



The Search of Life In The Solar System

BY: Yasir M. O. ABBAS

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EXPLORING NEW WORLDS IN SPACE

Evidences

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- Is there an evidence for life out of the Earth???

- No

- Science of Probability

- Is there evidence that there isn't life out of the Earth???

- No

- Science of Possibilities



What do we search for?

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- What happened to create life in the Earth?
- Do these CONDITIONS are there some where in the solar system?
- Don't forget this question but Let's answer it later!



What Is LIFE ???

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- We KNOW nothing !!!
- CHANGE THE QUESTION:

What Does Life Do?

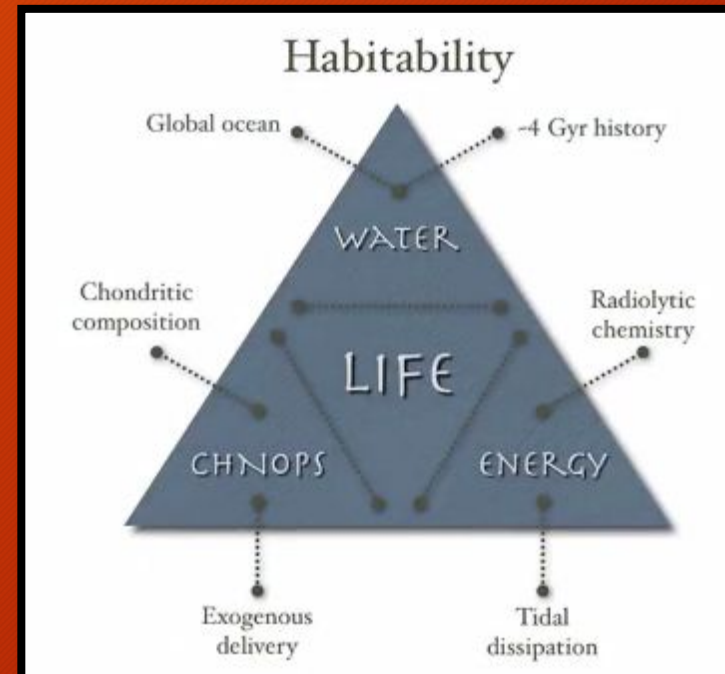
- Takes energy
- Grows
- Reproduces
- Complexity
- ?????????



STOP Defining in details

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- We don't want to define life, we take general characteristics.
- We tend to think that what we have applies to the universe.. But that is not TRUE always.
- We want to find it .. will know when we do!



