

# The Search for Life in the Universe

(or at least our galaxy)

Reading: Chapter 27

# Different Questions!

1. Is there life anywhere else?

2. Is there intelligent life ?

3. Is there intelligent life with which we could communicate?



# Survey Question

What do you think (right now) about the chances of life existing elsewhere?

1. There is no life except on Earth
2. There is primitive life somewhere else, but not intelligent life
3. There is intelligent life somewhere else, but we will not be able to detect or contact them
4. There is intelligent life elsewhere, and some day we'll be able to detect and maybe communicate with them

# Conditions for Life?

A moon?

Liquid Water:  $H_2O$  !

Hydrogen

Amino Acids?

Proteins?

Oxygen

DNA & RNA?

Nitrogen

Carbon

Iron?

(Silicon?)

# