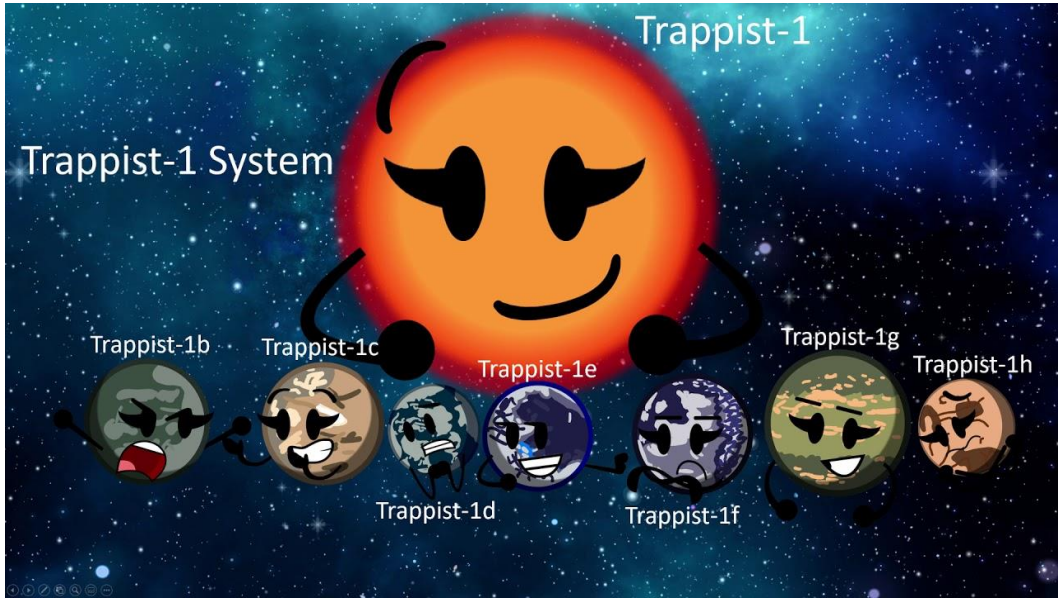


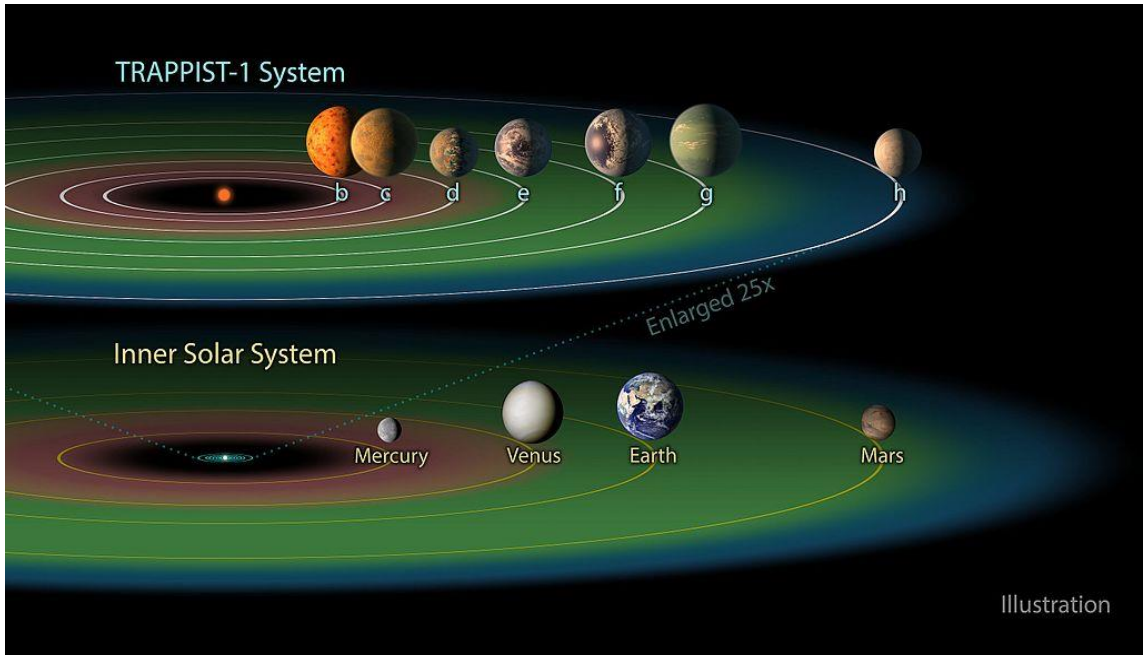
Few examples of different worlds

TRAPPIST-1 System



J. de Wit et al. 2018





HELL PLANET

WASP-72 b

During the day, the temperature is 2400 deg C

- Making the iron evaporates into the atmosphere to form metallic clouds.
- Then driven by strong wind (1600 Kmph) to cause rain.

