“The search for a second genesis life on other worlds in our Solar System”

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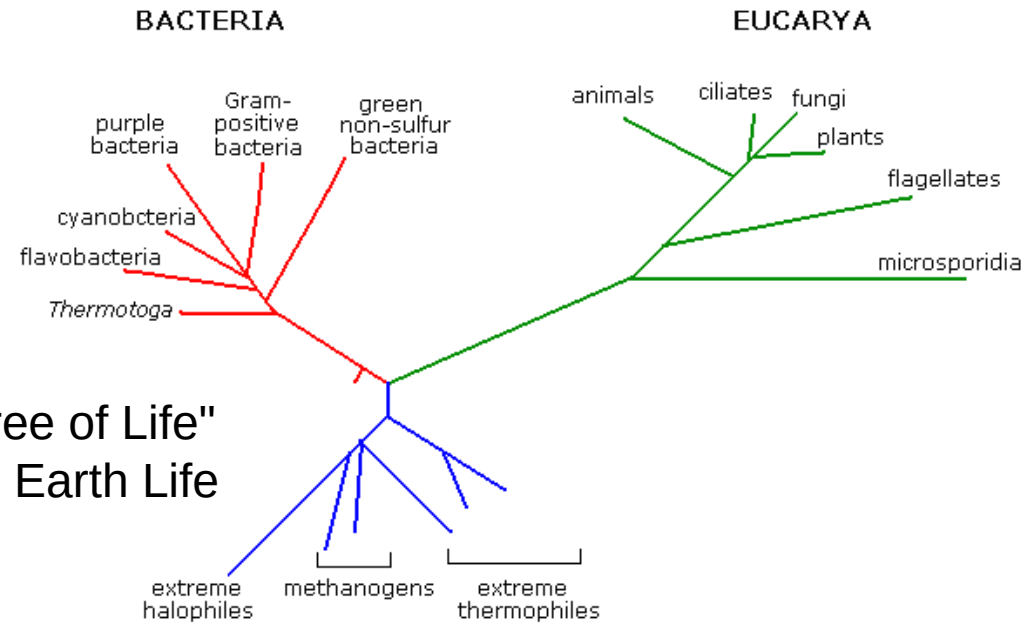
7/2019

The search for a second genesis of life

⇒ comparative biochemistry (life 2.0)

⇒ life is common in the universe (yeah!)

(by the zero-one-infinity rule)



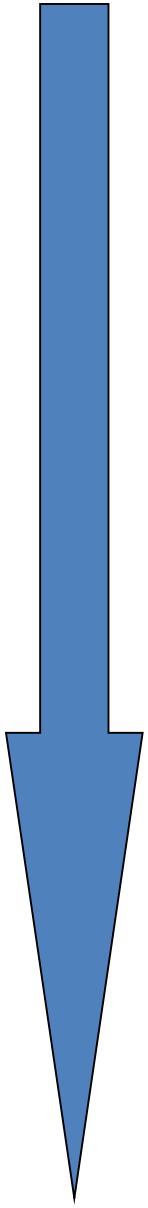
From Woese, 1987

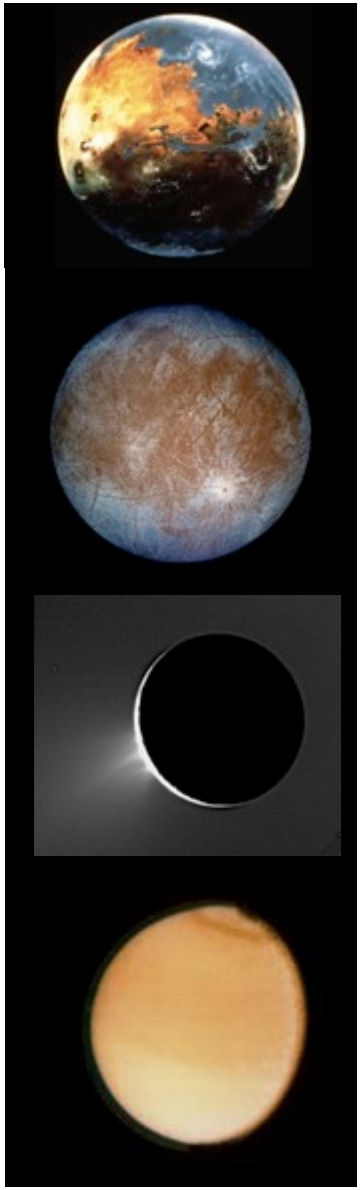
"The Tree of Life" defines Earth Life

Aliens: not on our tree of life

Where to look for life?

Increasing chance of life not related to Earth life





Mars ⋆⋆

Europa x
(moon of Jupiter)

Enceladus ★
(moon of Saturn)

Titan ?!
(moon of Saturn)

