

# **Astrobiology**

## **Exercise Class 9**

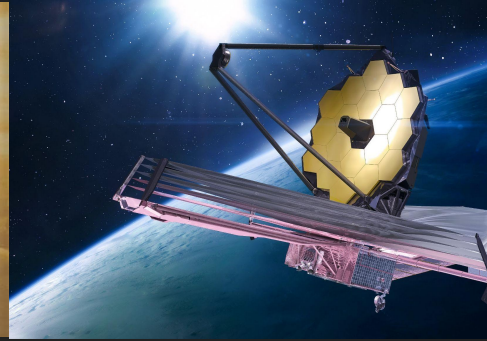
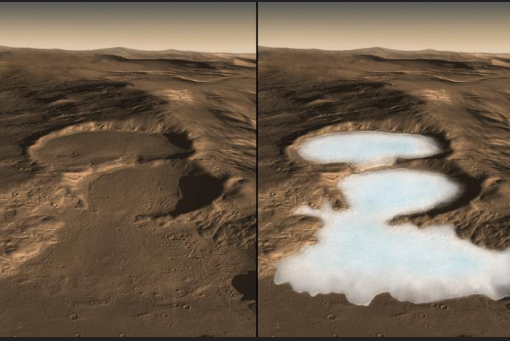
The great divide between the astrobiological fields

02-12-2023

1. I will talk a bit about astrobiology in the solar-system vs. for exoplanets
2. We will discuss together how different fields approach astrobiology
3. We play a small game
4. HW assignment nr. 5

# Instruments

- Solar-system science can use in-situ missions.
- Solar-system science can use direct observations (e.g. take pictures of the surface of Mars).
- Exoplanet research leans (currently) on indirect measurements.
- Need to think well about the biosignature
- Taking a direct image of an exoplanet is possible and will be further developed with future telescopes, but the data will not be as detailed.

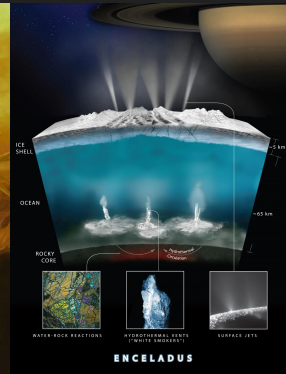


**ASTROBIOLOGISTS  
LOOKING  
AT EXOPLANETS**

**ASTROBIOLOGISTS  
LOOKING AT MARS**

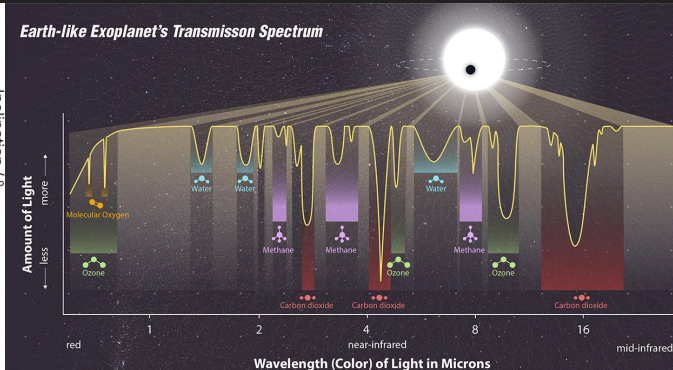
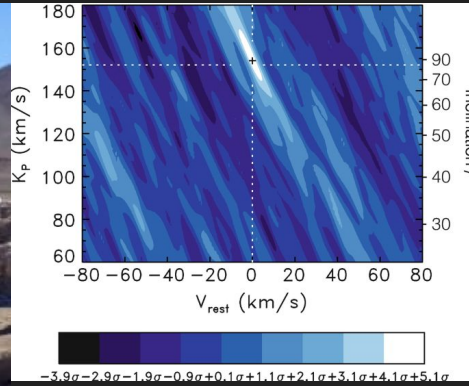
# Implications of finding life

- Finding life in the solar-system will give us more insight on the origin of life on Earth.
- We expect only simple, microbial life.
- If there were intelligent aliens in the solar-system, one could argue we would have had contact by now.
- Life on exoplanets could still be too far for exchanges.
- There are less constraints and thus more room for imagination.
- 'Technosignature' = sign of technology