Earth's Evil Twin

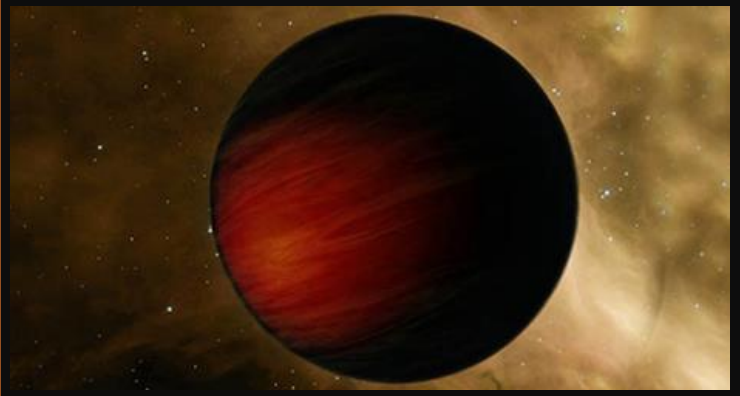
HD 189733b

Looks nice and Earthlike..

But it's not!

- It is a hot-Jupiter gas giant
- Day side: 1000 deg C
- Night side: 650 deg C
- It rains silicate glass sideways
- The blue color is thought to come from silicate particles in the planet's atmosphere
- Wind speed: 4350 mph (7000 km/hr)

