## Exoplanets and life in the Universe

#### In the footsteps of Copernicus

The cosmological principle that the Universe, as observed from any planet, looks much the same, is likely applicable to life in the Universe as well

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How did life emerge on Earth? Is the universe full of life?

Is our universe "built-in" it to produce matter - life - consciousness?



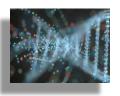


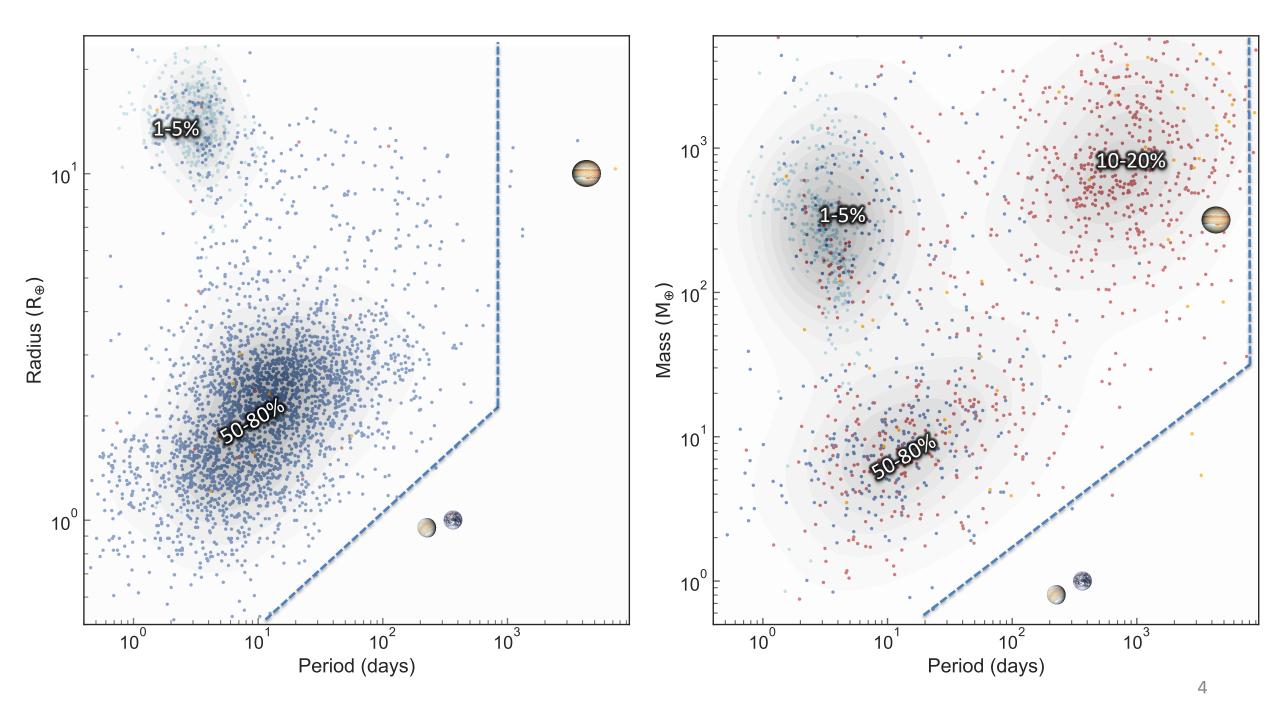


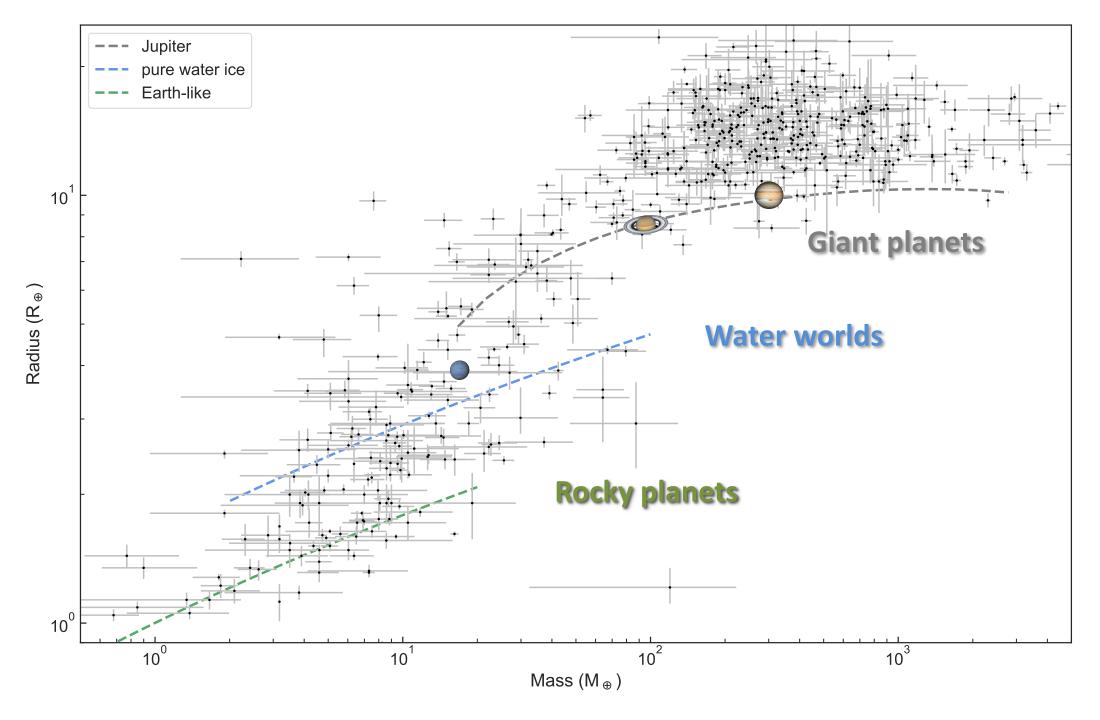
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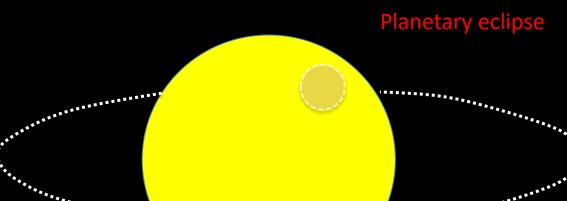




