Planetary Protection for CubeSat Missions

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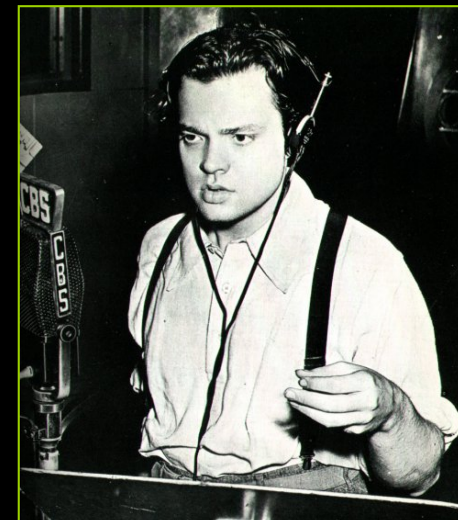
Planetary Protection in a Nutshell...

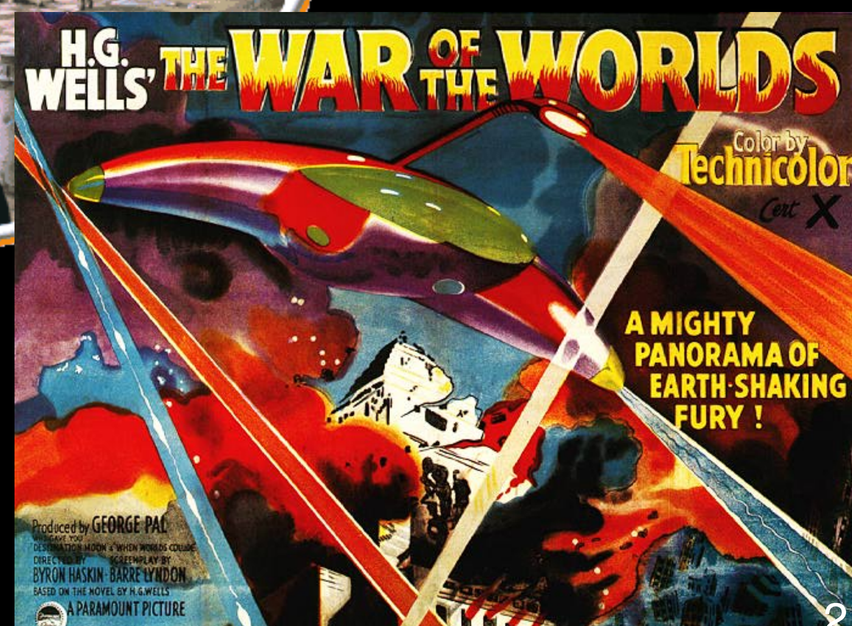
H.G. Wells
1898



Orson Welles
1938

And scattered about... were the Martians–dead! –slain by the putrefactive and disease bacteria against which their systems were unprepared; slain as the red weed was being slain; slain, after all man's devices had failed, by the humblest things that God, in his wisdom, has put upon this earth.

...By virtue of this natural selection of our kind we have developed resisting power; to no germs do we succumb without a struggle...

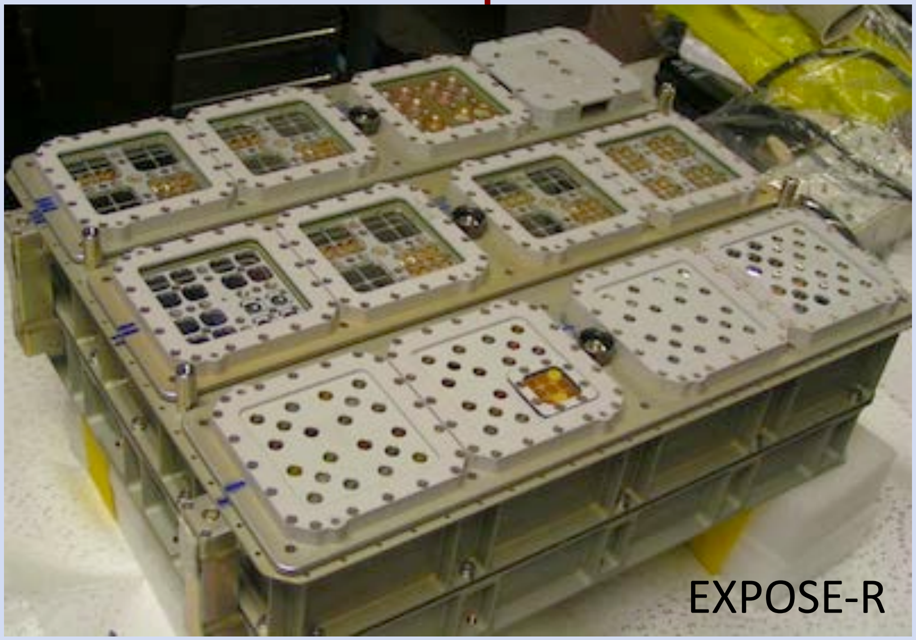


Planetary Protection Policy
(from NPD 8020.7; near-verbatim from COSPAR)

