the future

What is Astrobiology?

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What is the future of life?

Interaction among the environment, biosphere and us

- ★Future environment and planetary factors
- ★Response of life to this change - including humans
- ★Life beyond planet earth
- ★Fate of our universe

Setting the scene: Environment of early earth

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radiation:

- *PAR*
- *UV*

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rotation of Earth

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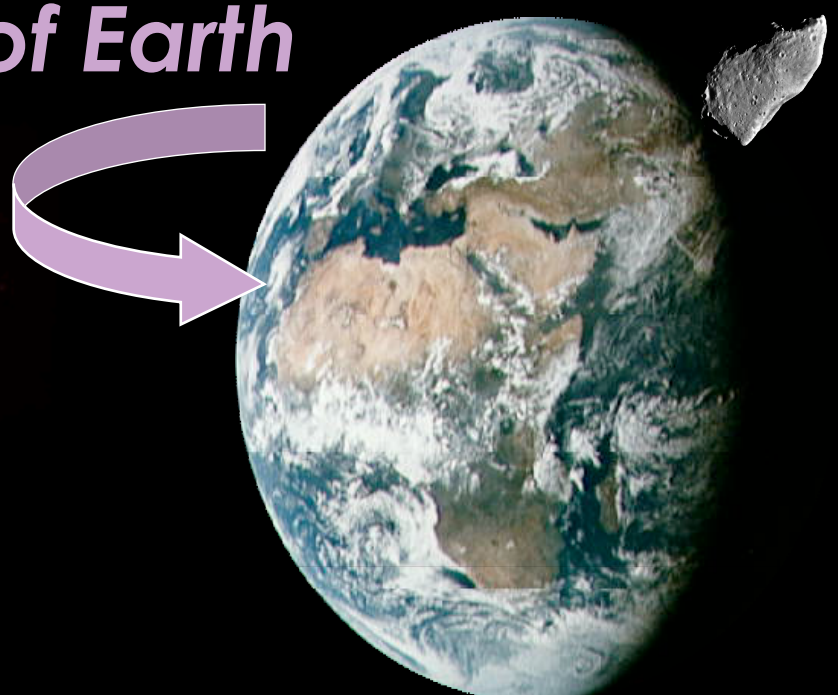
rotation of Earth



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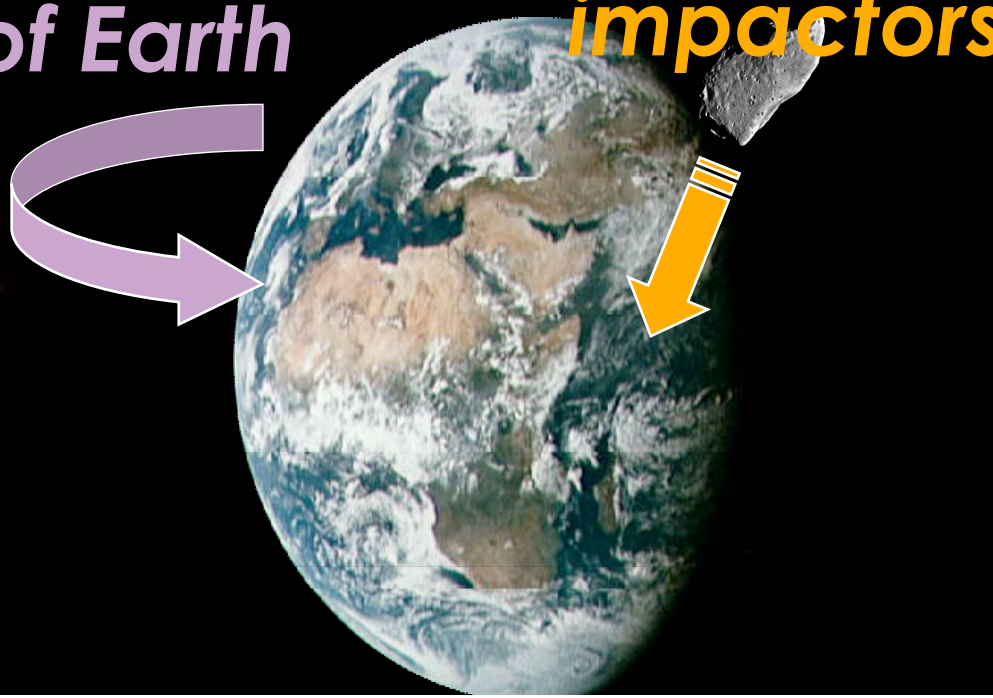
rotation of Earth

impactors



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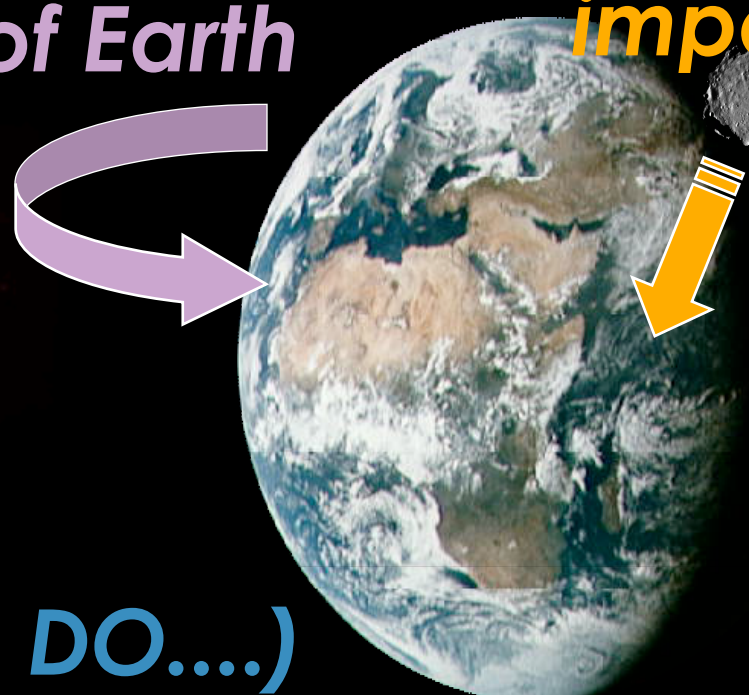

water:
- *temperature*
- *radiation (PAR, UV)*
- *chemistry (pH, DIC, DO....)*

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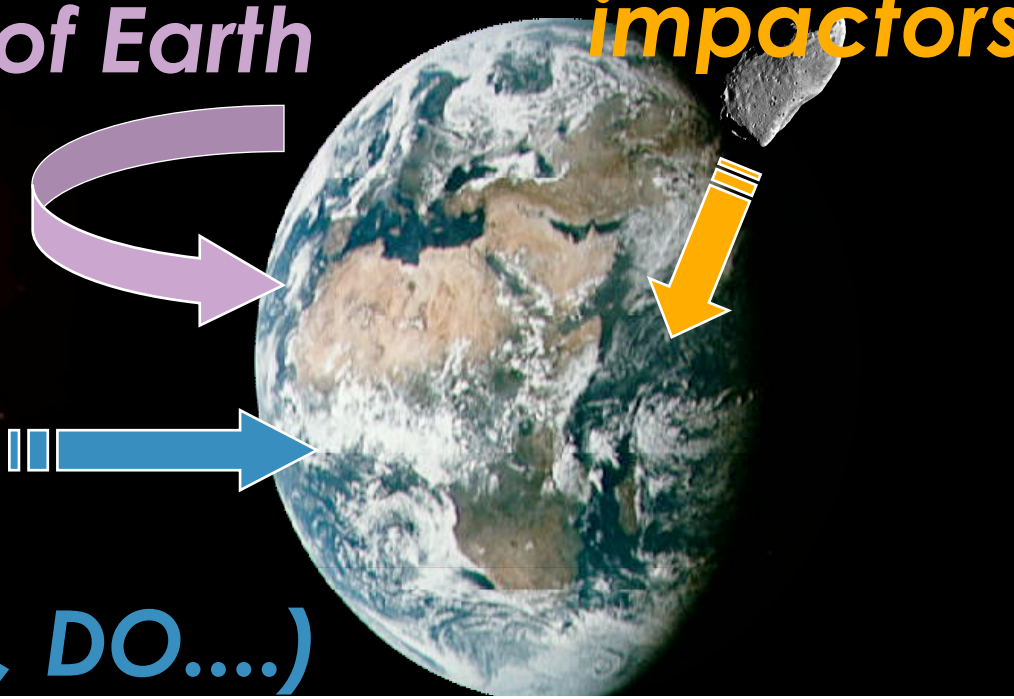