Mars is 1/10 the mass of Earth

No plate tectonics
Less gravity
No magnetic field

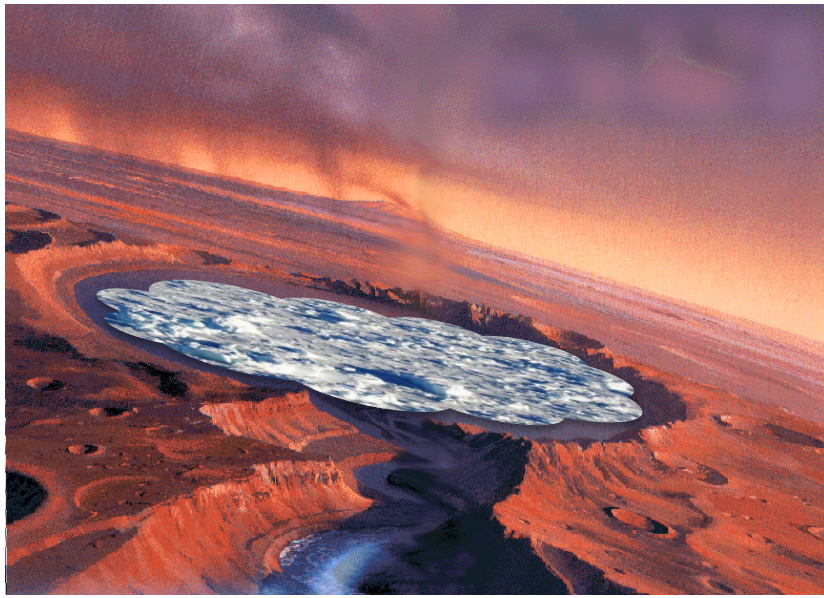
Curiosity on Mars

Landed 5 August 2012

Yellowknife Bay, Mars

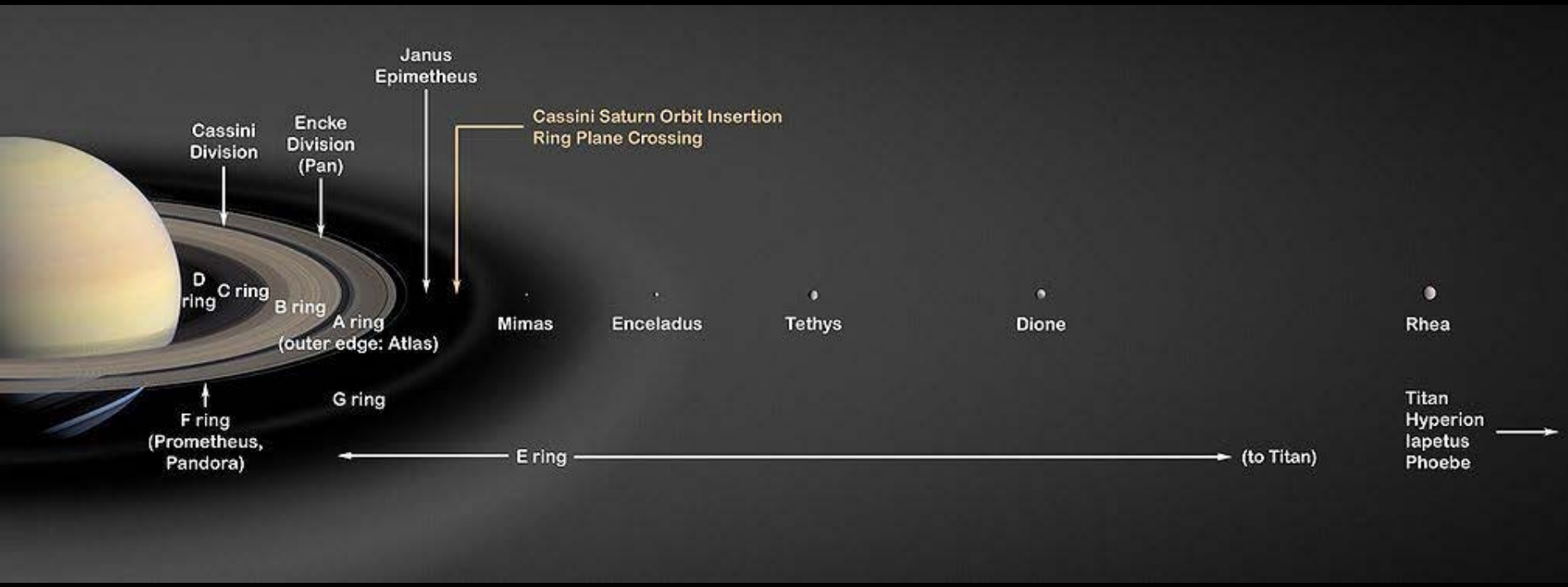
Yellowknife Bay: An ideal site for astrobiology

- 3500 Myr ago; Impact forms Gale Crater
- Soon thereafter water deposits sediments. They harden and become compact and are buried
- Exposed 70 Myr ago by wind erosion of upper later