Darkest known exoplanet



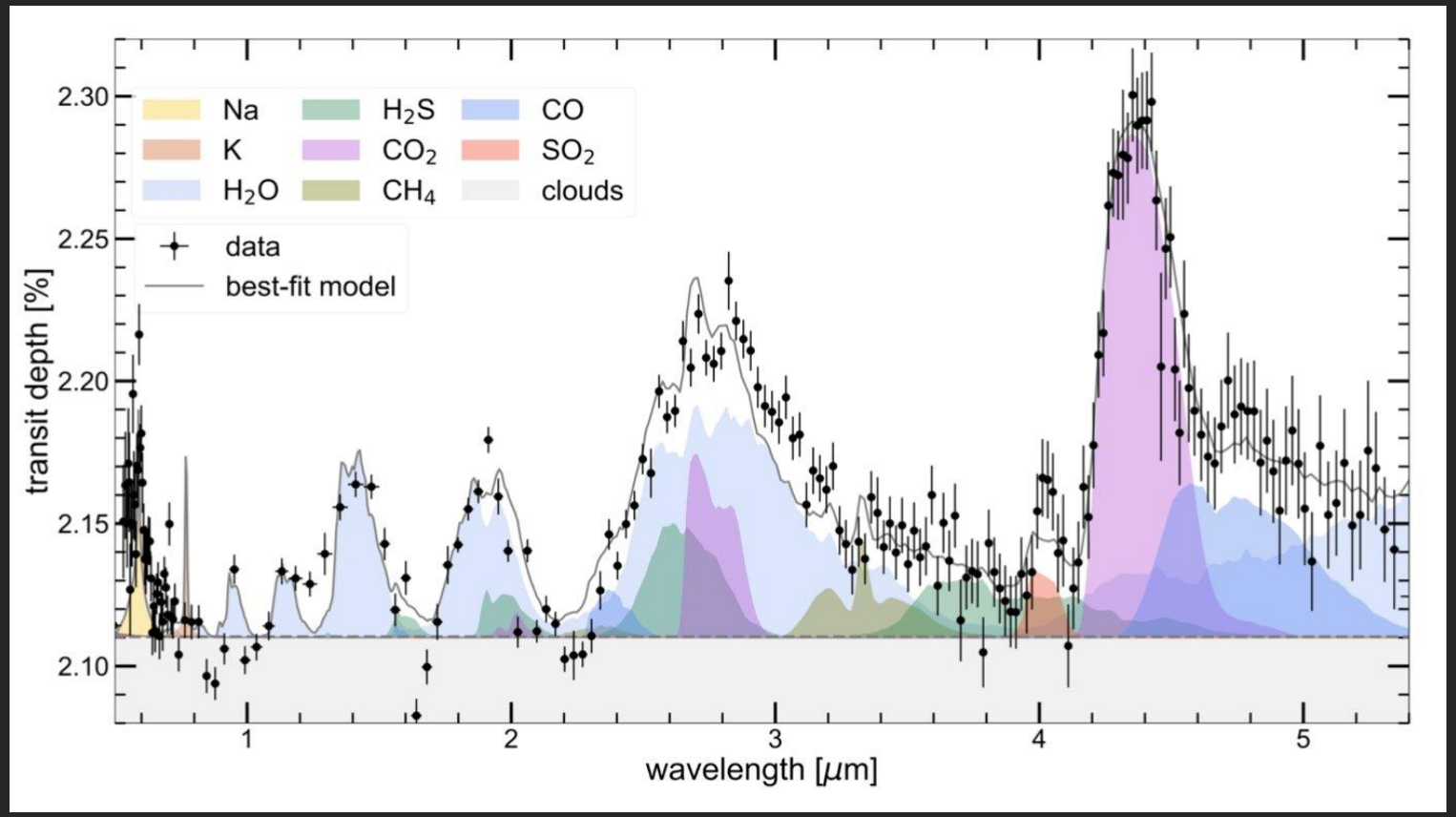
TrEs-2b

Less than 1% of the sunlight falling on it

The researchers propose that light-absorbing chemicals such as vaporized sodium and potassium or gaseous titanium oxide in the planet's atmosphere could help explain why it is so dark. Still, none of these can fully explain why the world is as stealthily cloaked as it is.

Arxiv papers on the discovery:

https://arxiv.org/abs/2211.10488
https://arxiv.org/abs/2211.10487
https://arxiv.org/abs/2211.10489
https://arxiv.org/abs/2211.10493
https://arxiv.org/abs/2211.10490



Rustamkulov et al.