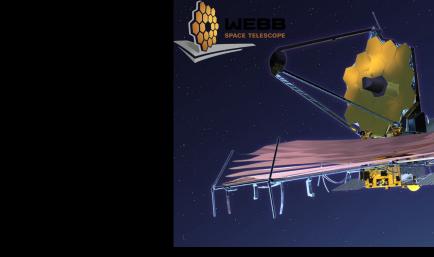


### **Atmosphere of transiting planets**

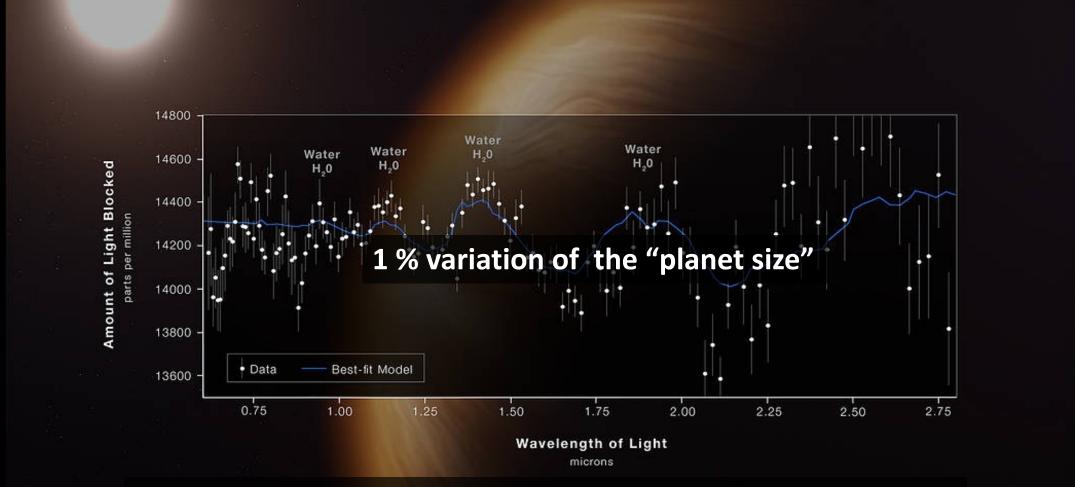








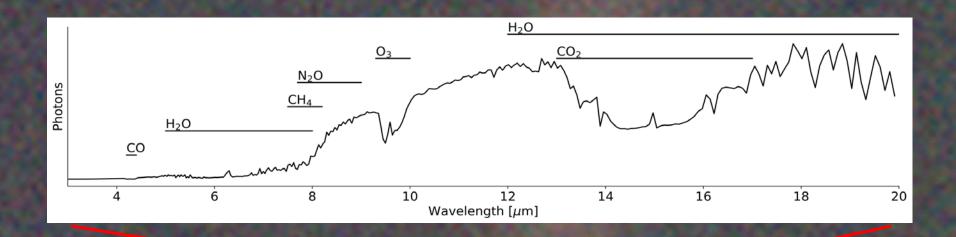
#### ATMOSPHERE COMPOSITION



100 Earth radius - 10 Jupiter radius or