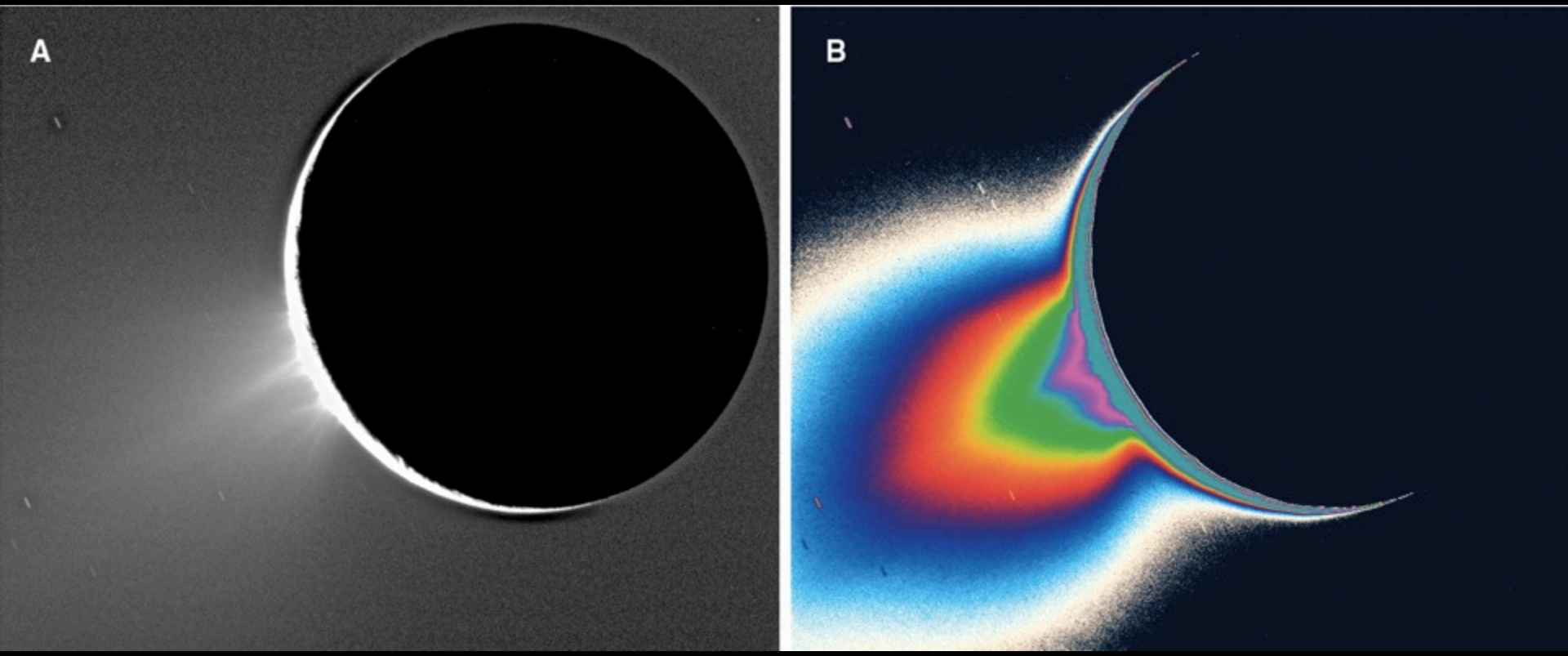


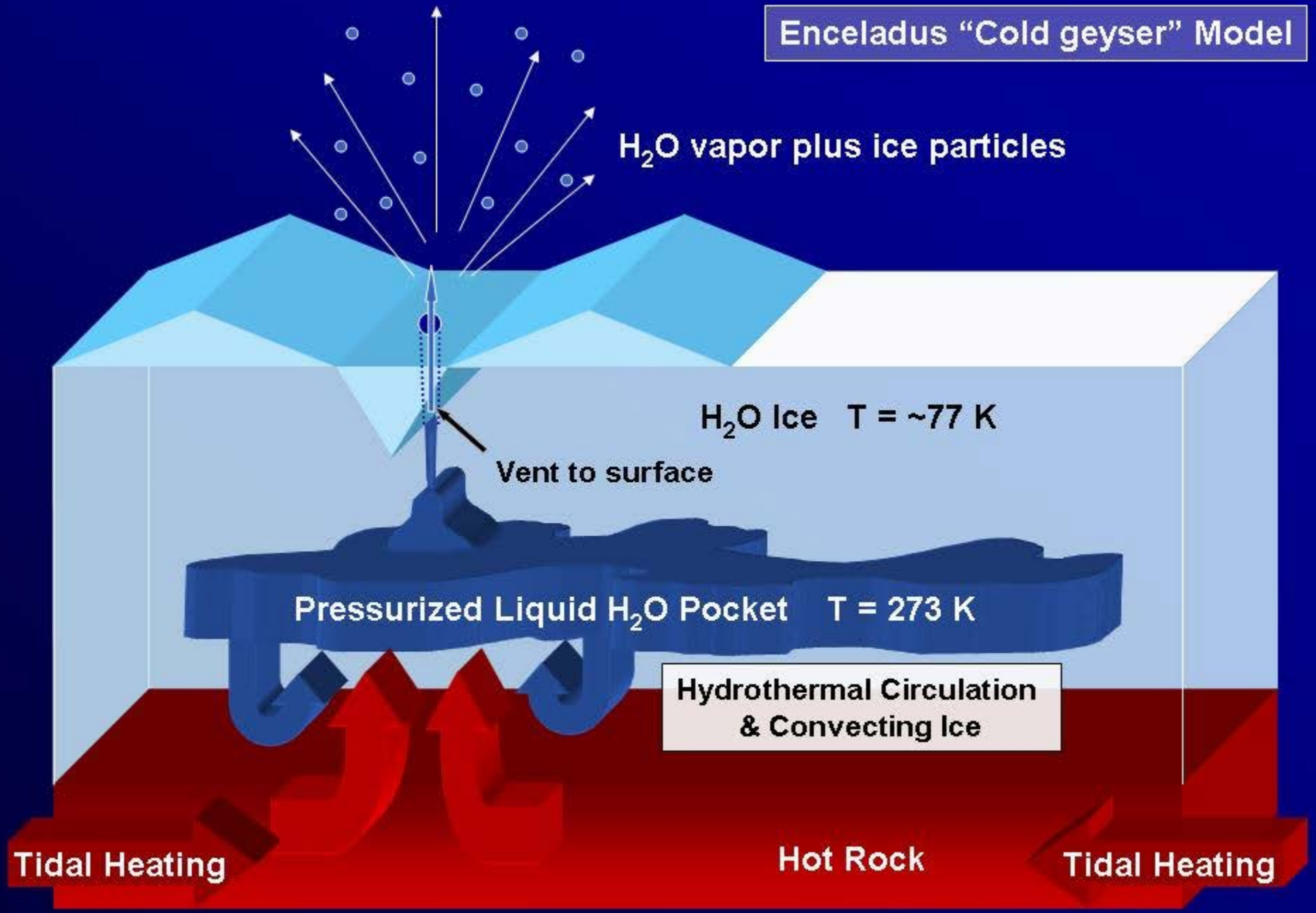
On the bottom of an ice-covered lake. A world of only microscopic life making large mounds. Analogs for early Earth and Mars. (Andersen et al. 2011)


Curiosity Big Result #1 : Grey Mars


Janus
Epimetheus
Cassini Saturn Orbit Insertion
Ring Plane Crossing
Cassini
Division
Encke
Division
(Pan)
D
ring
C ring
B ring
A ring
(outer edge: Atlas)
Mimas
Enceladus
Tethys
Dione
Rhea
G ring
F ring
(Prometheus,
Pandora)
E ring
(to Titan)
Titan
Hyperion
Iapetus
Phoebe

Jets of H_2O on Enceladus




Enceladus "Cold geyser" Model
H_2O vapor plus ice particles
H_2O Ice T = ~77 K
Vent to surface
Pressurized Liquid H_2O Pocket T = 273 K
Hydrothermal Circulation & Convecting Ice
Tidal Heating
Hot Rock
Tidal Heating