Interesting results from JWST

WASP-39 b

- Hot-Jupiter gas giant
- H2O and CO2 abundance

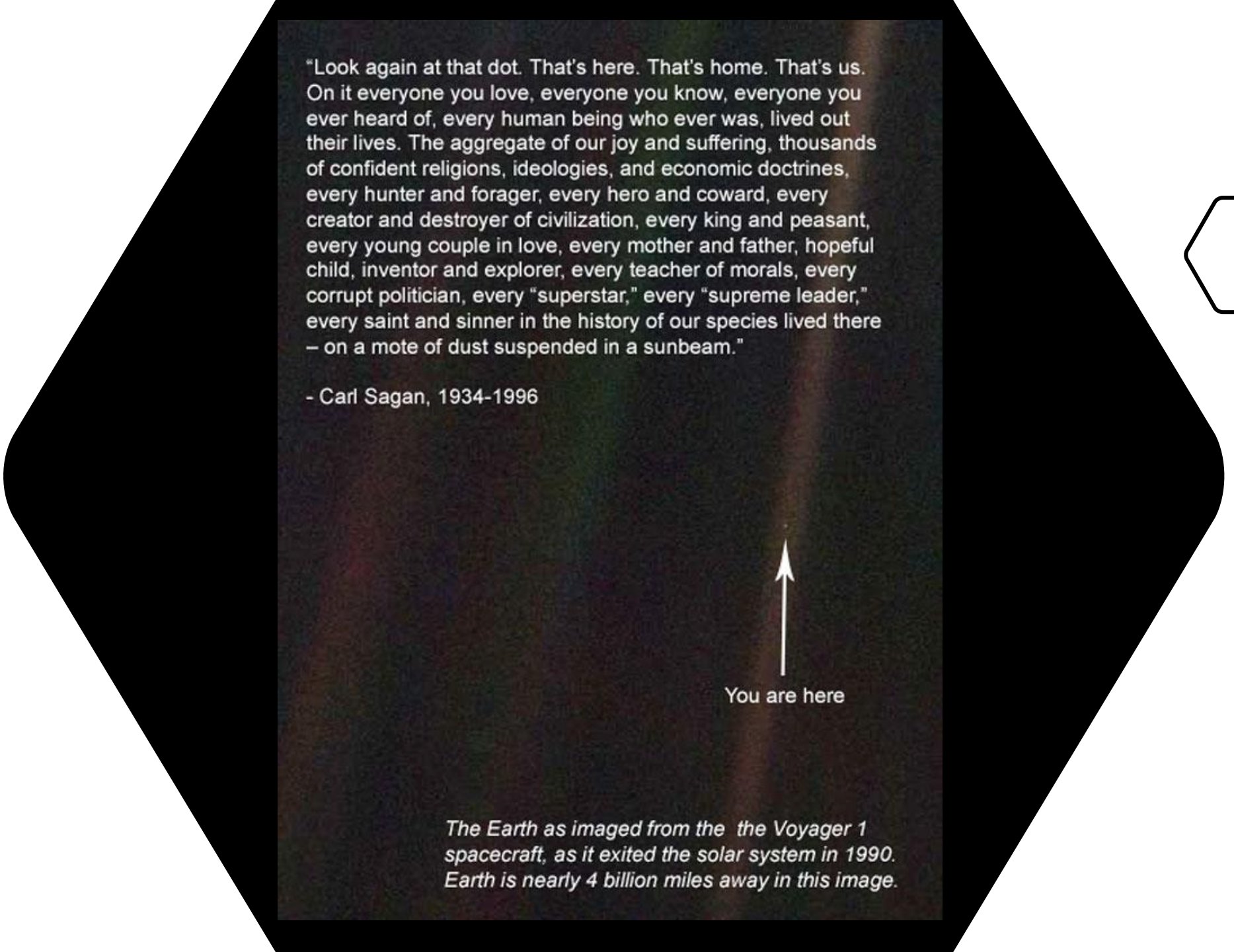
"The Discovery of Photochemistry happening in this exoplanet's atmosphere "