water:
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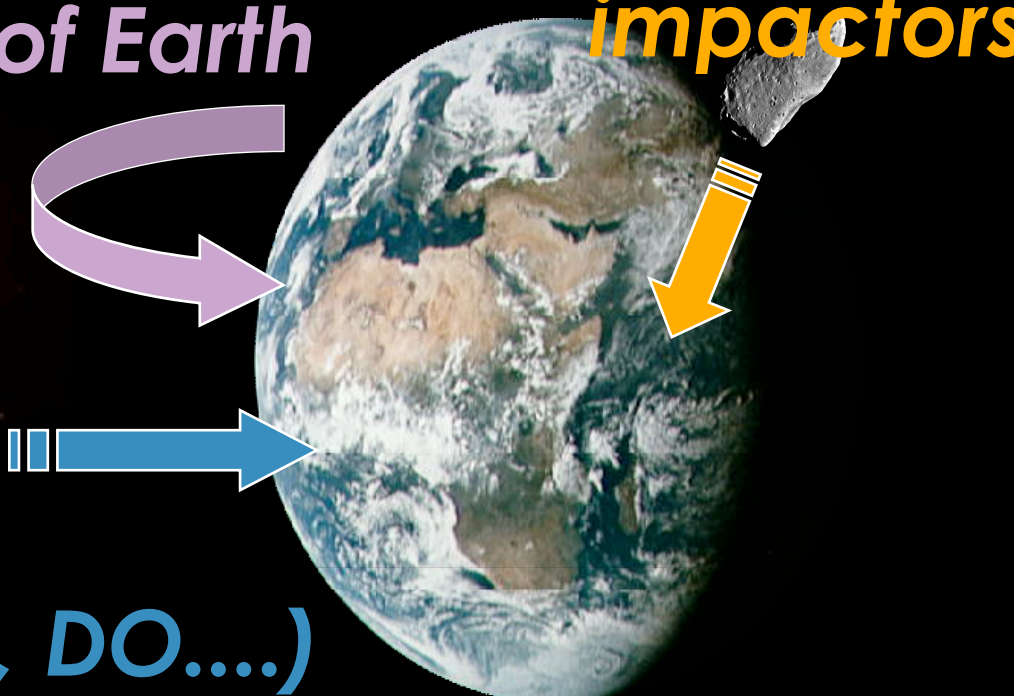
Setting the scene: Environment of future earth

radiation:
- *PAR*
- *UV*

atmosphere:
- *oxygen/ozone*
- *carbon dioxide*

rotation of Earth

impactors



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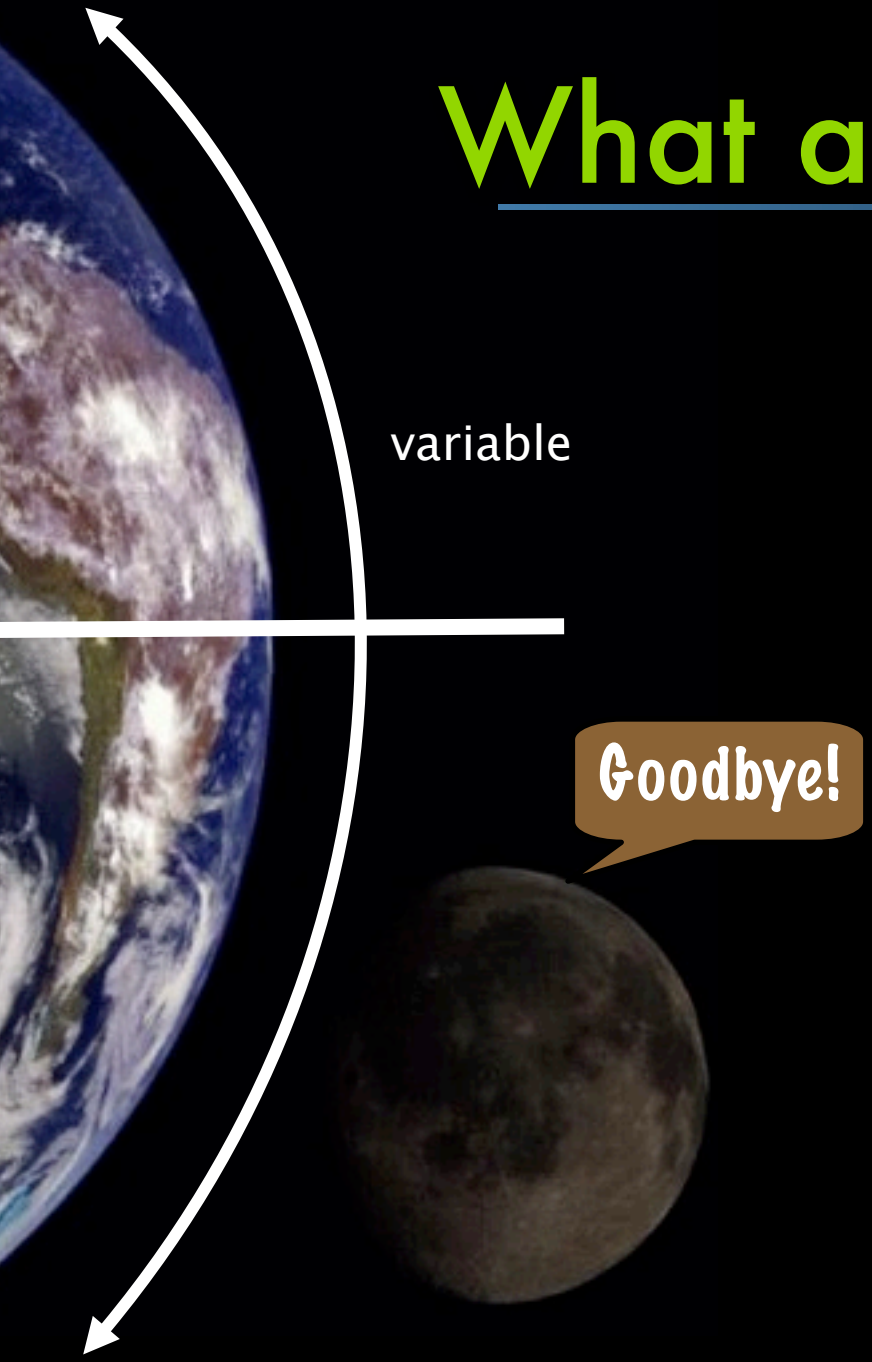
Why should you care about the moon?

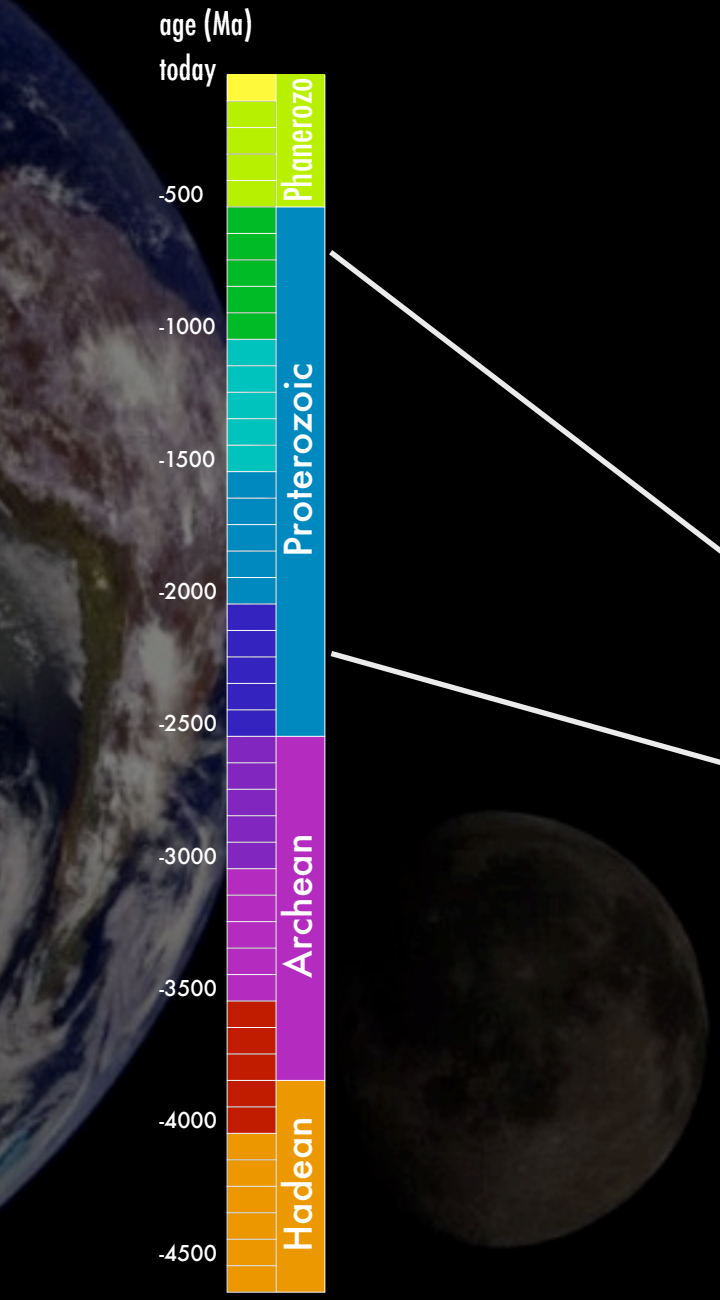
- Influence on life on earth
  - Stabilizes our obliquity and thus climate
  - Slows our day length
  - We wouldn't be here without it
- Of course important for space exploration
- But, due to tidal friction, the moon has been recessing ever since, about 4 cm/year today.