# Scientific background

- Because of the in-situ measurements, solar-system astrobiologists tend to have more background in chemistry and biology
- Scientific studies often contain field work, where Earth's conditions are compared to e.g. those on Mars.
- Exoplanet scientists have more often a background in physics
- Studies are more theoretical and programming is fundamental



# Planetary types

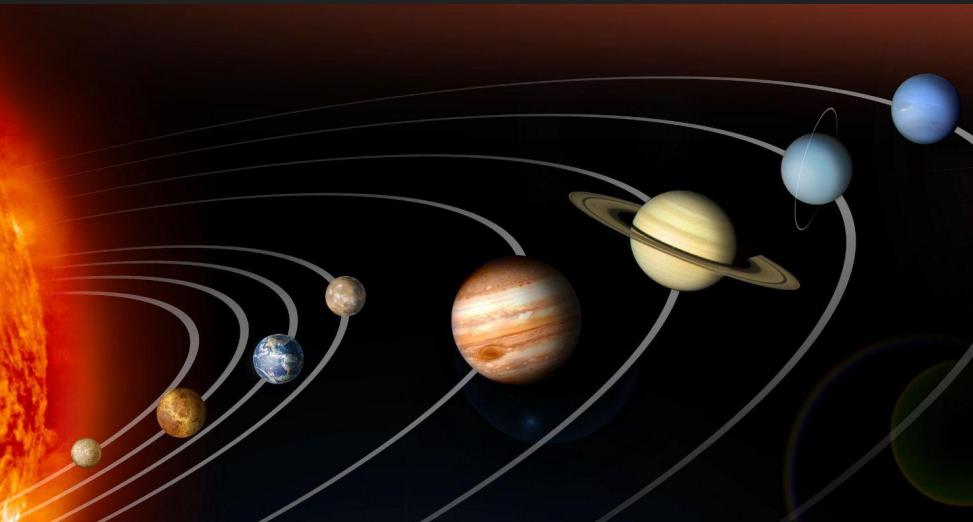
- The solar-system has a few more rocky planets, but these are of a very different composition.
- We can also study moons.
- Detected exoplanets are predominantly super-Earth and mini-Neptunes. These are not in the solar-system and if there is life it would be different.
- We know almost nothing about exomoons.



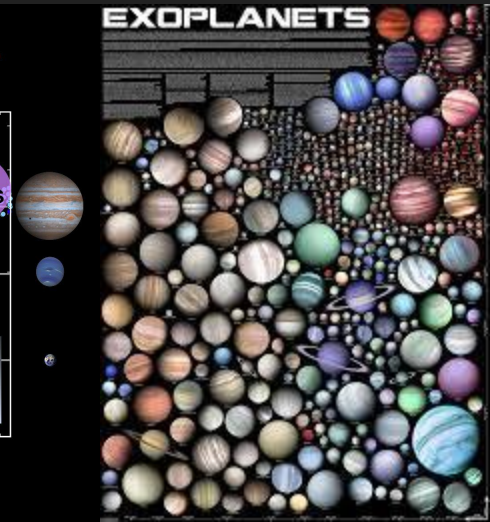
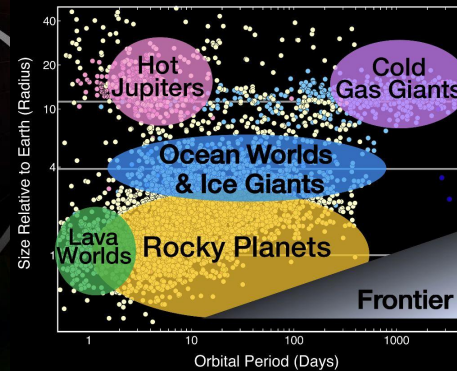


# Sample size

- The amount of solar-system bodies is limited.
- Exoplanets go up in the 1000's, so we can do statistics.



## Exoplanet Populations



At astrobiology related conferences or in the scientific literature there is often division between different 'kind' of astrobiologists

- Those studying planet formation (Physicists)
- Those studying the history of Earth (Geologists)
- Those studying the building blocks for life (Chemists)
- Those studying the evolution and complexity of life (Biologists)
- Those studying the nature of life (Statisticians and Philosophers)
- Those studying observational data from planets (Astronomers)

Also Computer scientists can play a role in these topics.