SO2

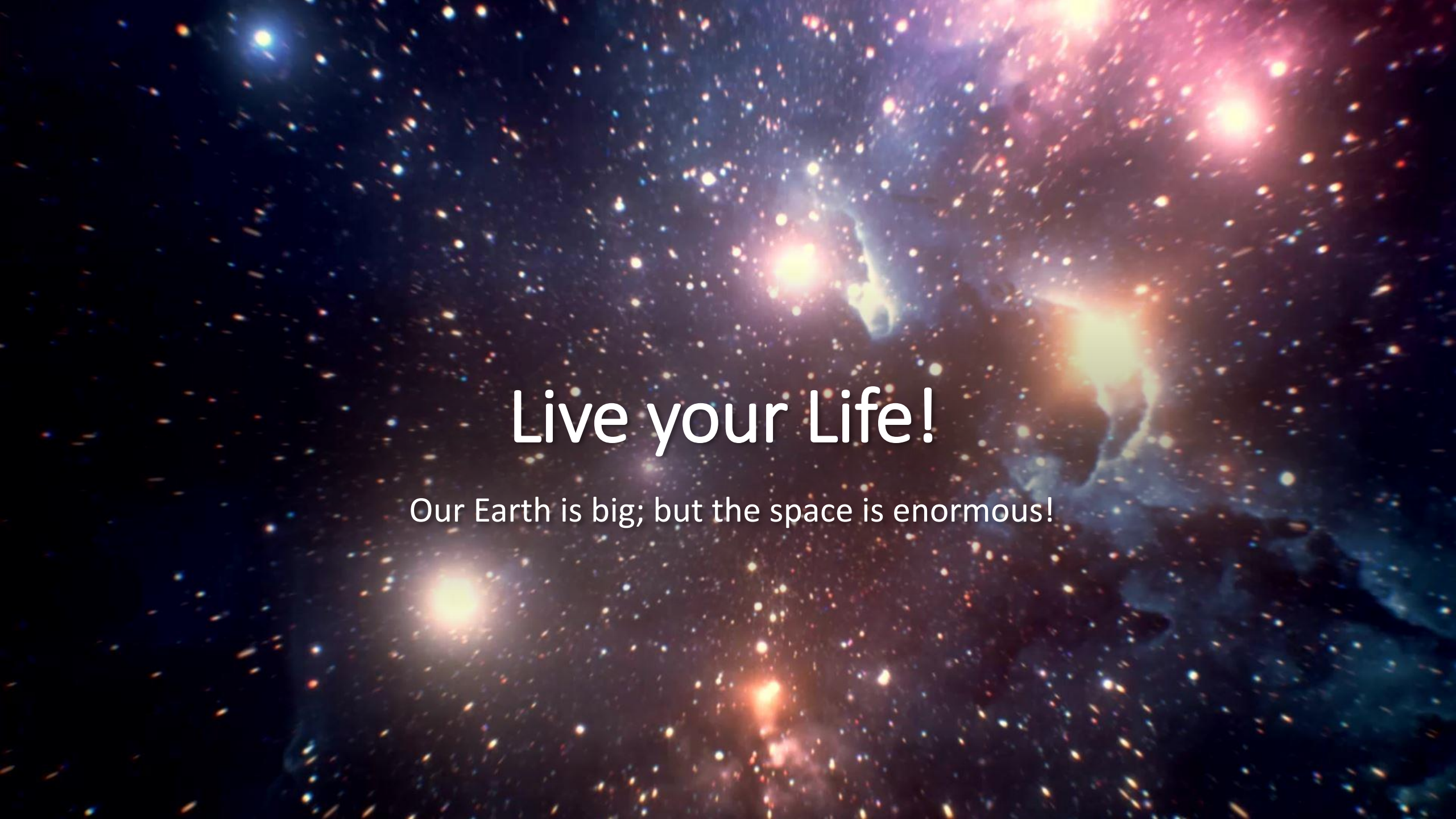
Photons from the star interact with abundant water molecules and results in forming Sulfur Dioxide molecules