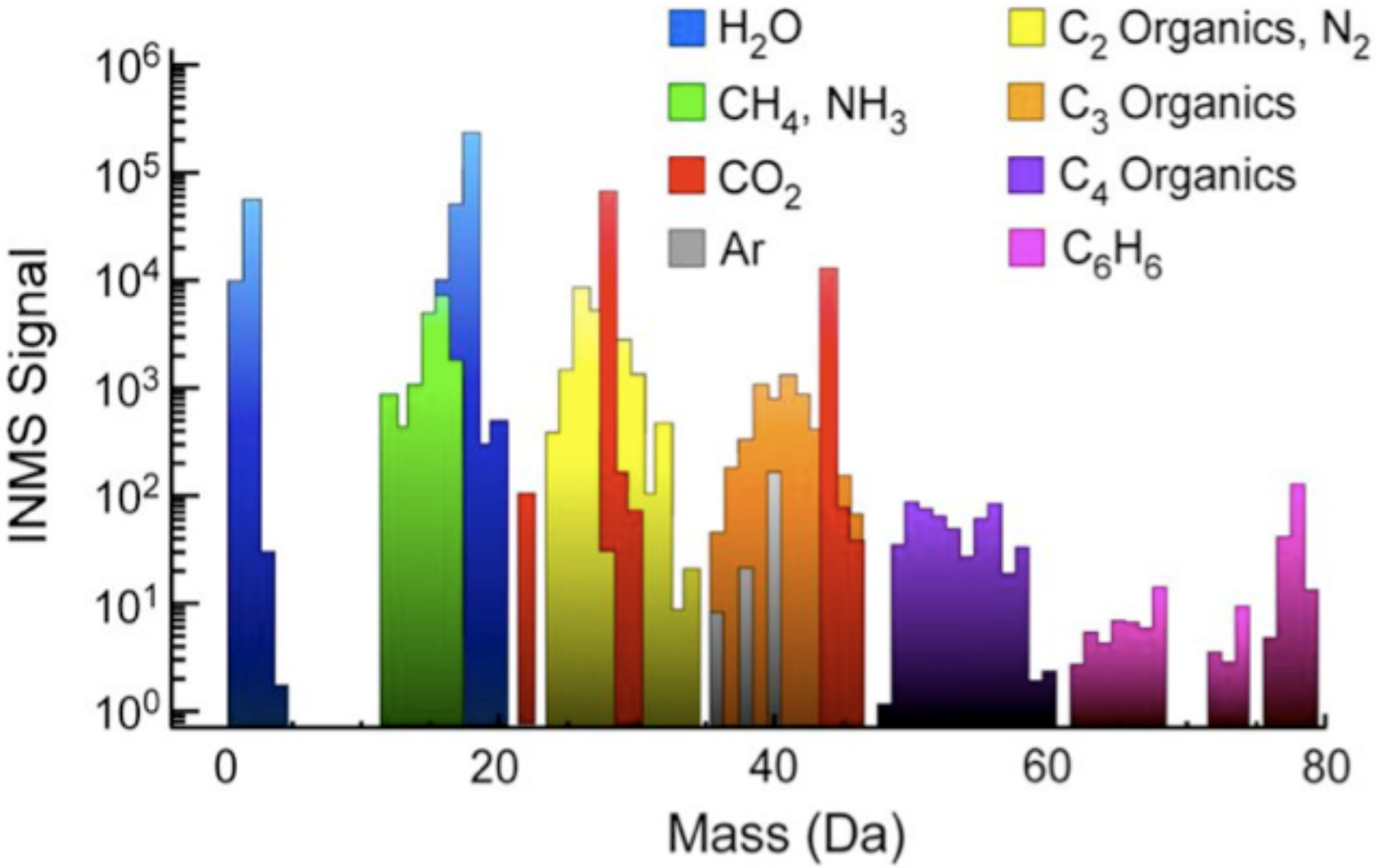
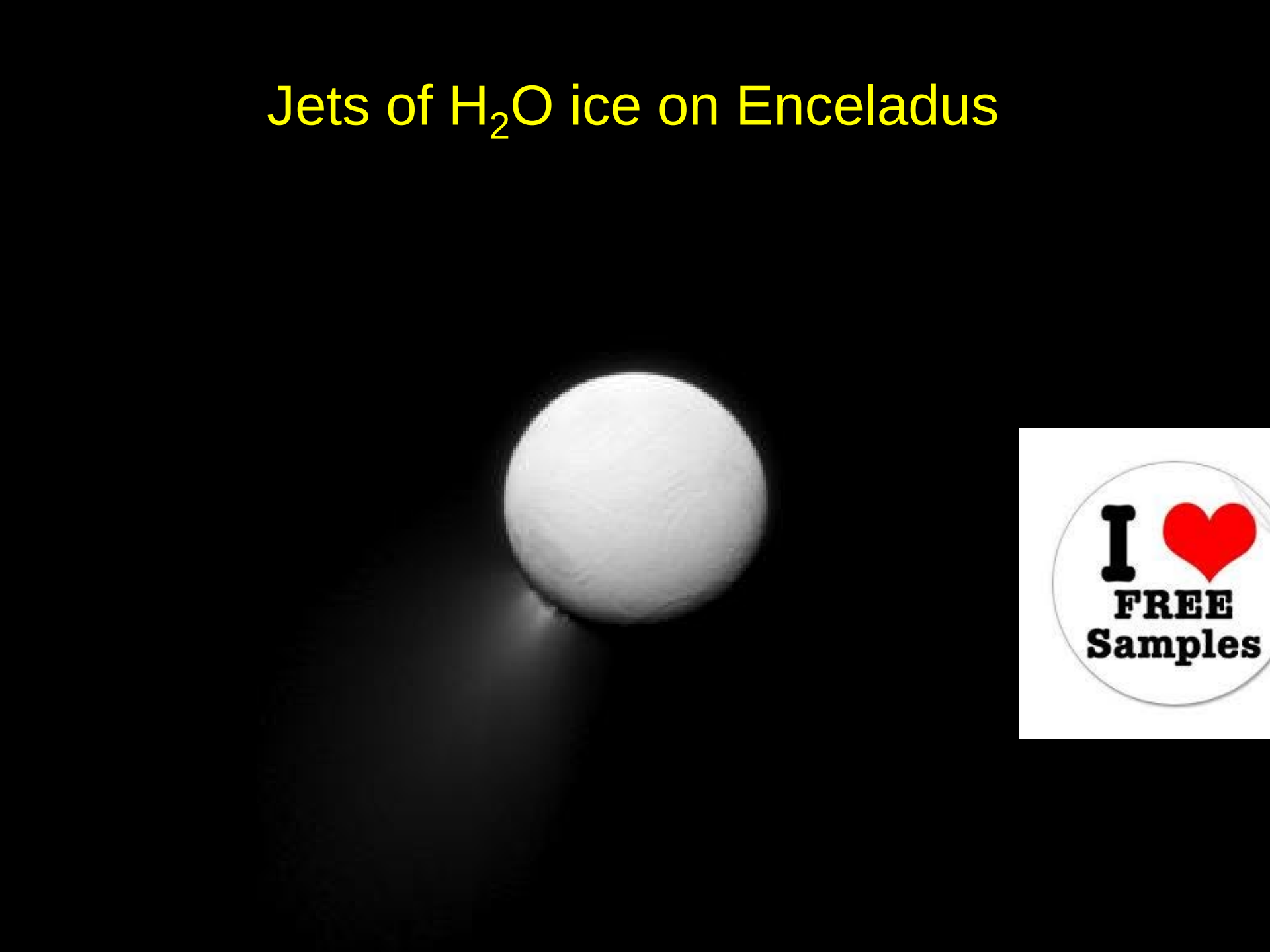