What about the future?



- Without the moon we would have a chaotic obliquity.
- Bad news: we are going to lose the stabilizing effect of our moon in under billion or so years, though the moon itself may come back.
- What can we do about this?
  - Hang on to our moon (decrease tidal friction?)
  - Hijack new moon (Europa?)
  - Deal with it
  - Get out of here!

Snowball earth



Snowball Earth refers to the hypothesis that the Earth's surface became nearly or entirely frozen over

No unambiguous glaciogenic deposits >2.5 Ga

Glaciation of essentially all continents in

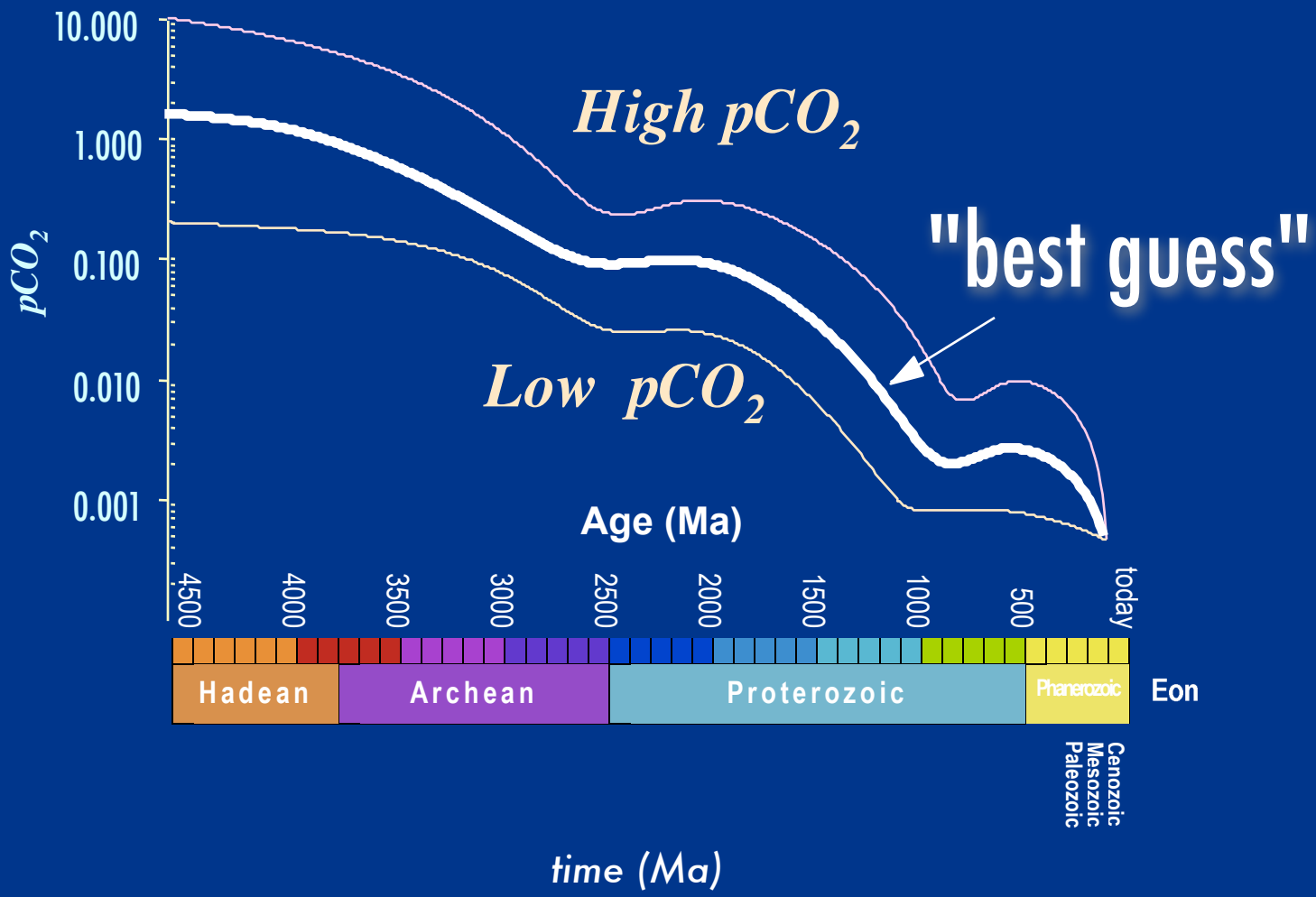
Late Proterozoic (800-600 Ma) and

Huronian (~2.3 Ga).

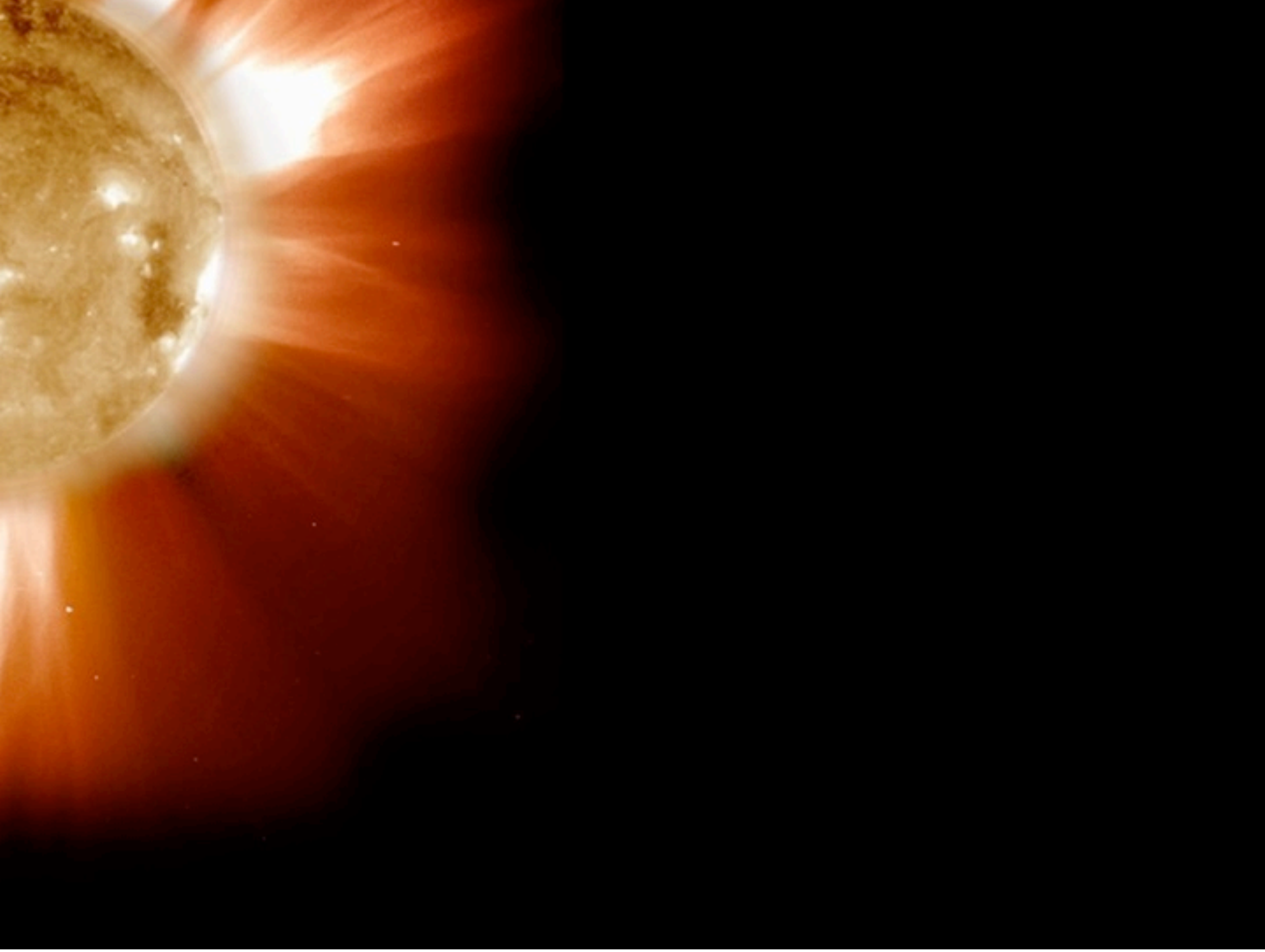
So, the Precambrian climate may have been similar to Phanerozoic - brief periods of glaciation