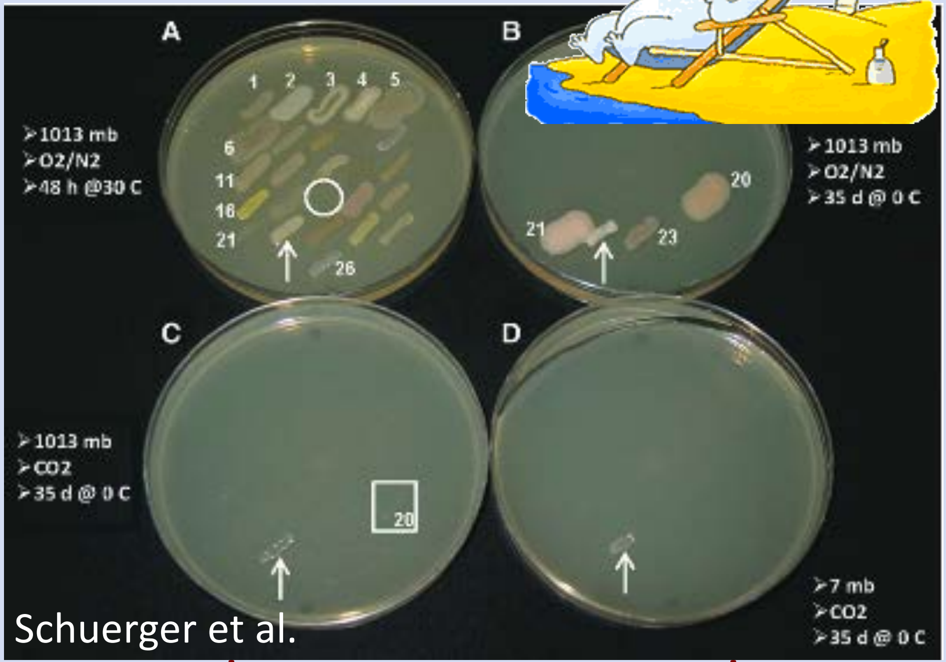
- “The conduct of scientific investigations of possible extraterrestrial life forms, precursors, and remnants must not be jeopardized.”
    - Preserves science opportunities directly related to NASA’s goals, and can support certain ethical considerations; originally recommended to NASA by the NAS in 1958
    - Preserves our investment in space exploration
    - Can preserve future habitability options
- “The Earth must be protected from the potential hazard posed by extraterrestrial matter carried by a spacecraft returning from another planet.”
    - Preserves Earth’s biosphere, upon which we all depend...
- Assignment of categories for each specific mission/body is to “take into account current scientific knowledge” via recommendations from advisory groups, “most notably the Space Studies Board.”

Earth Microbes are Surprisingly Capable...

Cleanroom isolates can survive for years on the outside of the International Space Station



EXPOSE-R

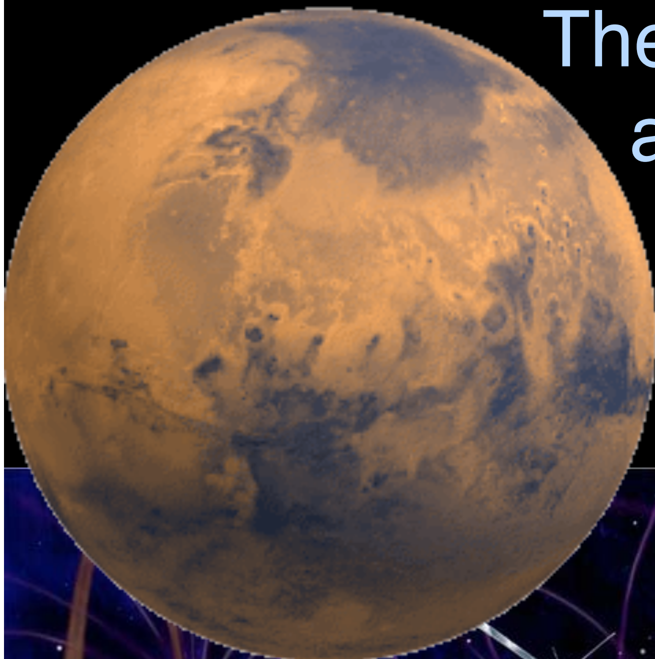


Schuerger et al.

Microbes common on cheese can grow in a Mars chamber

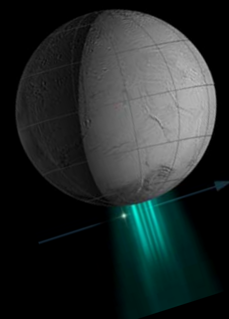
These observations were not made when planetary protection constraints were proposed in the 1960s: thoughtful precautions are key to protecting science and other future human activities in space.