Photosynthesis

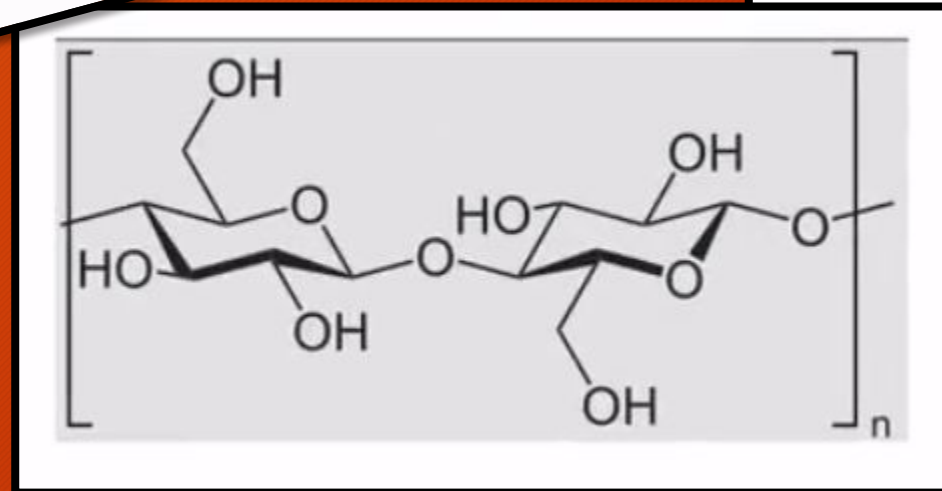
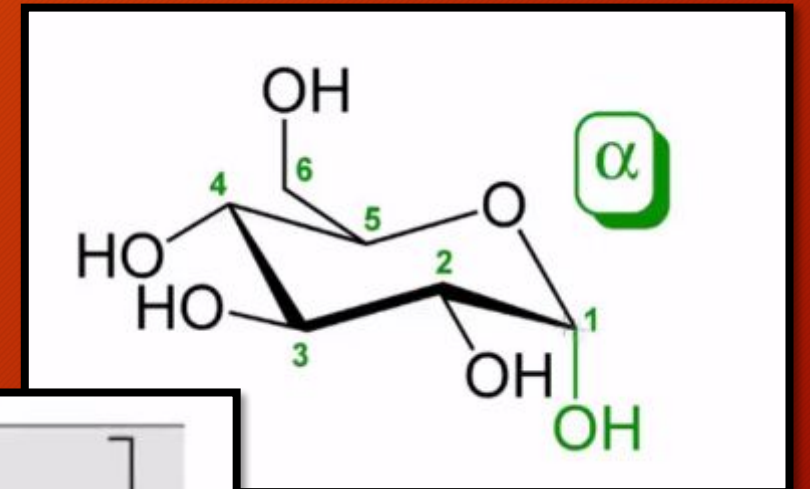
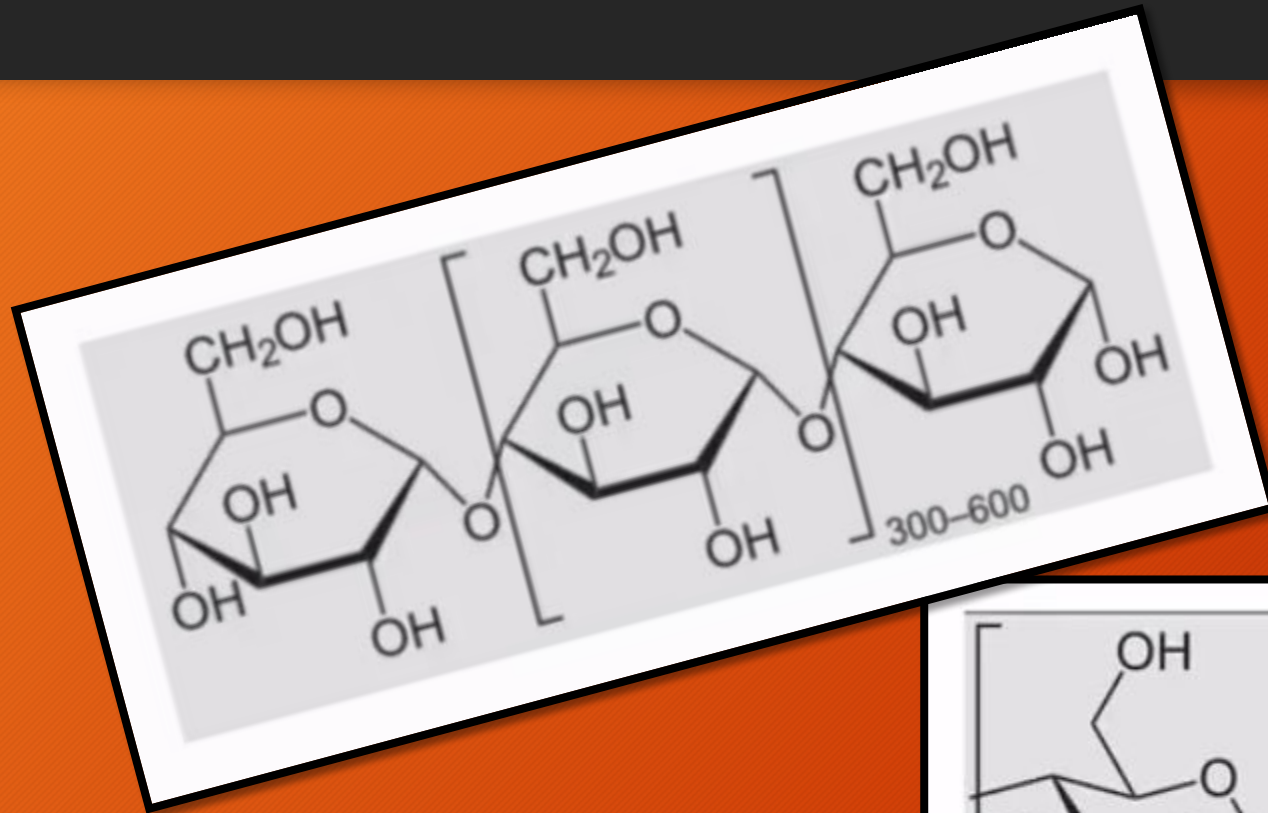
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- Terrestrial life is based on the Sun.
- How do humans take energy from the Sun????



Photosynthesis

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Water

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- Life needs LIQUID medium.
- chemical reactions.
- Transportation tool
- Photosynthesis >>
An easy process to store energy.
- Why water is special?
- Abundance in the solar system.
- Found in liquid phase commonly.
- Universal solvent >>
polar molecule.
- Water ice is less density than liquid water.



Alternatives

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Energy Sources

- Chemosynthesis.
- Methanogens (Archaea).
- Methane is the signature.