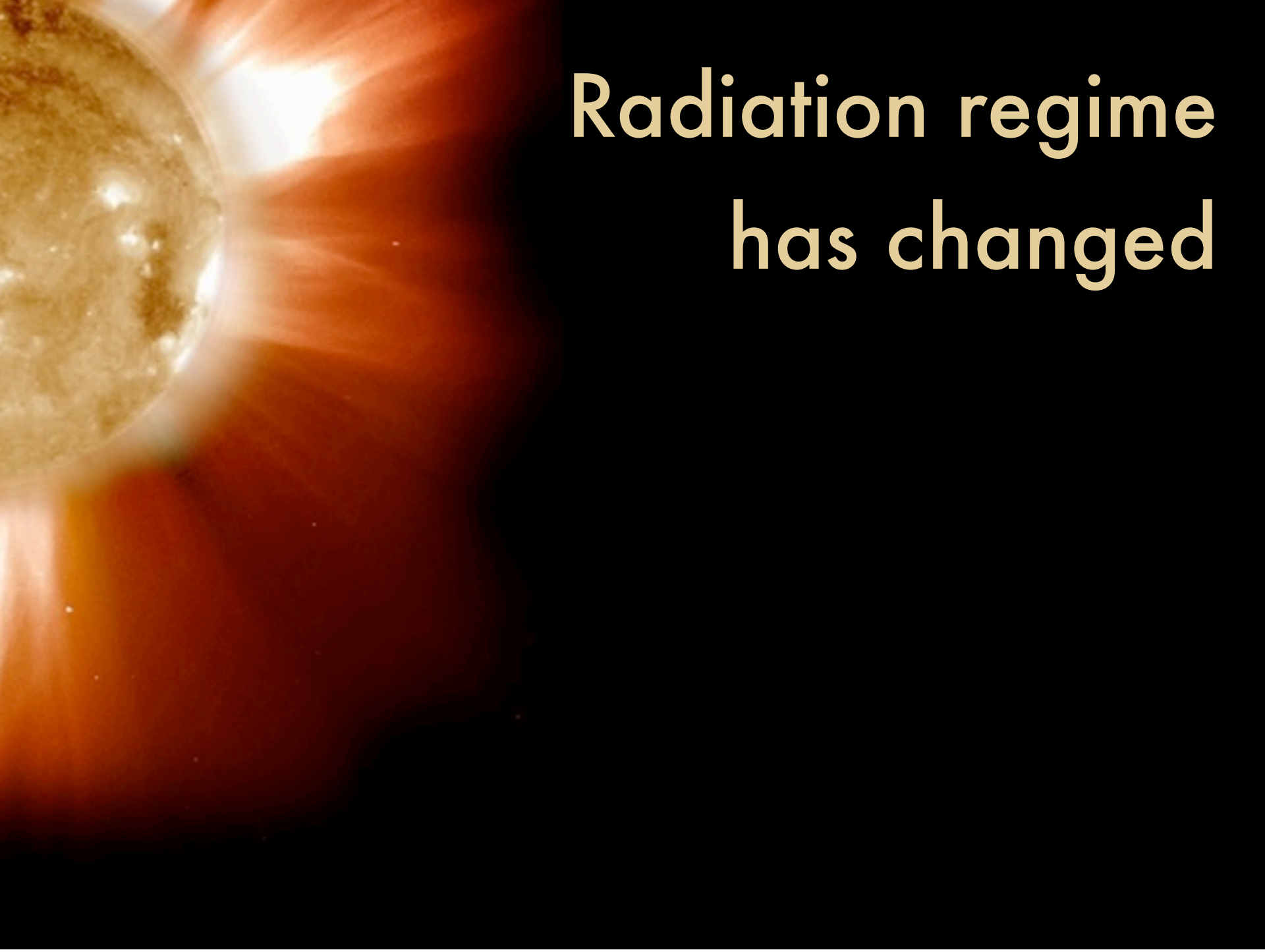
adapted from Walker, 1990

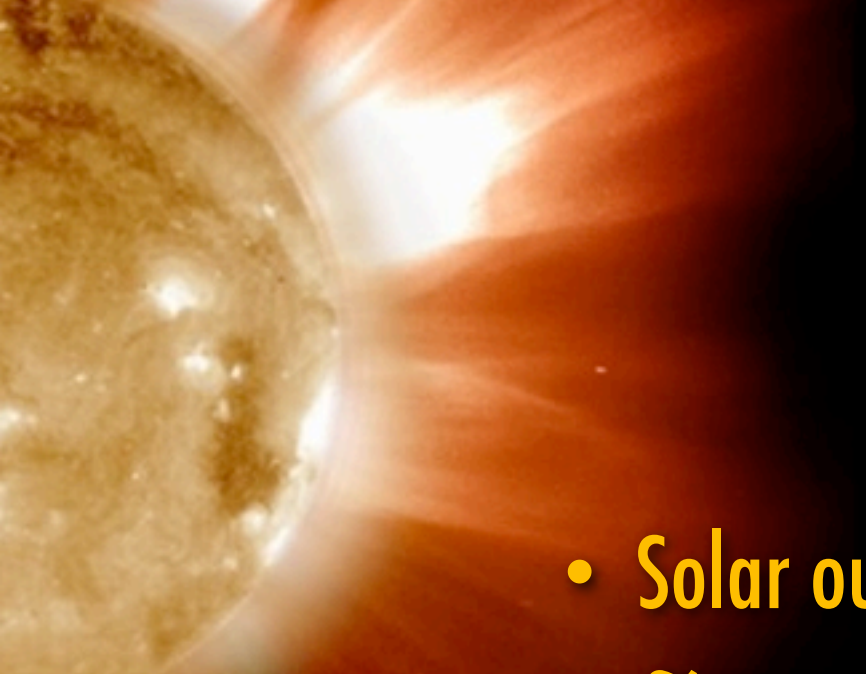
pCO_2 levels through time. How will these change?



redrawn from Kasting, 1987




Radiation regime
has changed



Radiation regime has changed

- Solar output has changed. Sun was ~70% as luminous when life originated.
- Thus, solar radiation reaching Earth has changed, and will continue to change.
- In a billion years the sun will be about 10% brighter than present.

UV regime will change

age (Ma)
today

-500
-1000
-1500
-2000
-2500
-3000
-3500
-4000
-4500

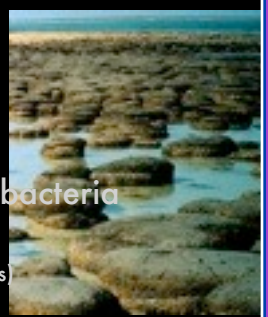
Phanerozoic
Proterozoic
Archean
Hadean

Dinosaurs & diatoms
plants invade
Cambrian explosion

Plant-animal-fungal split?

Great Oxidation
?origin of eukaryotes

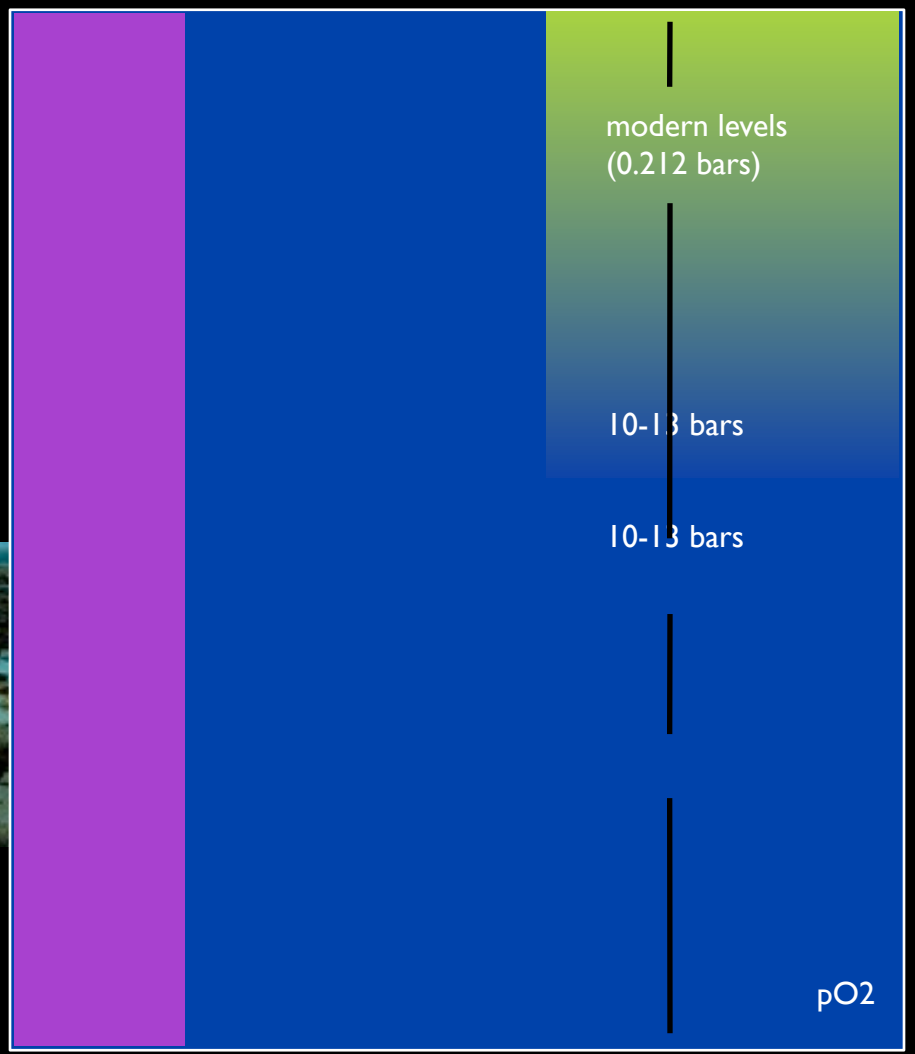
oxygenic photosynthesis



stromatolites w/ cyanobacteria
oldest known fossils
(Swaziland & Pilbara Supergroups)