Figure 22.18 Mass spectrum of the Enceladus plume from the October 9th 2008 flyby (Waite et al. 2009). The colors show contributions from various species and their breakdown products using the composition shown in Table 22.3.

Jets of H_2O ice on Enceladus



LIFE Life Investigation For Enceladus

The Goal: A joint US-Japan mission to study the plume of Enceladus for organics and life and return a sample to Earth.

Heritage: Stardust, Hayabusa (OSIRIS-REx, Hayabusa2)
Programmatic model: Cassini

To be proposed as a Discovery Mission

The challenge of returning to Earth an astrobiology sample which might contain life from a habitable world

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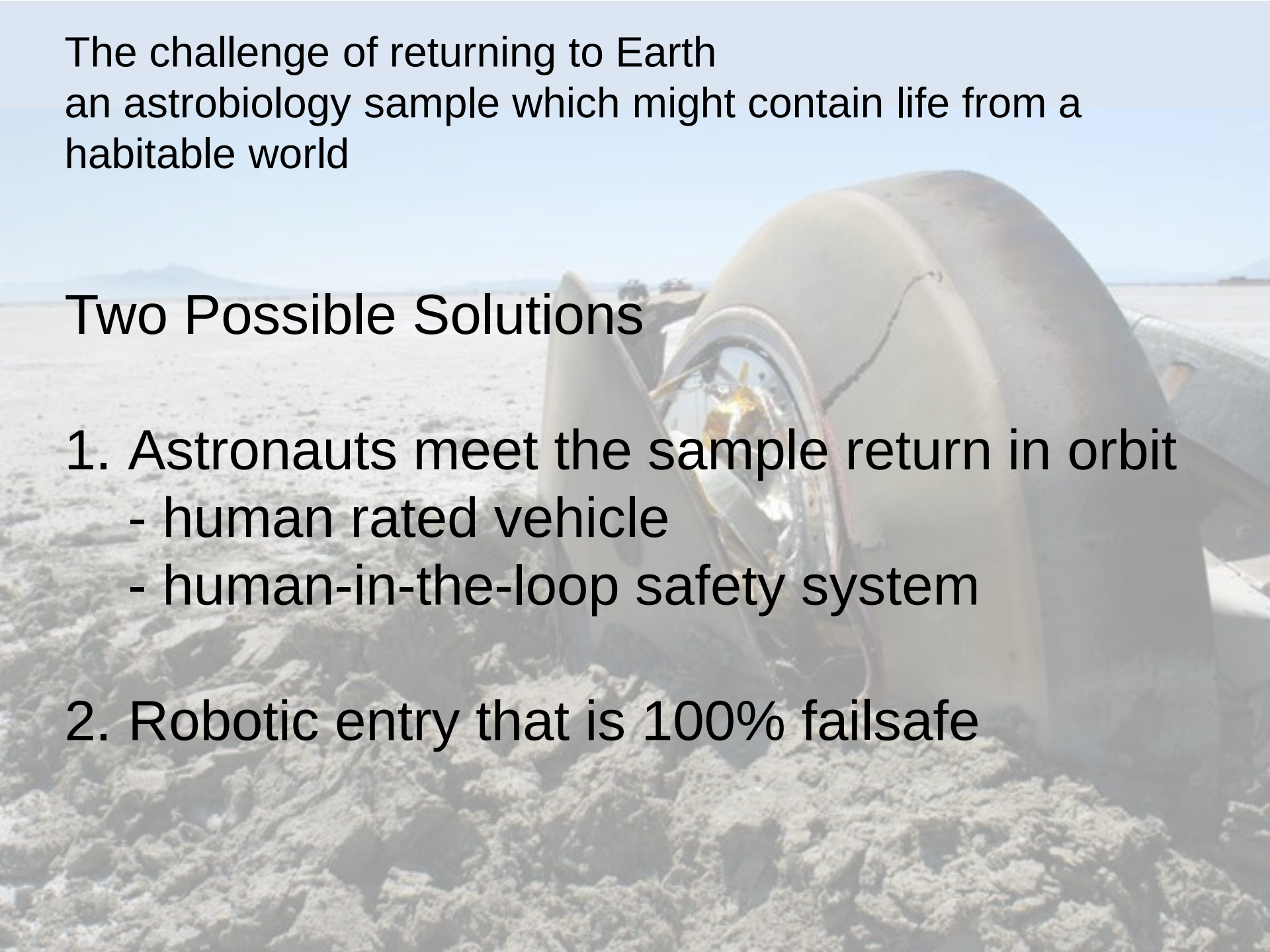


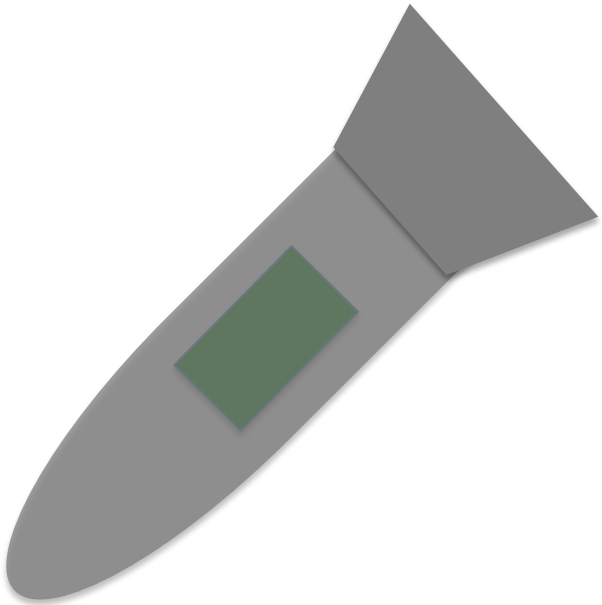
Two Possible Solutions

1. Astronauts meet the sample return in orbit
   - human rated vehicle
   - human-in-the-loop safety system

2. Robotic entry that is 100% failsafe

100% Failsafe entry system

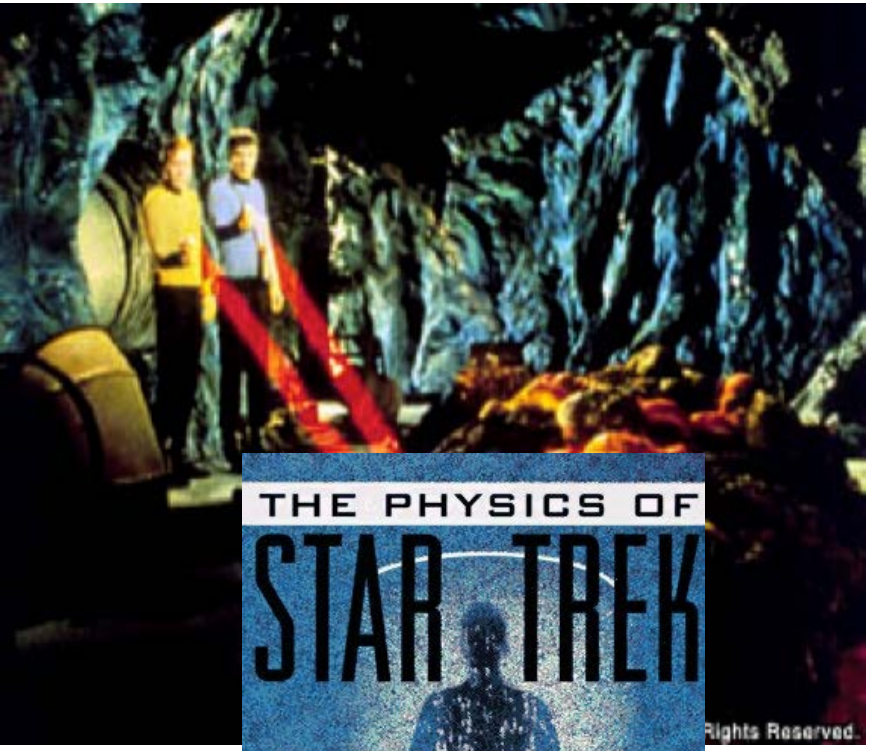
1. Don’t move
2. Don’t think
3. Don’t make any decisions

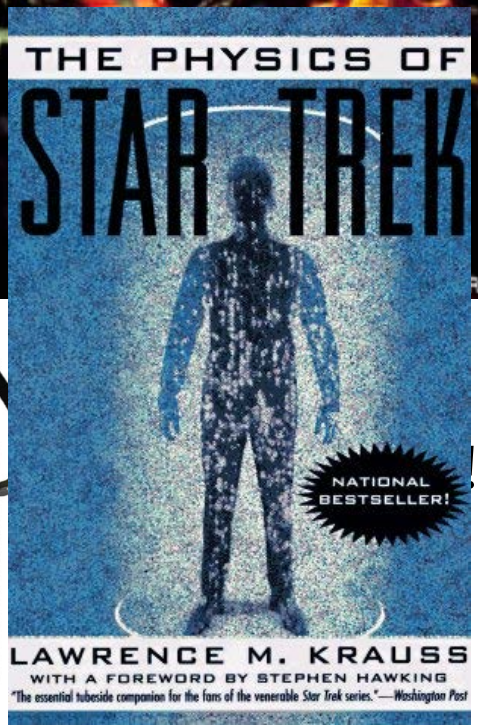


- No parachute
- No deployable mechanisms
- Lands at terminal velocity
- Payload is designed to survive
- Like a meteorite (they survive landing)

With the new HEEET shielding

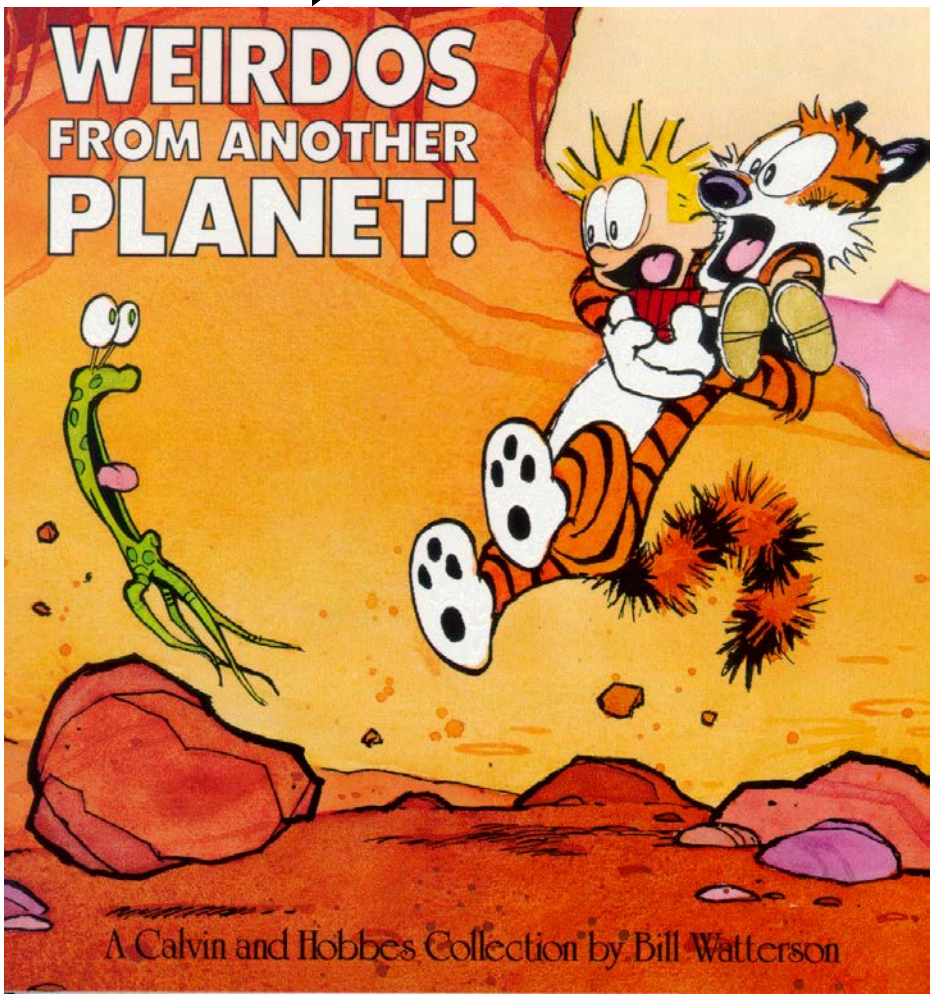
How do we recognize alien life?