Liquid

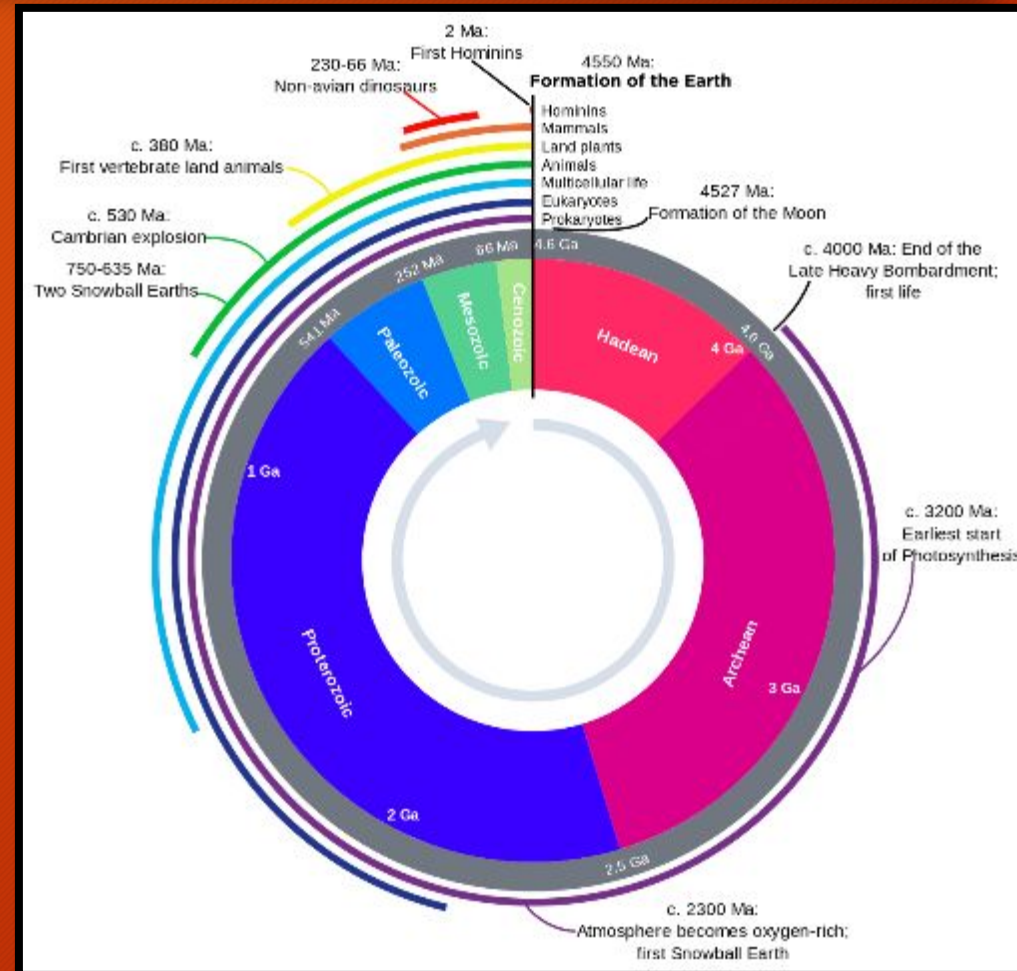
- Ammonia NH₃



History of Life on Earth

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- 4.5B Years old
- Almost half of the Earth's age the chemosynthesis was dominant.
- Then a switch flipped to photosynthesis.



Mars

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- 1976 the Viking lander.
- Several Experiments
 - Look for organics!
 - Look for microbes!
- Not applicable due to decomposers.



Looking for microbes

- Take a sample, add water and watch the waste.

[waste came out]

- Take a sample, heat it, add water and watch the waste.

[NO waste came out]

Looking for organics

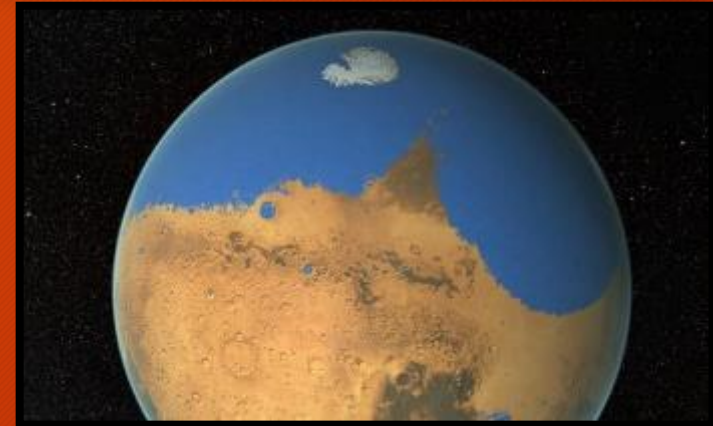
- Without diving in the details, the experiment involve heating the sample.



Mars

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- Evidences for habitable warm and wet environment.
-
- More than 20 missions to Mars, 9 are active.
- There is water ice on Mars. The search is for liquid water. There're sings for that!



Mars

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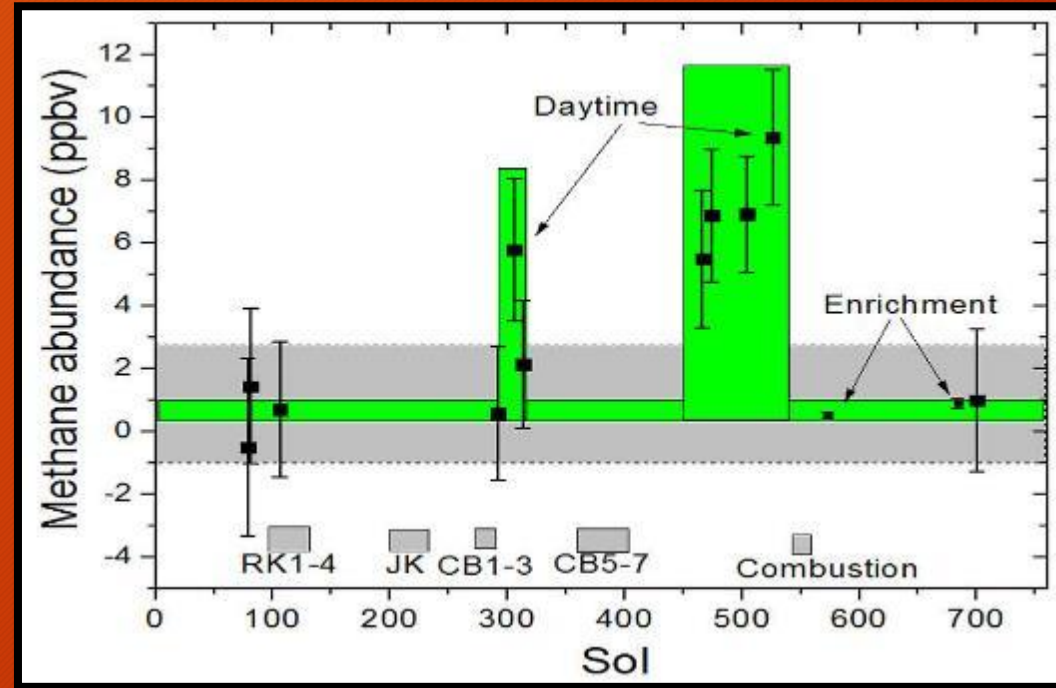
- A meteorite from mars has been found that never heated.
- The idea of exchanging lives raised.
- We just waiting to see their DNAs !