oldest rocks (Isua Supercrustal Group)

formation of the Earth



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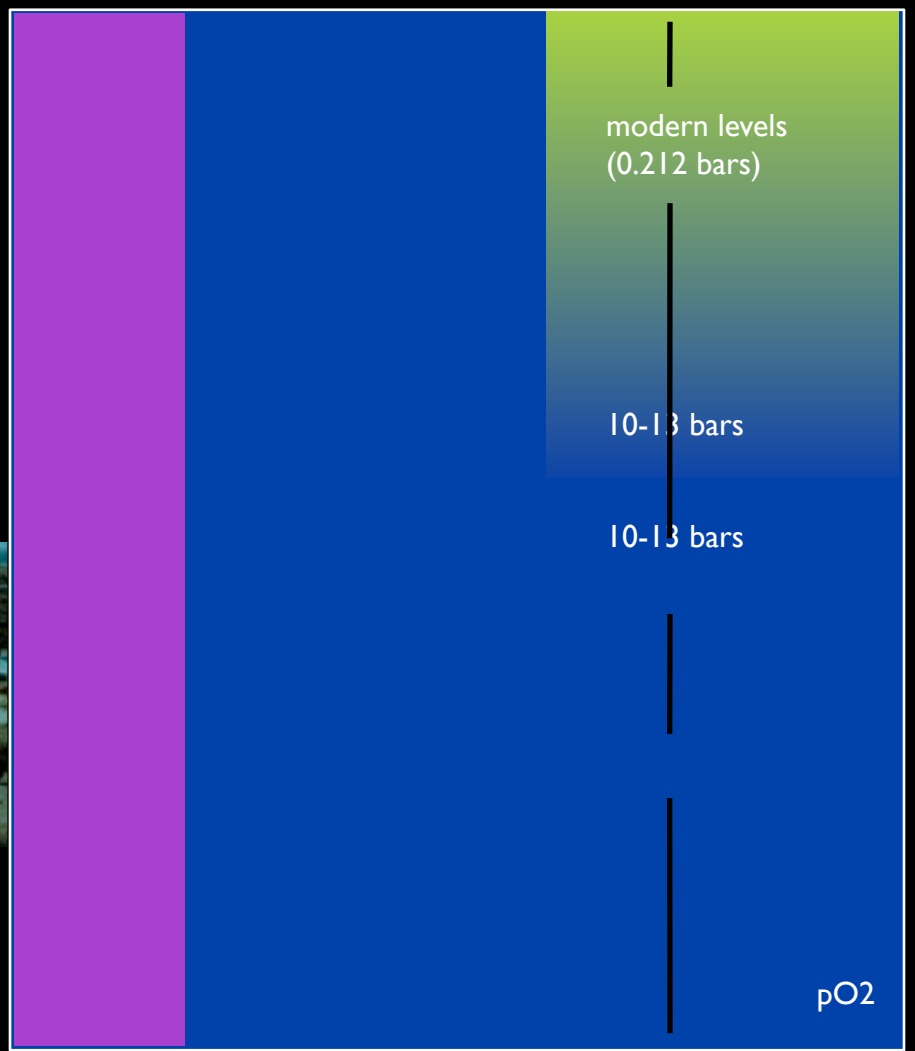

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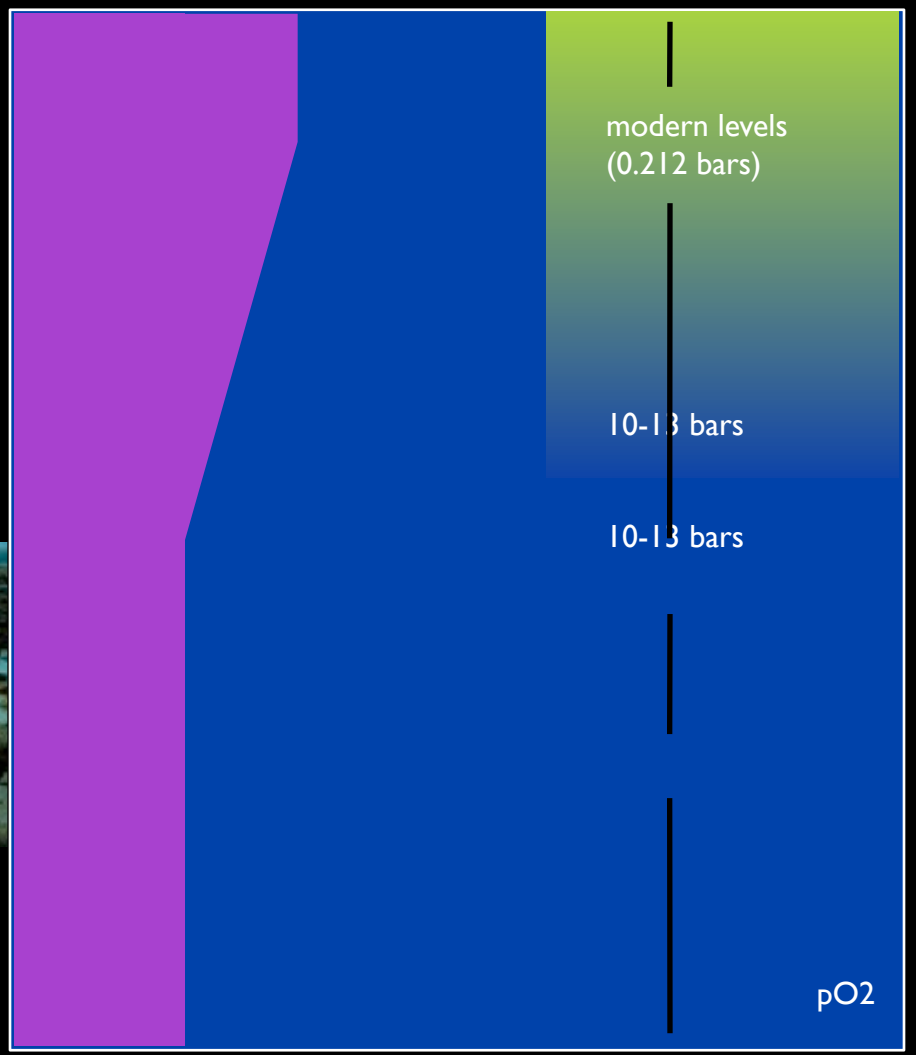

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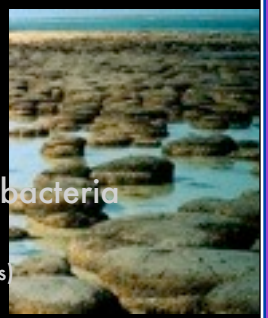