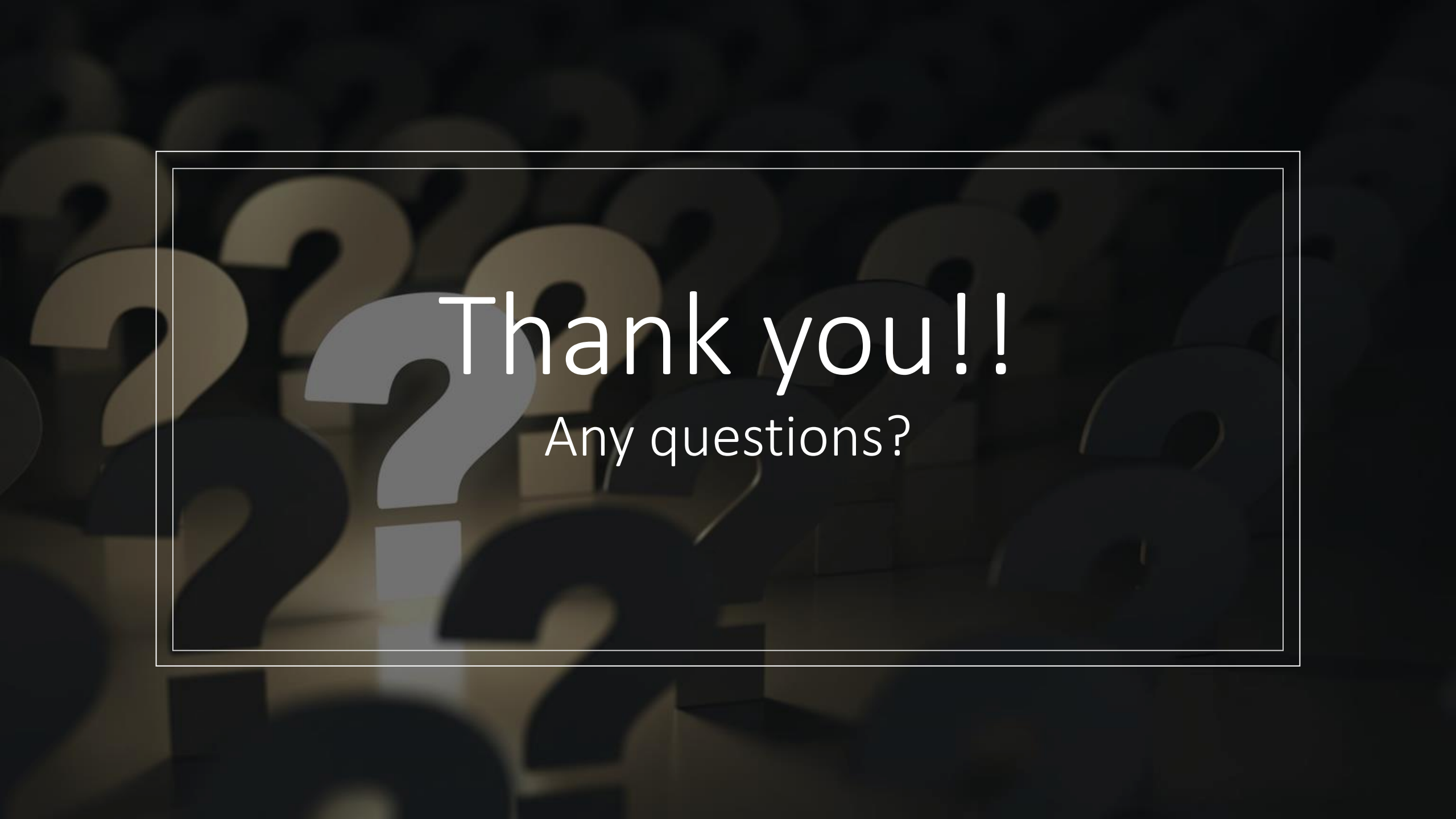
Hubble Deep-space Image

Each dot is a galaxy!



The Earth as imaged from the the Voyager 1 spacecraft, as it exited the solar system in 1990. Earth is nearly 4 billion miles away in this image.


Live your Life!
Our Earth is big; but the space is enormous!


Thank you!!
Any questions?

References:

- https://exoplanets.nasa.gov/what-is-an-exoplanet/planet-types/overview/
- https://www.space.com/12612-alien-planet-darkest-coal-black-kepler.html
- https://universemagazine.com/en/trappist-1-planets-capable-of-sustaining-life/
- https://object-cosmos.fandom.com/wiki/Lieopa