Methane in Mars

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- Many scientific groups studying Mars announced to find methane in abundance.
- Wasn't convincing!
- Not verified!
- Till Curiosity said there is barely METHANE with some spikes!
(No explanation yet)



Paradigm Shift

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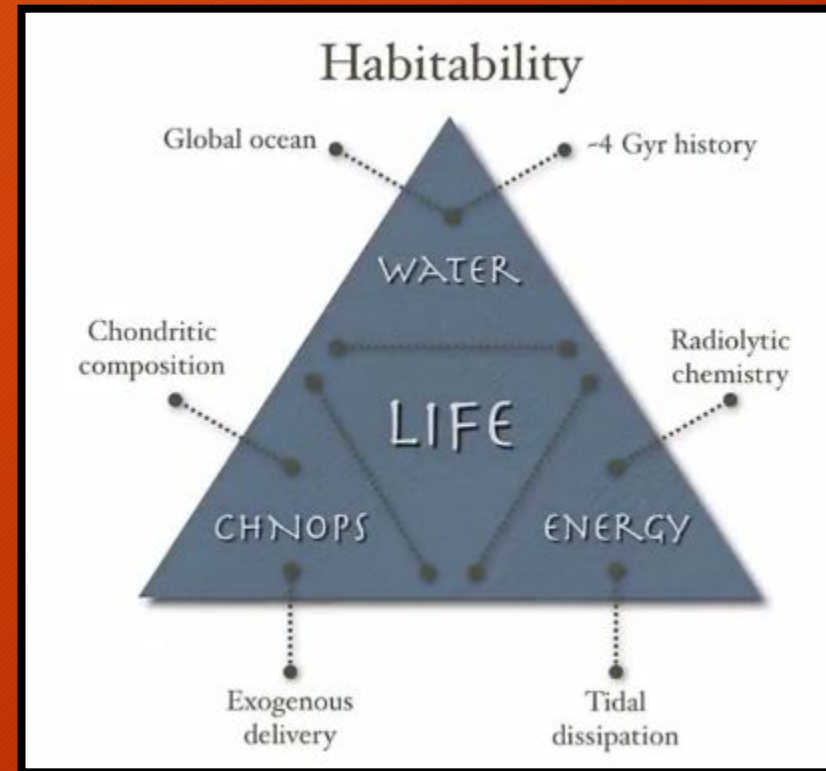
- The old model for habitability is to be in just the right distance from the star to have the liquid water on the surface. [1 AU]
- New Model: Tidal activity that enables liquid water beneath the ice.



Europa

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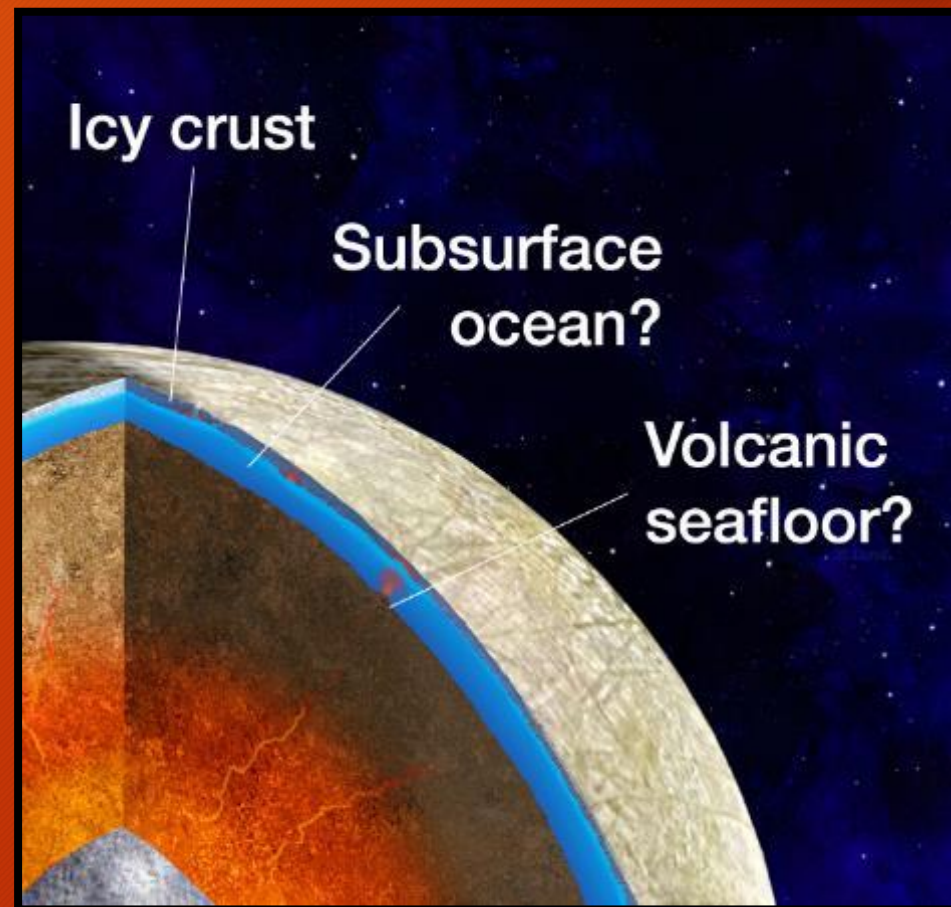
- Oceans of salty liquid water under ice.
- The suitable Tidal Energy Dynamic.
- Rocky sea floor.
- Exploration & Flybys
 - Voyager spacecraft.
 - Galileo spacecraft.
 - Future mission (ESA & NASA)



Europa

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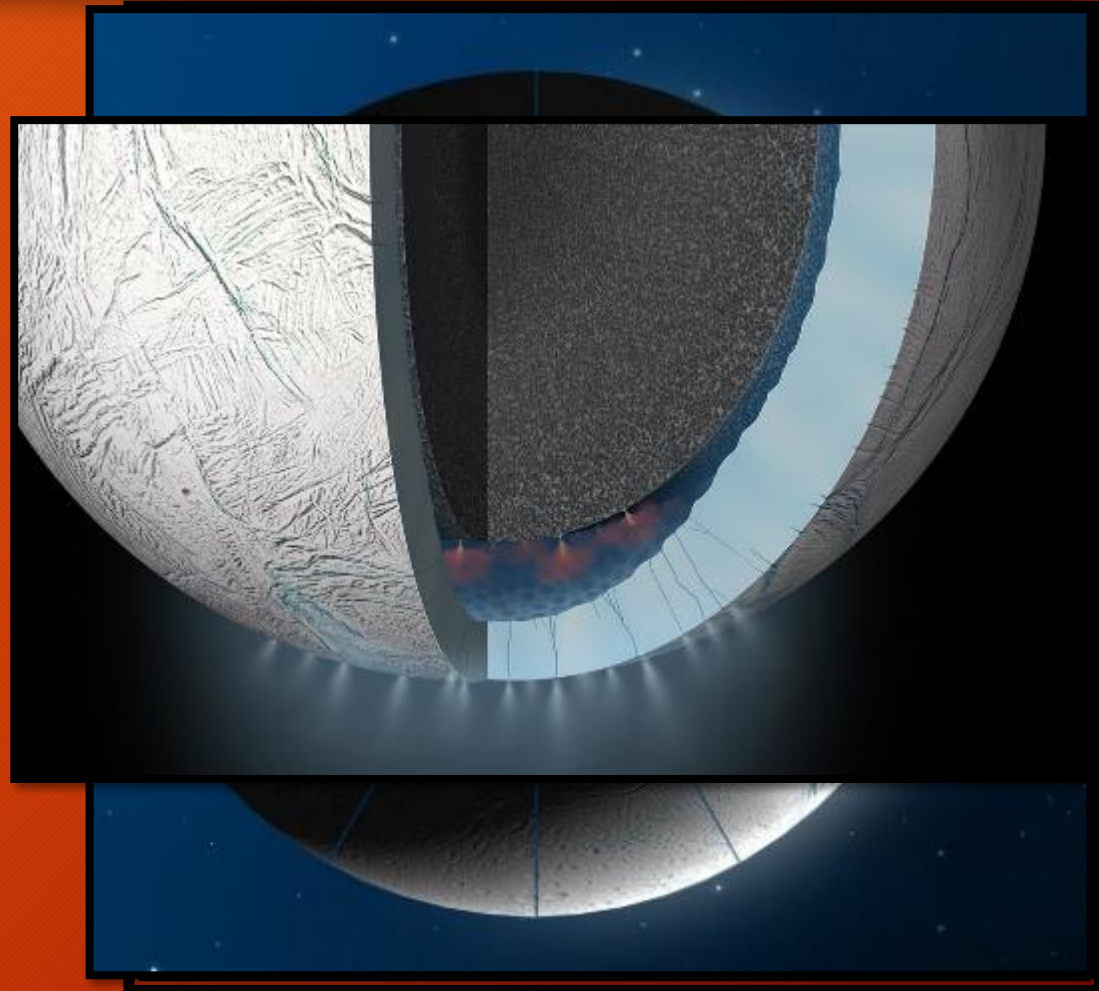
- About the size of our moon.
- 230% water compared to Earth.
- Metallic core.
- Rocky mantle.
- Water crust.