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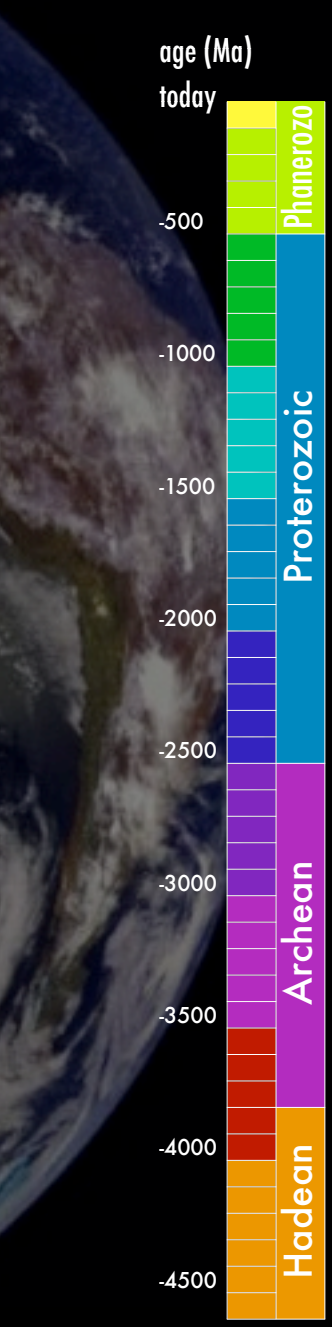
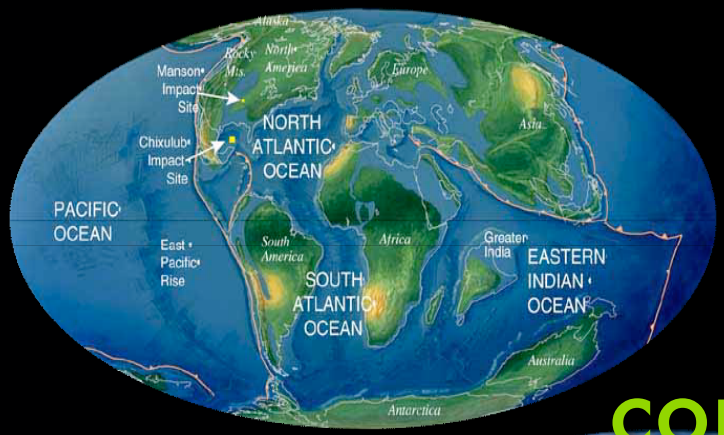
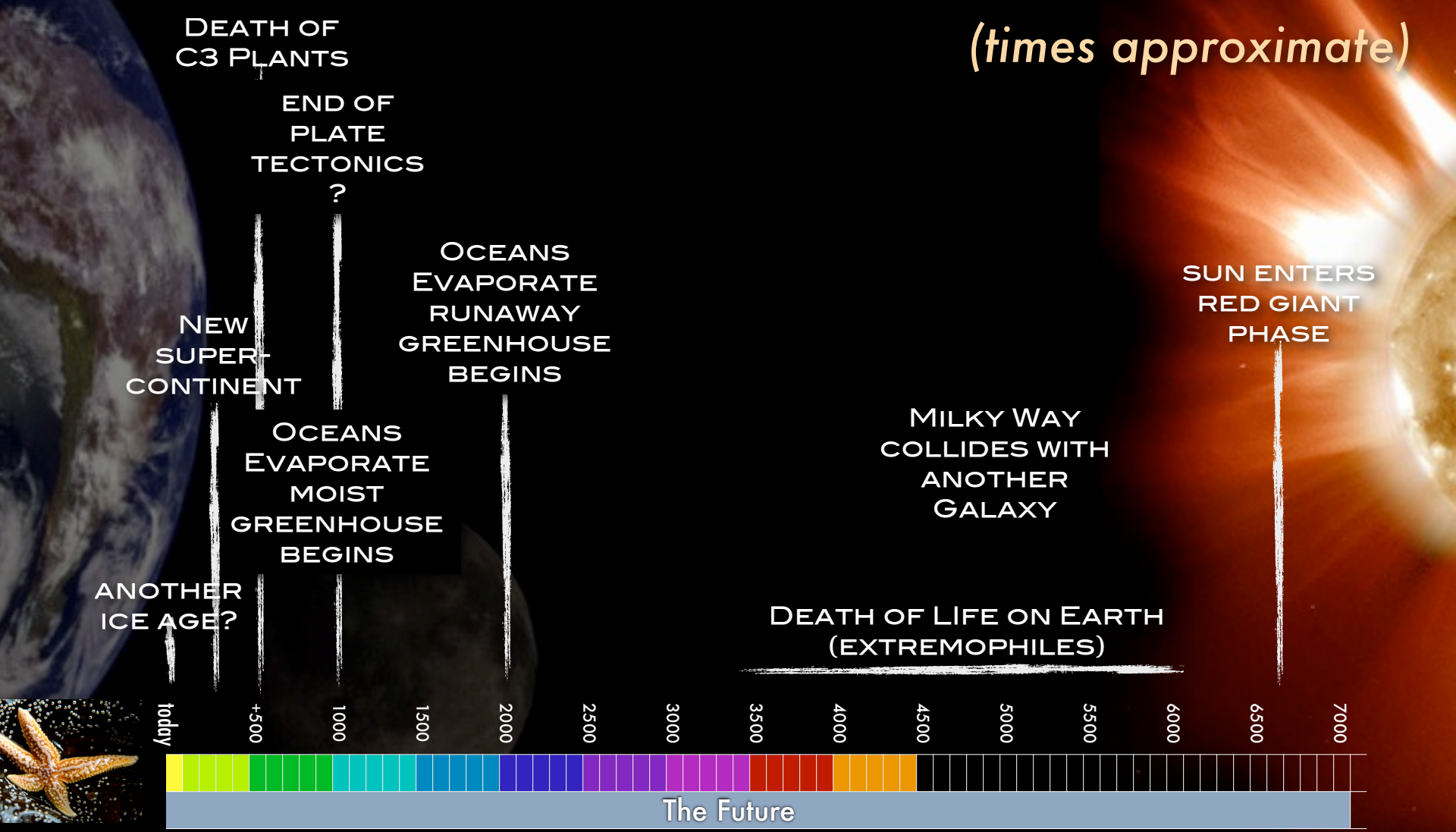
Major Events in Geologic History. Plate tectonics will continue, for a while.





The future of earth

(times approximate)



Ward & Brownlee, *The life and death of planet earth.* 2002.

What is the future of life?

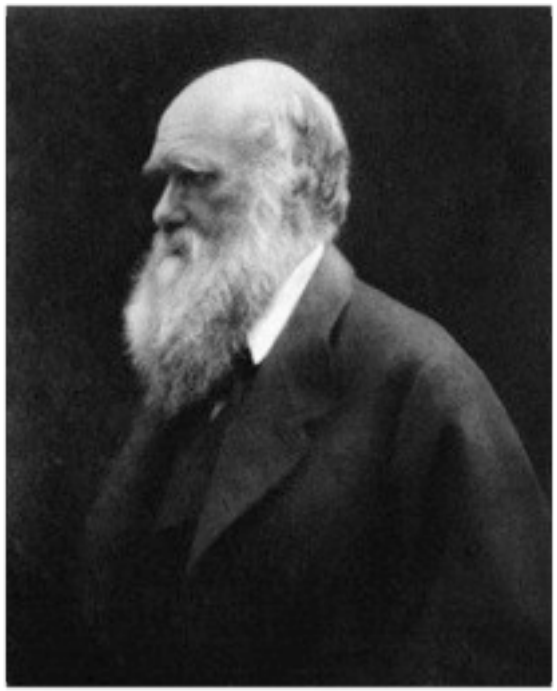
Interaction among the environment, biosphere and us

- ★Future environment and planetary factors
- ★Response of life to this change - including humans
- ★Life beyond planet earth
- ★Fate of our universe

On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life.

Charles Darwin,

M.A., Fellow of the Royal, Geological, Linnæan, etc. societies; Author of "Journal of researches during H. M. S. Beagle's Voyage round the world. London: John Murray, Albemarle Street, 1859"



Will this still be relevant?

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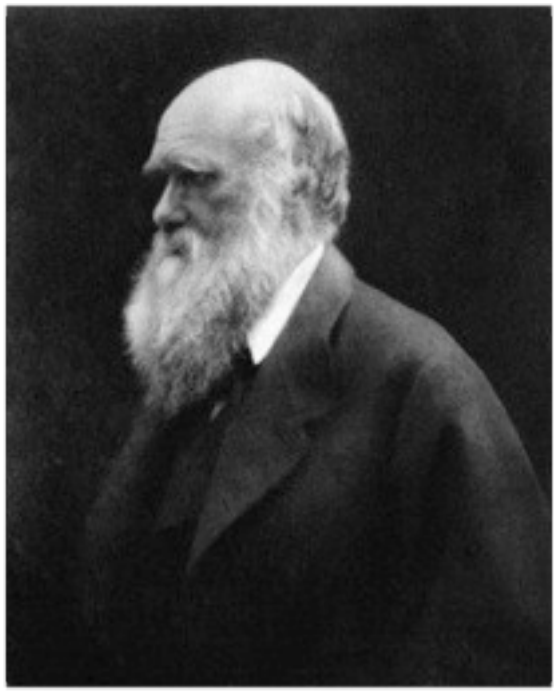