ultra cool star radius — 1 Solar type star radius



## Direct imaging of planets

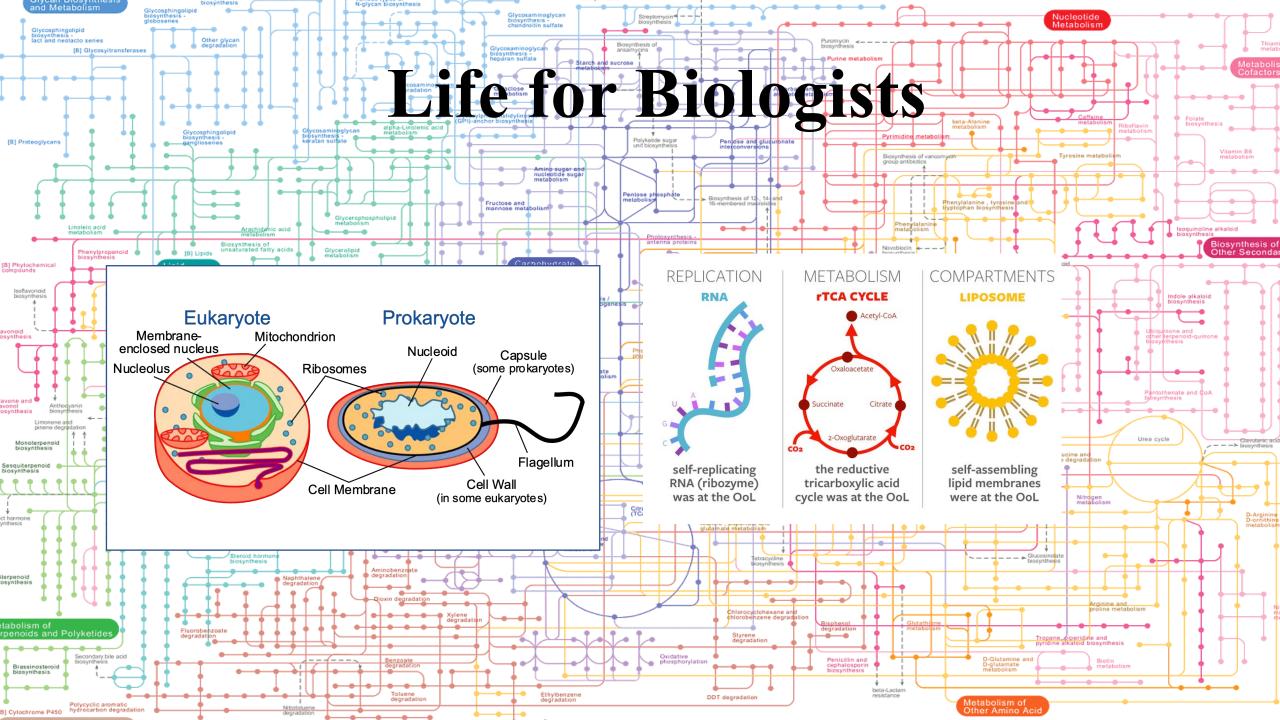


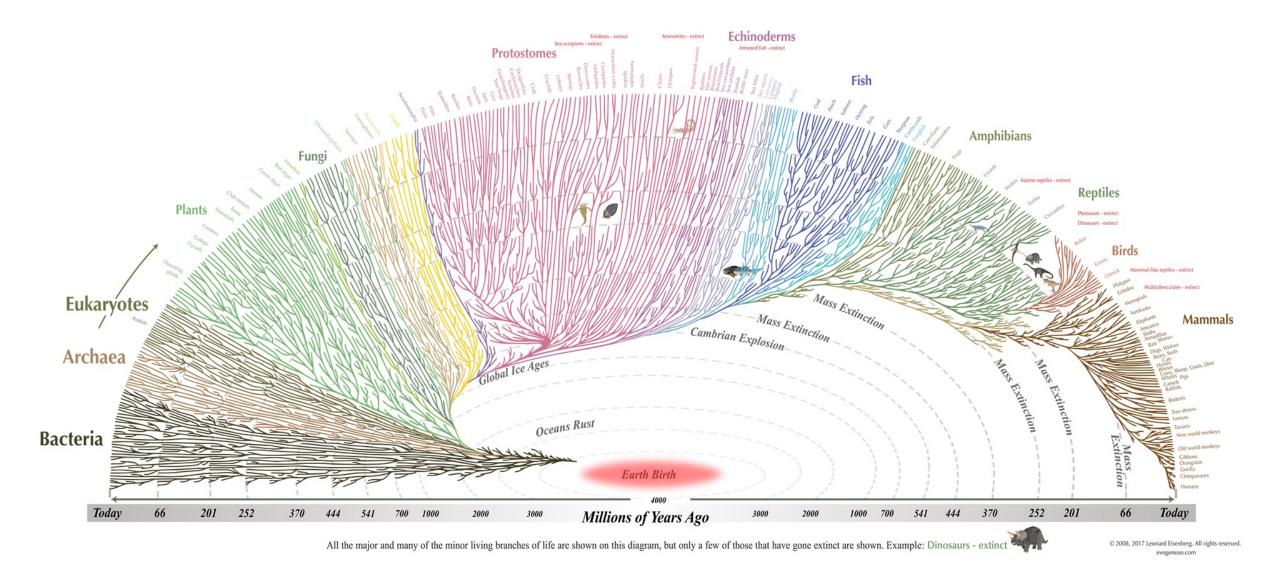
ESO's Extremely Large Telescope planned to start scientific operations in 2027