Enceladus

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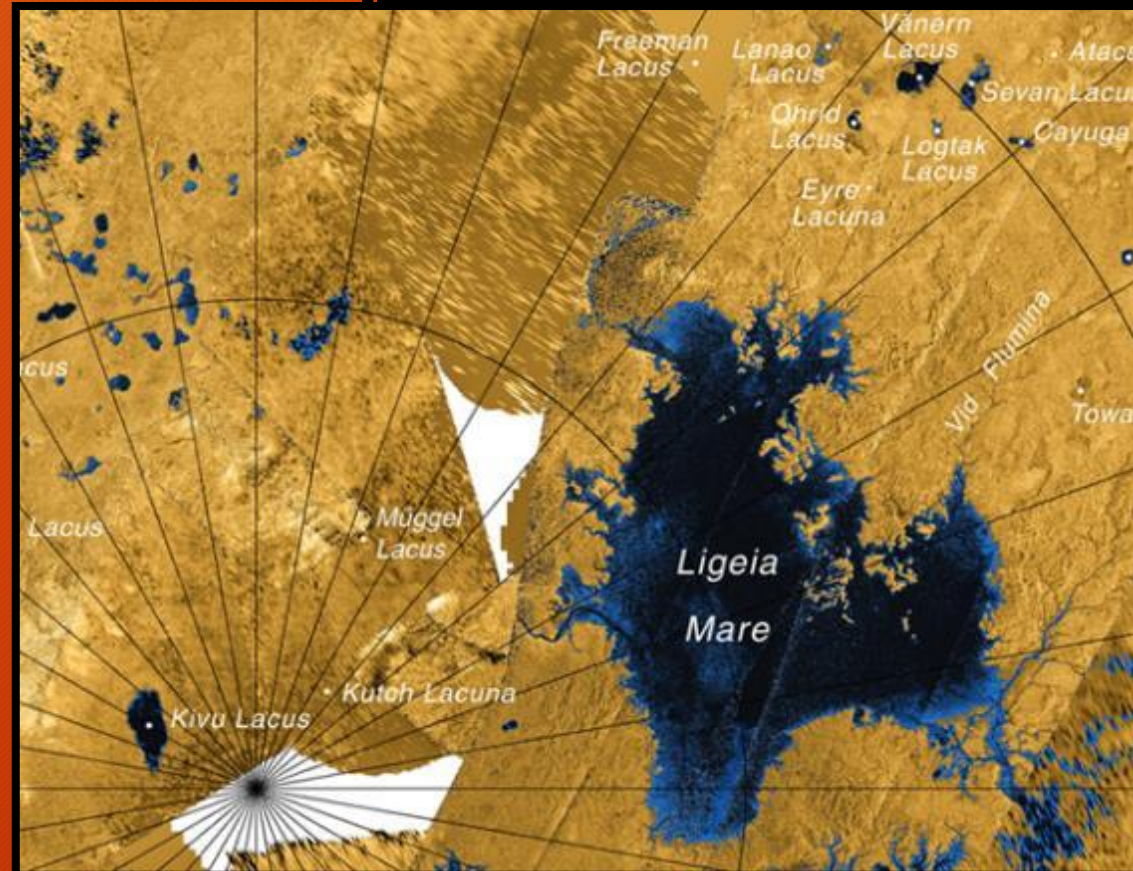
- Small rocky icy, just 500 Km
- No great tidal energy
- A lot of organics plus water.
- Slightly more dense region beneath the ice.
- All criteria but (time?) !
- Exploration and flybys:
 - Cassini Spacecraft



Titan

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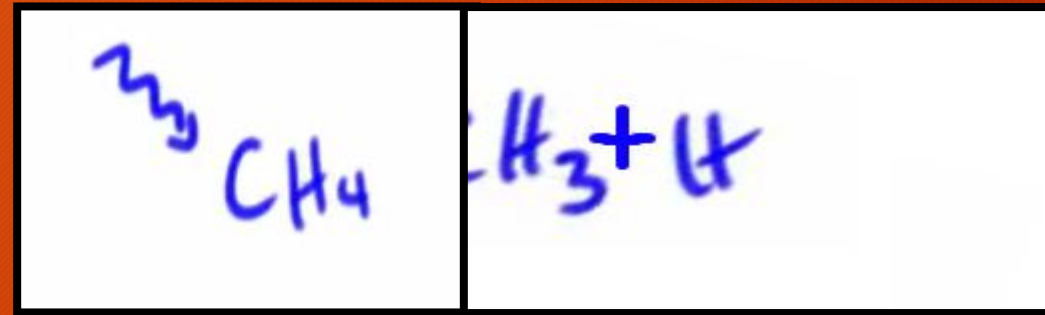
- Saturn's moon.
- Large
- A lot of Methane causes the haze.
- Clouds.
- Rain !!! :D
- Exploration & Flybys
 - Voyager spacecraft.
 - Cassini spacecraft.