No entry for “tricorder”

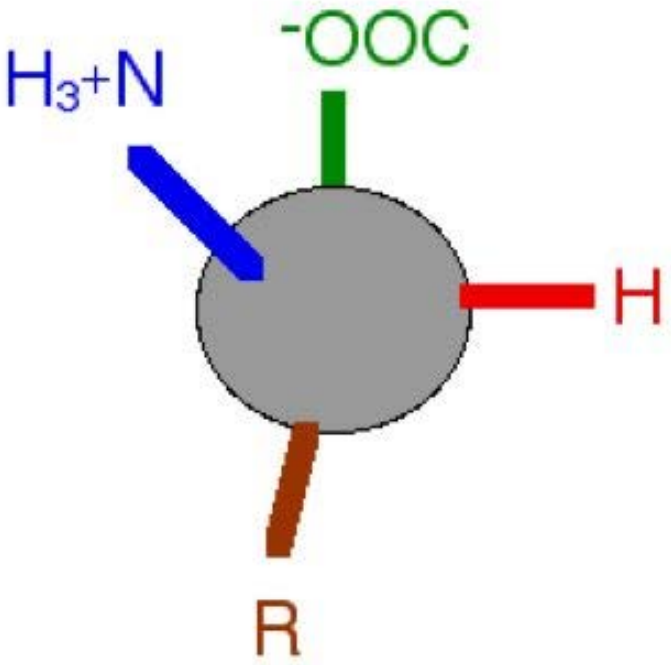
we’ll know it when we see it!



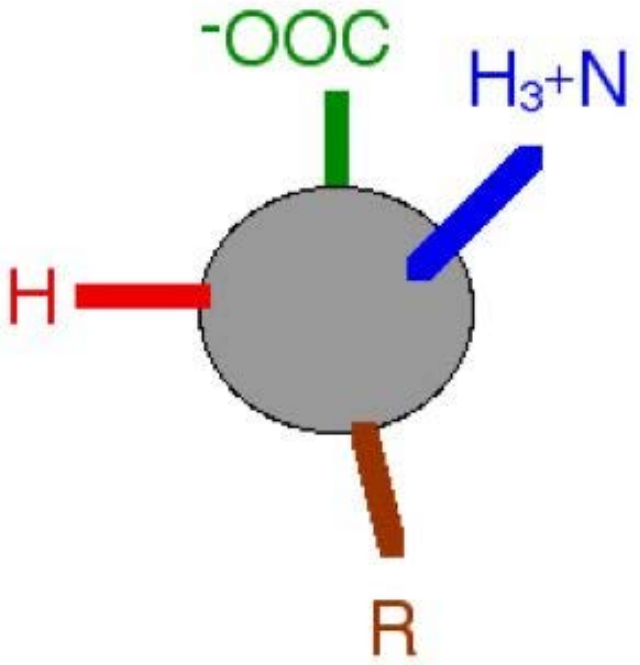
If we find organic material on Mars, Europa, Enceladus, or Titan how can we tell if it was ever alive?

If its like us then easy, less interesting
If its alien then hard, but interesting

Two sources of non-biological organic materials:
Meteorites and Miller-Urey synthesis experiments
How do they differ from life?