11 June 2021









#### "Classical questions" about origin and prevalence of life

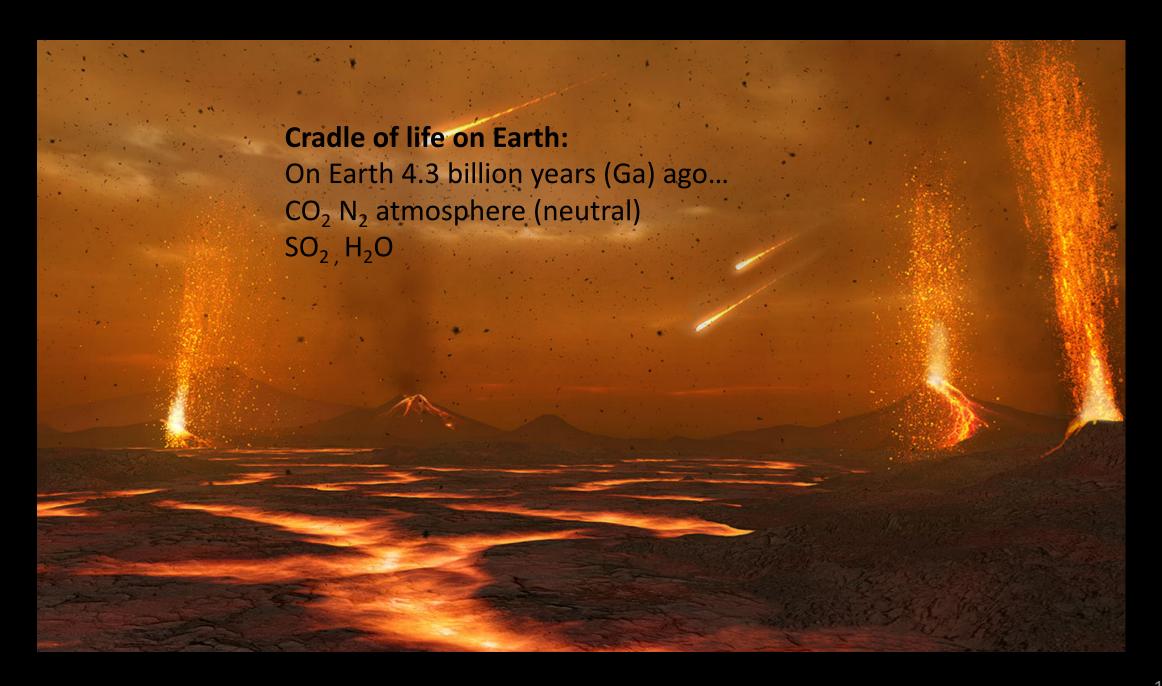
- How Chemistry is morphing to biology
- How much have we retained direct vestiges of prebiotic chemistry
- Is the growth of complexity an intrinsic property of the dissipative nature of life system
- Can we consider life as we know it to be an optimum and unique configuration for our planetary condition promoted by Darwinian evolution

Life is ubiquous and flourishing on modern Earth but it has never been observed to originate from inanimate materials despite abondance of feedstocks.

#### This suggest:

- different conditions are required to start it
- These conditions where met "at least once" in the Solar system history

To find out must be either **reinvented** it on Earth or **observed** on extraterrestrial systems



## Prebiotic scenarios

Deep sea hydrothermal vents, (CO<sub>2</sub> as a feedstock serpentinization and by Fischer-Tropsch reactions