Titan

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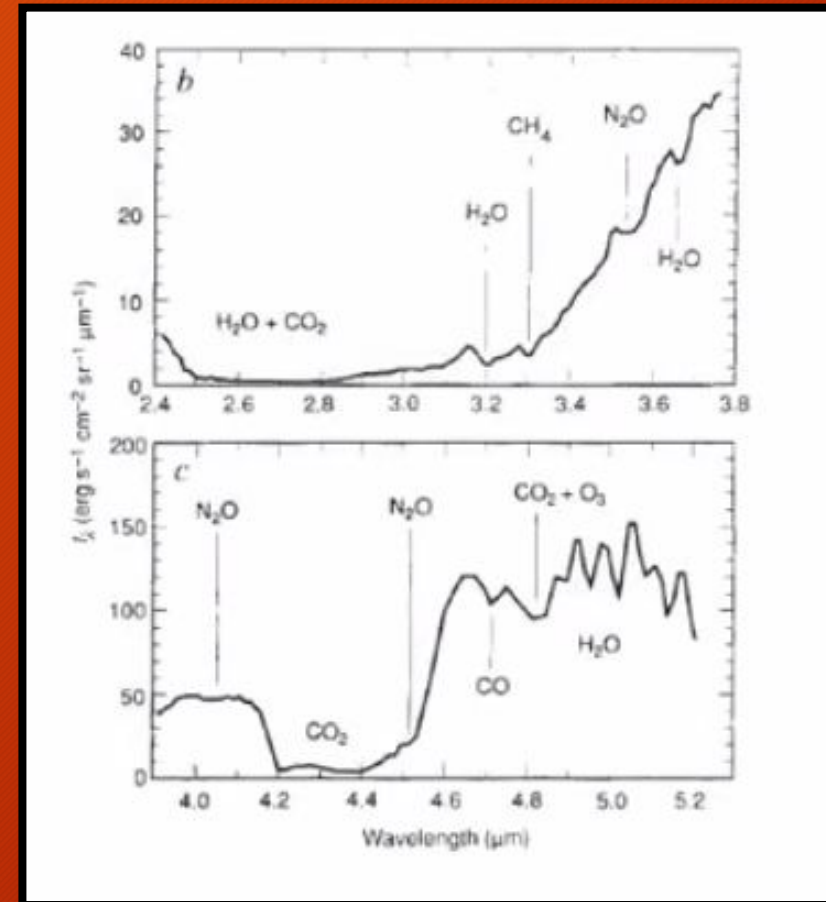
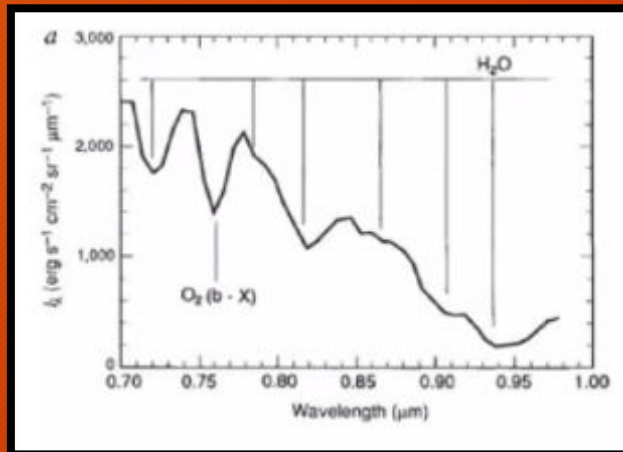
- There is water but as rocks
- Scientists are searching for methane based life.
- Very cold weather slows chemical reactions of taking energy.
- A lander from Cassini discovered decaying in (H₂) near the surface.
- Mystery unrevealed !!!



A Mission to find life

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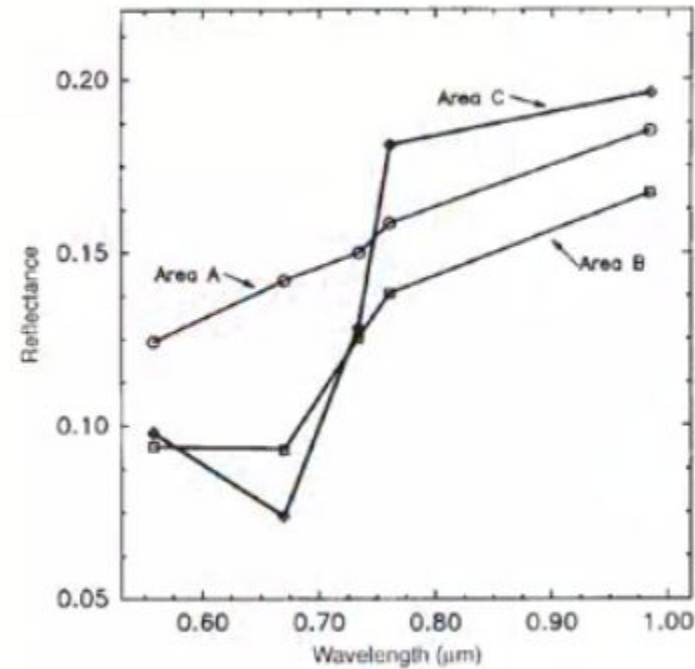
- Galileo Spacecraft
 - High Resolution Images
 - Atmosphere compositions.
 - Reflected waves.
- The results of atmosphere analyses shows abundant of:
 - Water vapor
 - Oxygen (Too Much)
 - Methane