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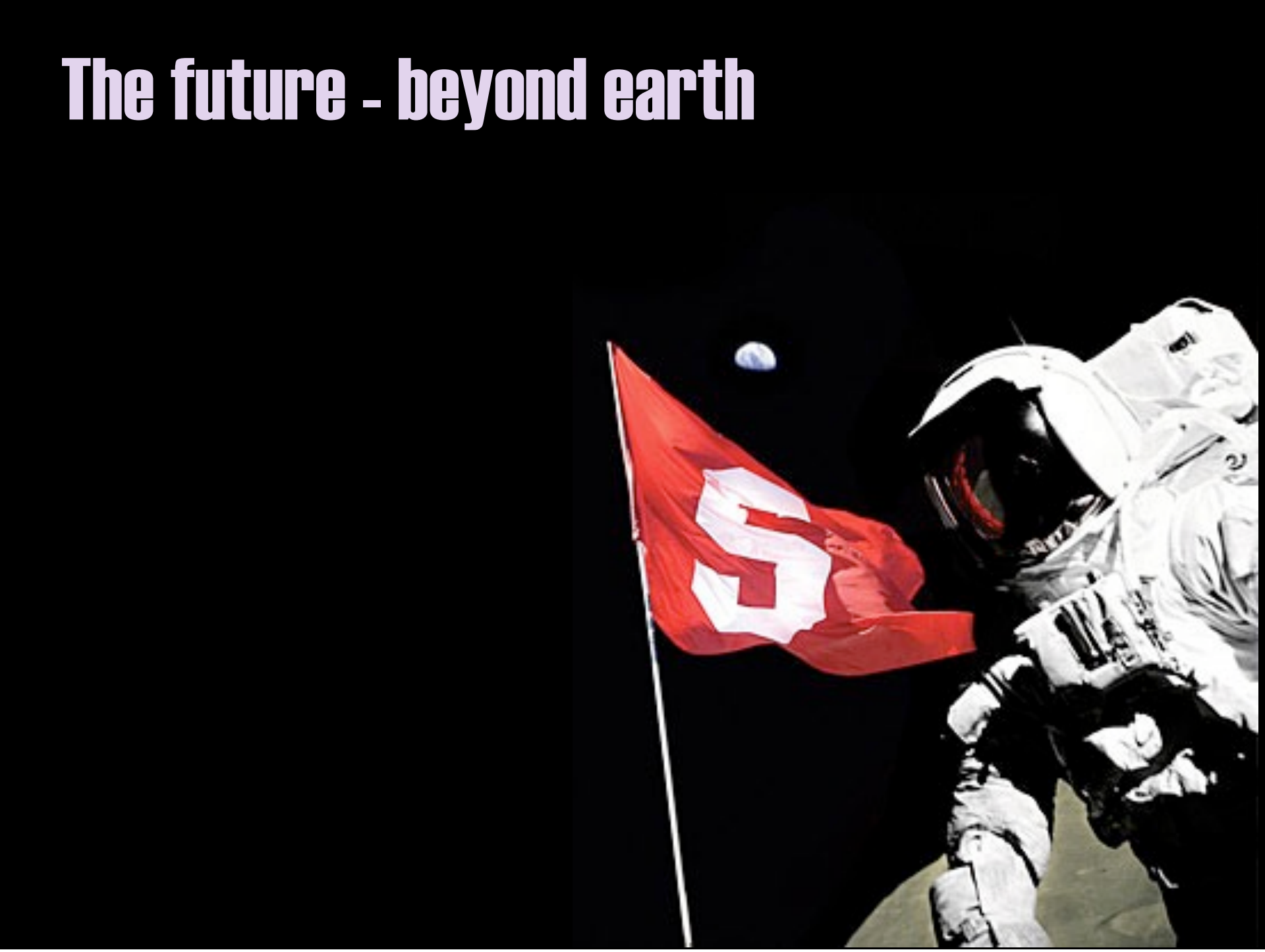
The Past:

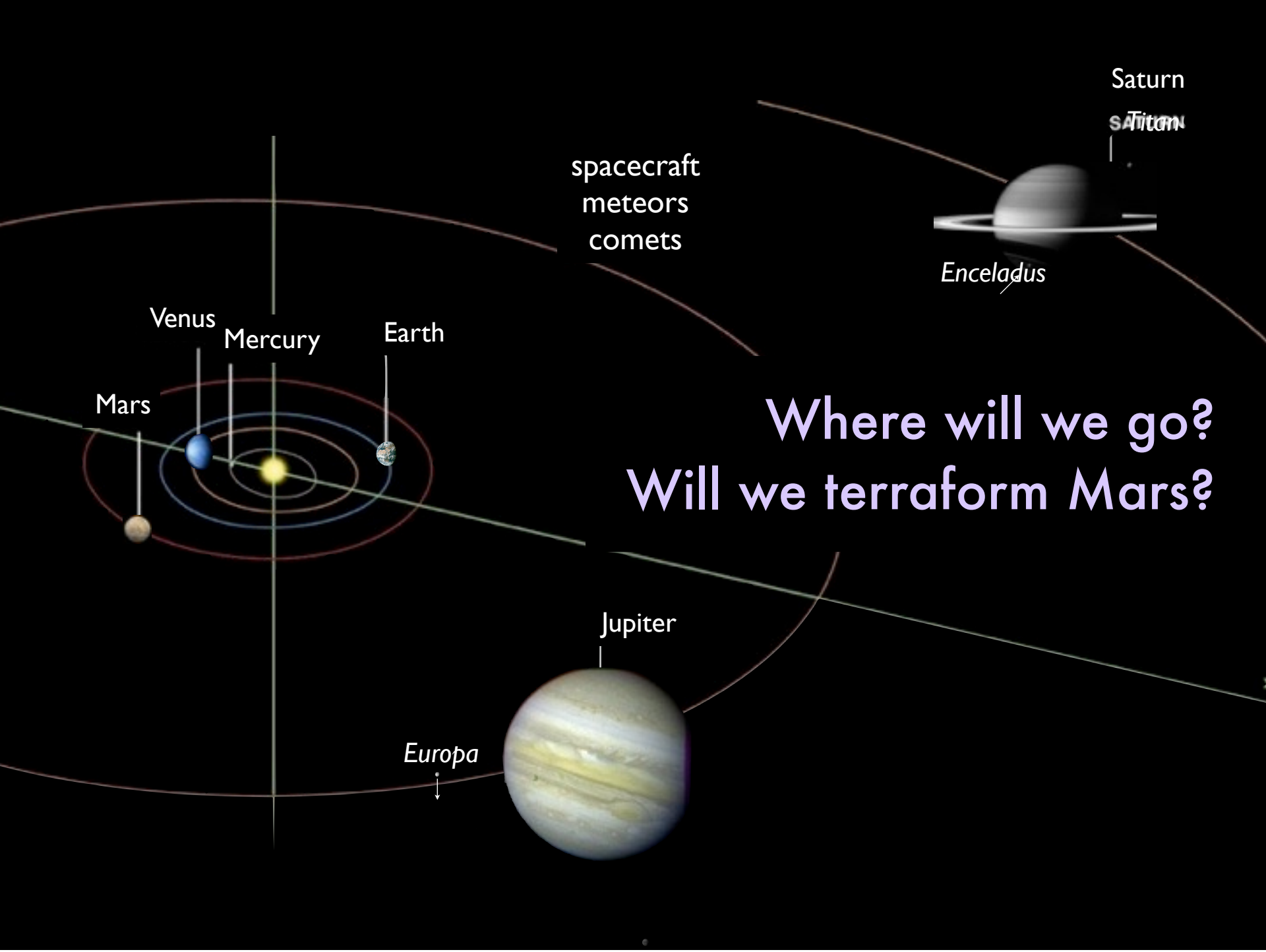
Key events in human space exploration*

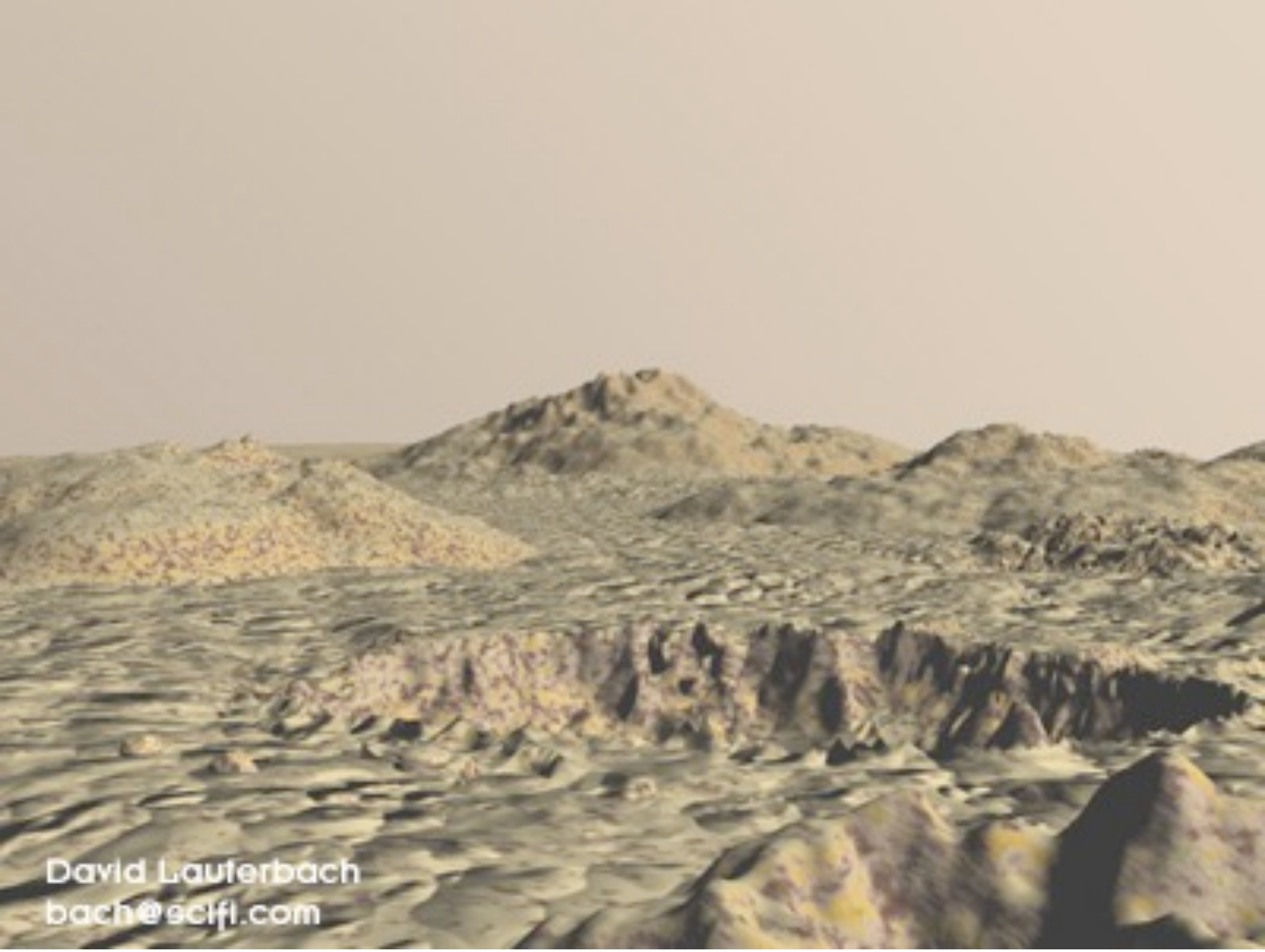
- Sputnik (1957)
- Gargarin (1961)
- Shepard (1961)
- NASA (Mercury, Gemini, Apollo)
- Apollo 11 (1969)
- Space Stations (Salyut, Skylab, Mir, ISS)