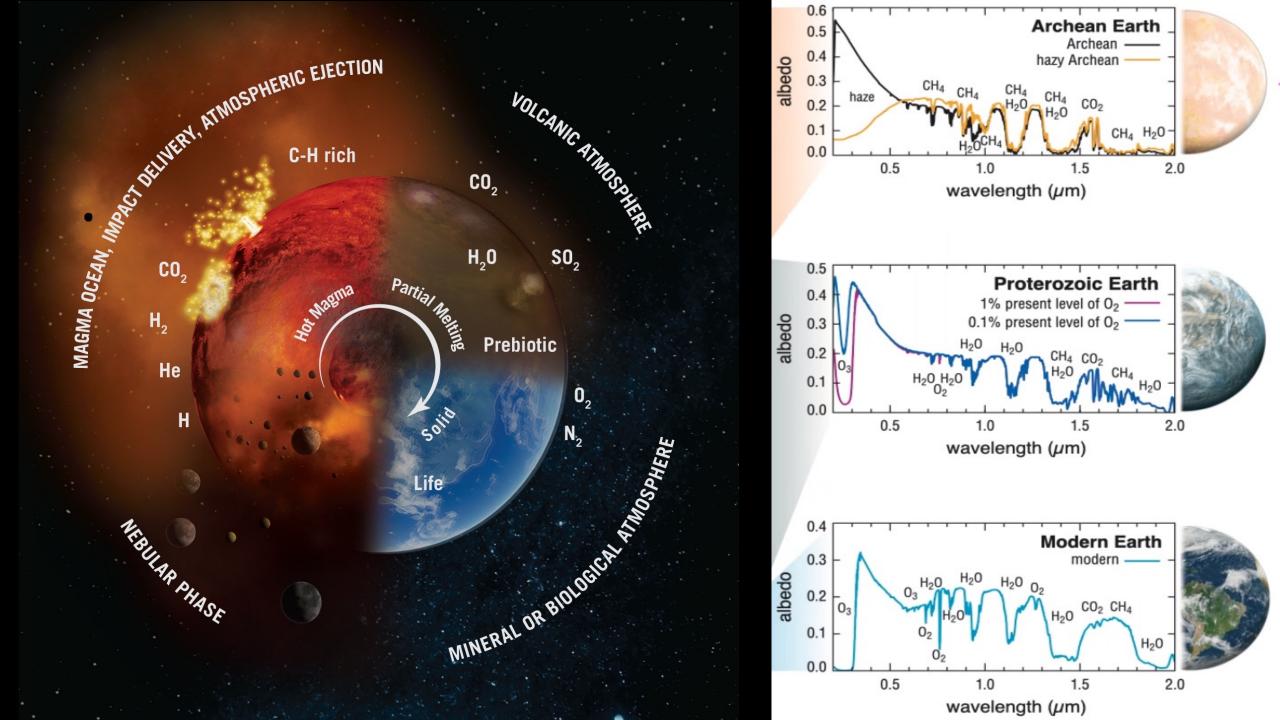


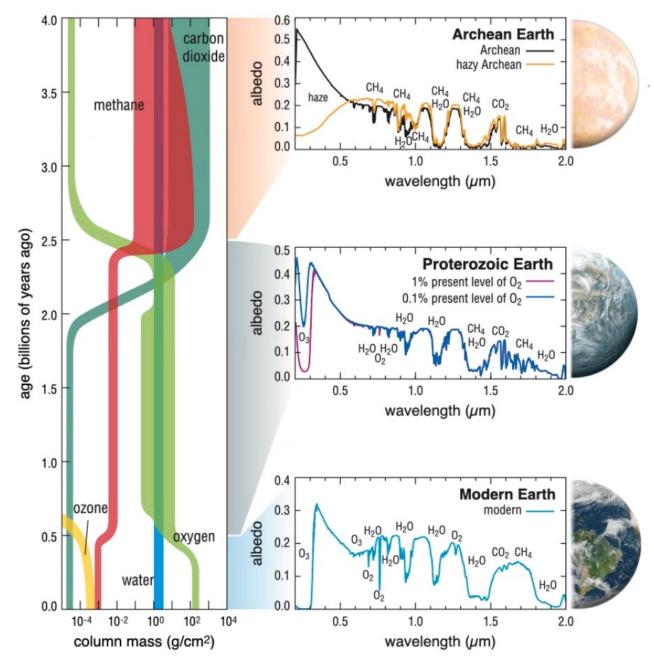
cyanosulfidic chemistry (HCN) & most compatible with geochemical planetary scenarios Miller-Urey experiment, lightning in a highly reducing atmosphere (CH4 & NH3) as carbon and nitrogen feedstocks



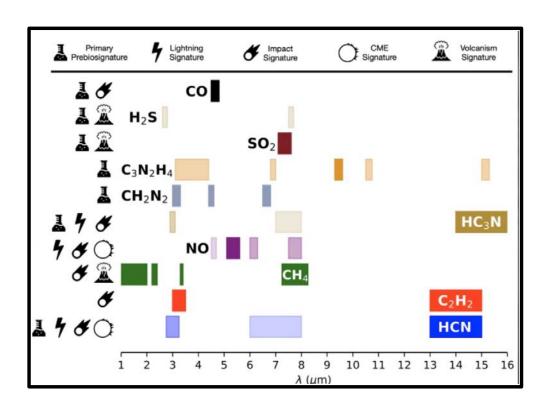
Dilution issue Not making life today!

Compatible with Comet impact Photochemically instable
Titan like





Credit: Arney, Domagal-Goldman, Griswold (LUVOIR Final Report)



# The end