A Mission to find life

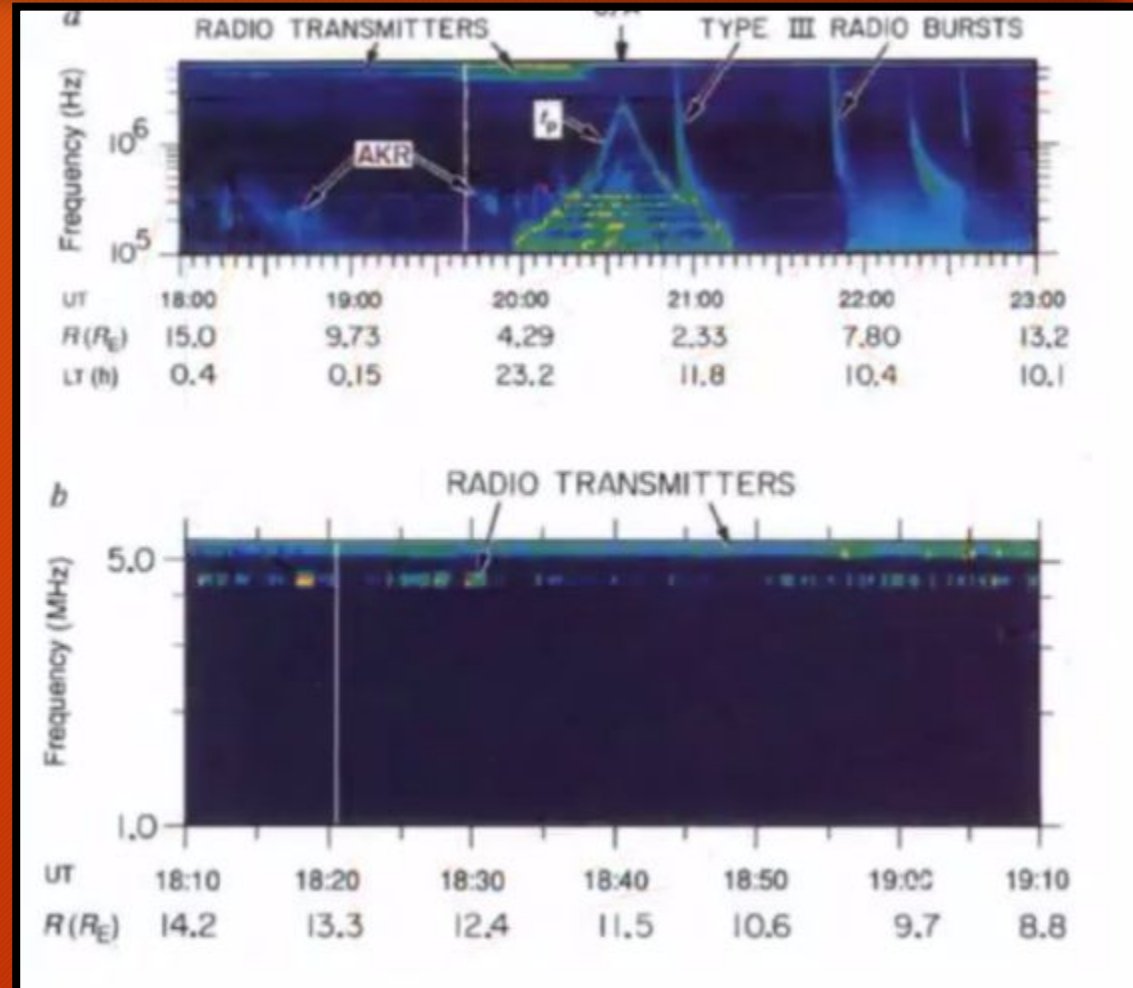
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- Measurements of reflection of certain wavelength
- Images show no man made features at Res 1km, by 100m could see some.



A Mission to find life

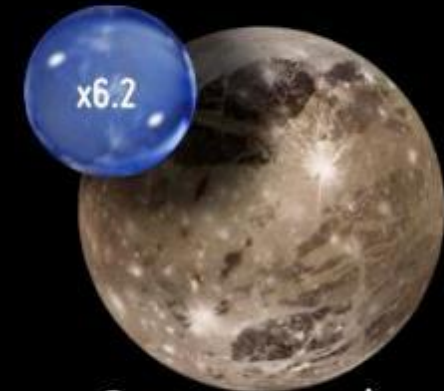
- Intelligent life?
- Only one measurement showed that (Radio Rx)
- Steady frequency
- Modulated
- From below of the atmosphere.



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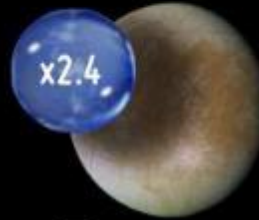
Oceans of the Solar System



x6.2

Ganymede

(5.4% Liquid Water)



x2.4

Europa

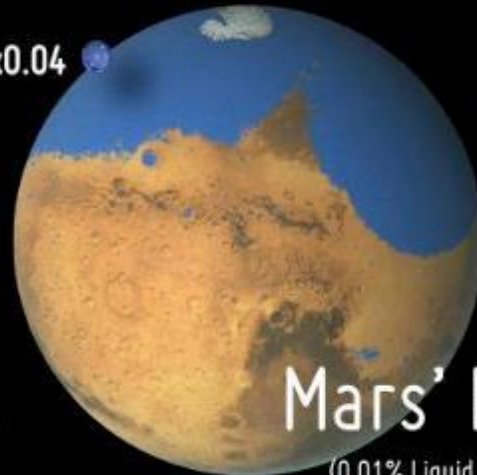
(6.4% Liquid Water)



x1

Earth

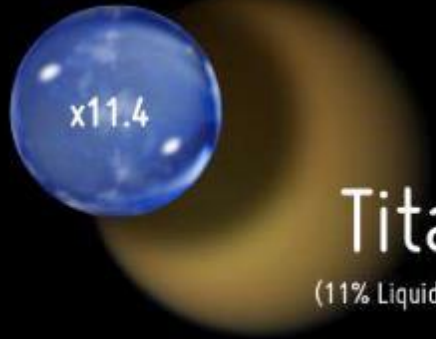
(0.02% Liquid Water)



x0.04

Mars' Past

(0.01% Liquid Water)



x11.4

Titan

(11% Liquid Water)

(estimated percent of liquid water by mass excluding ice)

Credit: PHL @ UPR Arcibo, NASA

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Short Video (~5 mins)

References

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- Based on “The Science of the Solar System” by CalTech in Coursera.
- Wikipedia website.
- NASA website.
- ESA website.



Q & A

THANK YOU