* *What Every Astrobiology student should know and NASA history web site*

The future - beyond earth




Saturn
Titan
spacecraft
meteors
comets
Enceladus
Venus
Mercury
Earth
Mars
Where will we go?
Will we terraform Mars?
Jupiter
Europa


David Lauferbach
bach@scifi.com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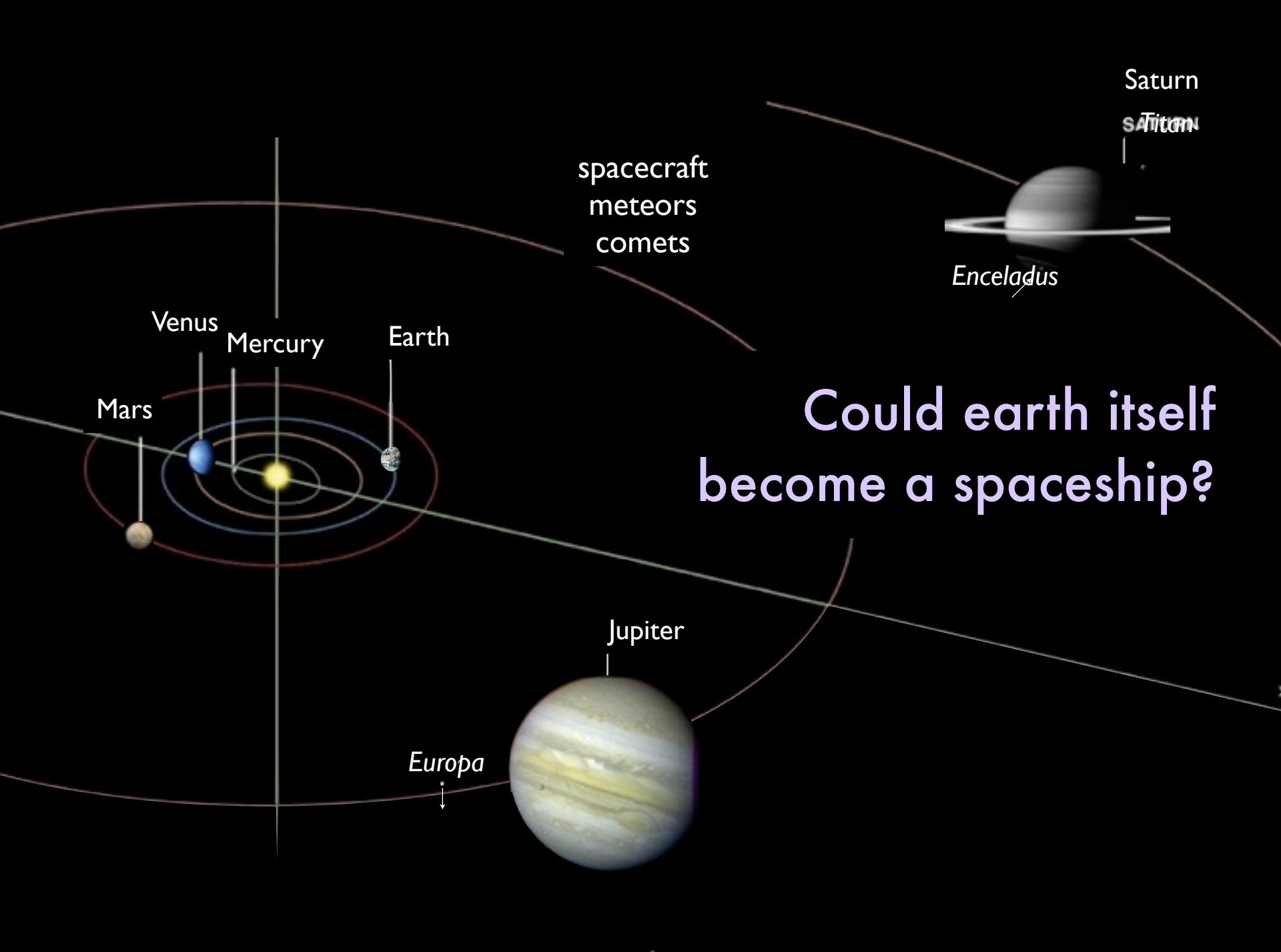
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Mercury
Earth
Mars
Could earth itself become a spaceship?
Jupiter
Europa

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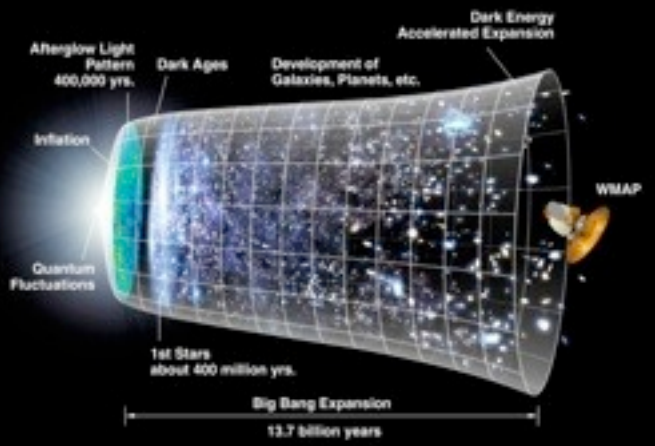
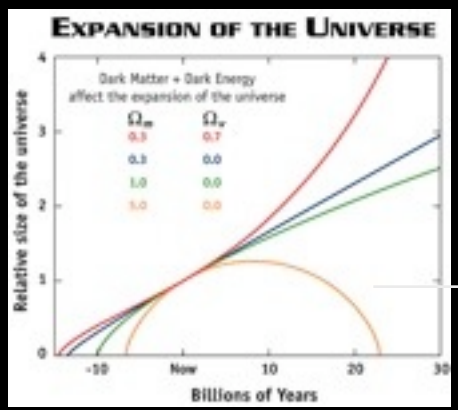
fate of the solar system?

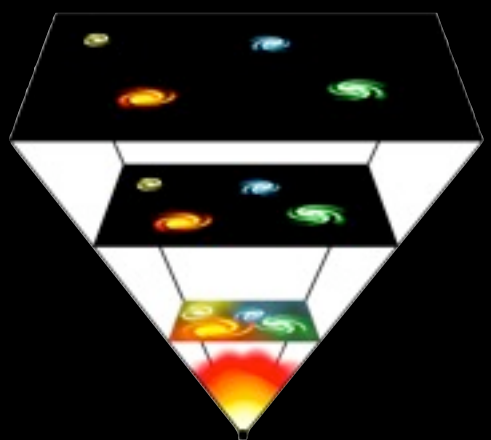
fate of the Milky Way?

fate of the universe





- big freeze
- big rip
- big crunch
- big bounce
- multiverse



You are left with the ultimate question:

Should you study for the final?

my take...

my take…

We are between a Greek tragedy and
A Christmas Carol.

my take…

We are between a Greek tragedy and A Christmas Carol.

Like a Greek tragedy, we are beginning to see our fate. But, like Scrooge, we are also starting to learn what we can do about it. And evolution has implanted us with the imperative to survive.


AD ASTRA!