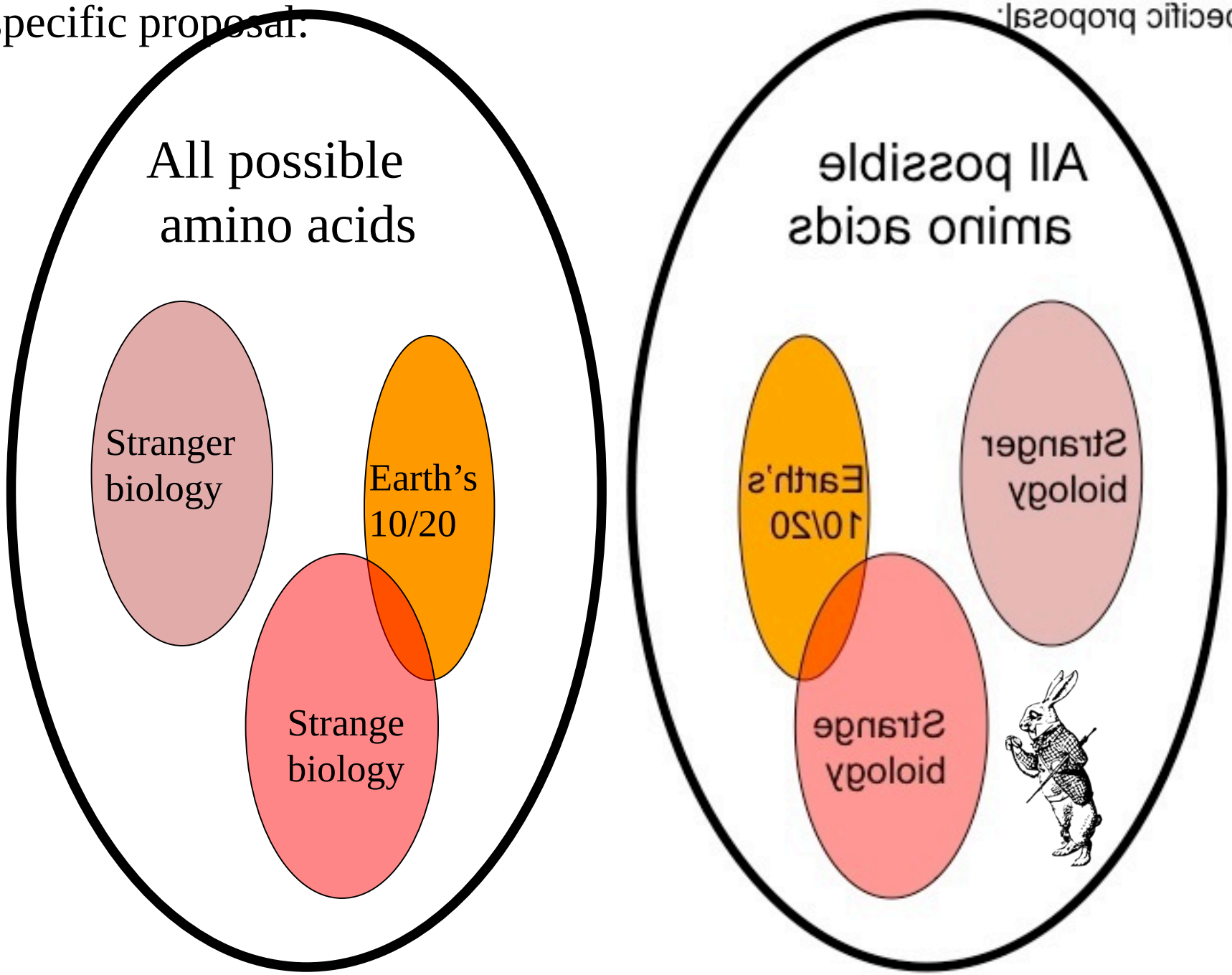


L - amino acids
used in proteins



D - amino acids
not in proteins

A specific proposal:



What will you do if you find a second genesis on Mars?

Unprepared for success!

Moral Status of Alien Microbes

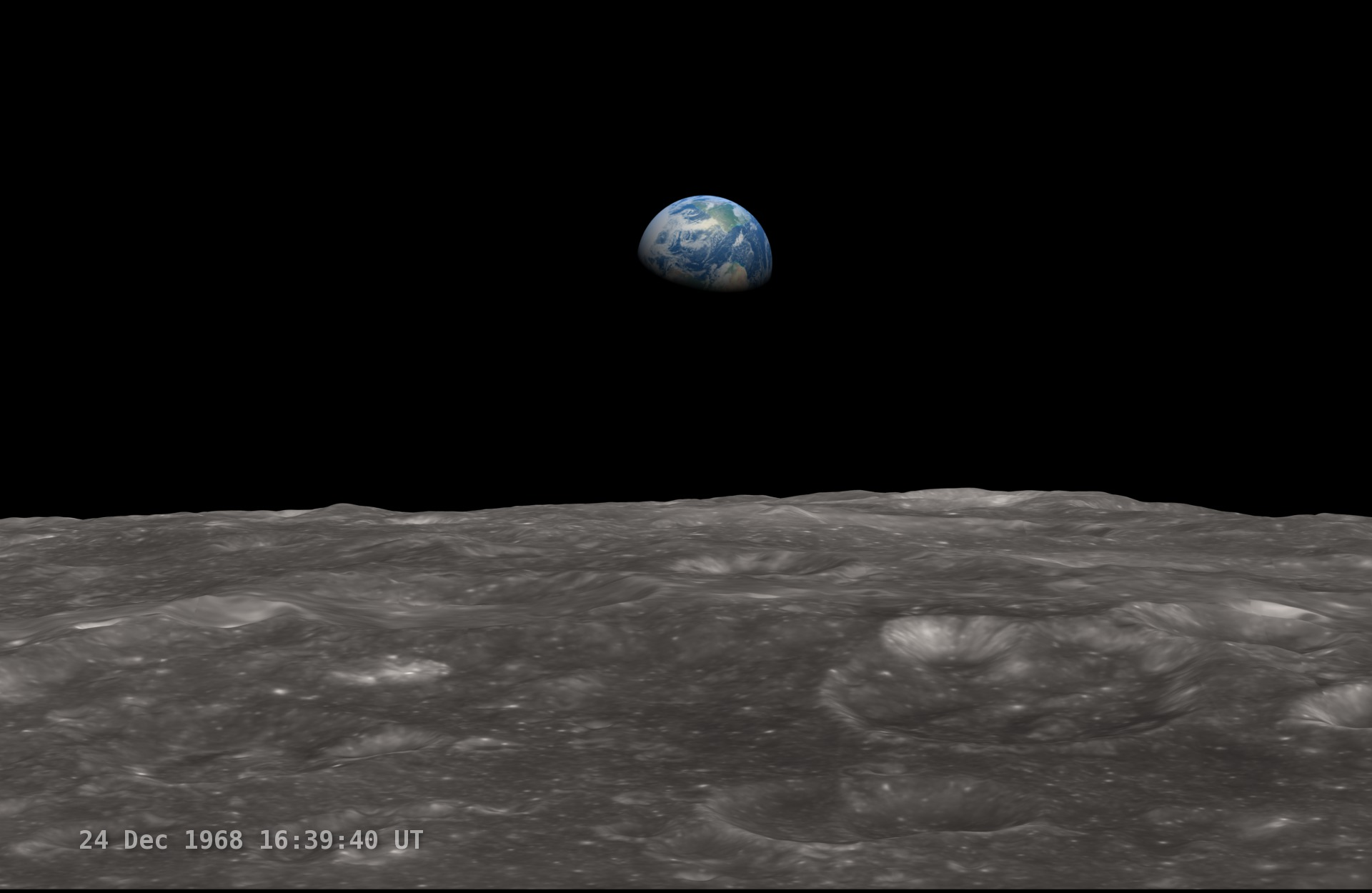
- If we find a second genesis in our Solar System: there are then three moral sets: humans, life1, life2

- Microbes which score low moral status based on pain, complex behavior & communication would have high moral status as being the sole representatives of the set life2

Recommendation

The robotic and human exploration of Mars should be done in a way that is biologically reversible. We must be able to undo ('ctrl Z') our contamination of Mars if we discover a second genesis of life there.

McKay 2009 Science, **323** 718.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