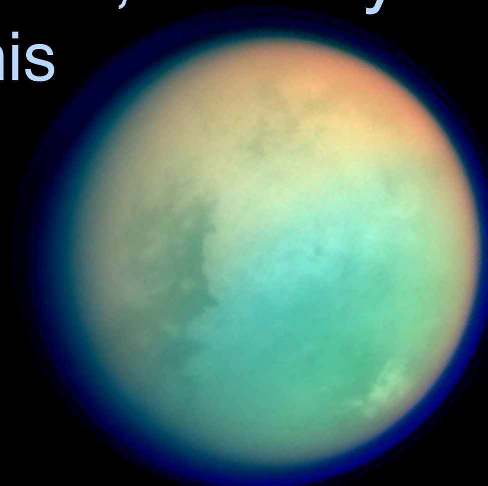
Planetary Environments are Diverse

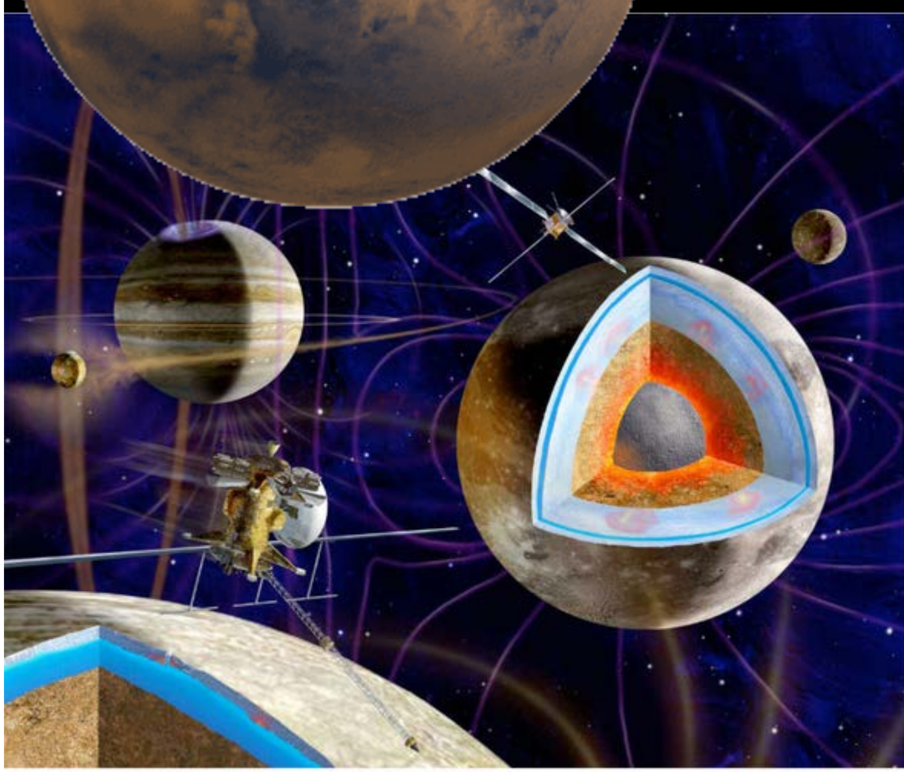


The unaltered surfaces of most planets are cold, and by being cold, are dry

- spacecraft can change this







Artist: Michael Carroll

Interior environments may be more similar to Earth:

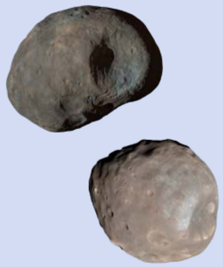
- possible subsurface oceans, both hot and cold
- subsurface rock, similar(?) to inhabited Earth rocks

Planetary Protection: What, Us Worry?

- Avoid contaminating target bodies that could host Earth life (e.g., Mars, Europa, Enceladus)
- Ensure biohazard containment of samples returned to Earth from bodies that could support native life (e.g., Mars and possibly moons, Europa, Enceladus)
- On human missions, characterize and monitor human health status and microbial populations (flight system microbiome) over the mission time, to support recognition of alterations caused by exposure to planetary materials

<u>Earth's Moon, Most Solar System Bodies</u>

Documentation only; No Operational Constraints on *in situ* activities or sample return



<u>Phobos/Deimos</u>

Document *in situ* activities; Possible return constraints

<u>Mars, Europa, Enceladus</u>

Documentation and operational restrictions to avoid introducing Earth life; Strict biohazard containment of returned samples

Protecting Diverse Objectives at Mars

Can be consistent with scientific interests, but with more Earth contamination it becomes more difficult to detect Mars life...

Phased Approach: Be careful early; tailor later constraints to exploration or other goals, using knowledge gained on previous missions

- •Humans have many interests at Mars; understanding potential hazards supports all of them
- •Searching for Mars life or biohazards becomes more difficult because Earth contamination can overprint biosignatures and reduce signal-to-noise ratios
- •Future colonization could be challenged, if unwanted Earth invasive species are introduced
  - – Blocking aquifers
  - – Consuming resources
  - – Interfering with planned introductions

NASA Policy Instruction in place: Human mission requirements under development by HEO and SMD

The Basic Rationale for Planetary Protection Precautions

(as written by Bart Simpson, Dec. 17, 2000, “Skinner’s Sense of Snow”)

Science class should not end in tragedy….
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