As people in this scientific field come from a wide range of backgrounds it can be difficult to 'speak the same language'.



**I'm asking you to fill out the next 8  
slides together with me.**

Pick which group you belong to best:

Geologist  
Biologist  
Chemist  
(Astro) Physicist  
Social Scientist  
Mathematician / Statistician  
Philosopher  
Literature studies

**Now write down an important scientific questions that approaches astrobiology from your field. Something that can (hopefully) be answered the next two decades or so.**

I give you an example as a physicist:

How likely are planets to have liquid water by their formation process?

# Astrobiology according to a Geologist

# Astrobiology according to a Biologist

# Astrobiology according to a Chemist

# Astrobiology according to a (Astro) Physicist



# Astrobiology according to a Social Scientist

# Astrobiology according to a Mathematician / Statistician

# Astrobiology according to a Philosophers

# Astrobiology according to a Literature scientist

# Now we play a game

We all start standing up

Every question you can answer with (a) hands on your head or (b) hands on your shoulders.

If you got it wrong: game over :( sit down.

Last one to stand wins a Christmas cookie.

# 1. What did I ask the AI?



Describe a astrobiological space mission to [redacted]



An astrobiological mission to [redacted], one of the moons of Saturn, would involve sending a spacecraft to study the moon's surface, subsurface, and environment in order to search for evidence of past or present life. [redacted] is of particular interest to astrobiologists because it has a subsurface ocean that could potentially support life.

- (a) Enceladus (hands on head)
- (b) Europa (hands on shoulders)



## 2. What did I ask the AI?



What is a [redacted]?



A [redacted] is an organism that thrives in high pressure environments. These organisms are found in a variety of extreme environments, including deep sea trenches and other high pressure environments, where they are able to survive and thrive despite the extreme conditions.

- (a) Halophile (hands on head)
- (b) Piezophile (hands on shoulders)

### 3. What did I ask the AI?



What is the [redacted] cycle?



The [redacted] cycle is the process by which [redacted] moves through the Earth's atmosphere, oceans, and land, and between living organisms and the environment. [redacted] is an essential element that is central to life on Earth, and the [redacted] cycle plays a vital role in the functioning of the planet's ecosystems.

- (a) Silicate (hands on head)
- (b) Carbon (hands on shoulders)

## 4. What did I ask the AI?



What is [redacted]?



[redacted], also known as biopoiesis or origin of life, is the study of how life on Earth emerged from non-living matter. The process of [redacted] is thought to have occurred billions of years ago, and it is not fully understood. However, scientists have proposed a number of different theories and models to explain how life could have emerged from non-living matter under the conditions that existed on Earth at the time.

- (a) Pansperma (hands on head)
- (b) Abiogenesis (hands on shoulders)

## 5. What did I ask the AI?



What is role of [redacted] on Earth's habitability?



[redacted] plays a number of important roles in the habitability of Earth. Some of the key ways in which [redacted] impacts Earth's habitability include:

1. Protection from solar wind: Earth's [redacted] field helps to protect the planet from solar wind, which is a stream of charged particles that is emitted by the Sun. Solar wind can strip away the Earth's atmosphere and make the planet inhospitable to life. Earth's [redacted] field deflects solar wind and helps to protect the planet from this harmful radiation.

- (a) Magnetism (hands on head)
- (b) Gravitation (hands on shoulders)

Tie-breaker: how many exoplanets are as of now confirmed by NASA?

# Homework 5

## Questions from the media

### Deadline 02.12.2023

Send them to [marit@ics.uzh.ch](mailto:marit@ics.uzh.ch)

Scientists often have to answer short and sometimes difficult questions, either from the media or during debates. Below are some of the questions Ben Moore has been asked by journalists about life, the universe and everything.

Choose seven of these and answer them in one paragraph (each answer should roughly be between 60 and 160 words). There are no correct answers, you may have completely different opinions than Ben Moore or your colleagues. That is fine. It is a useful skill to be able to respond to such questions in a coherent manner expressing your opinions in a concise fashion and accurately.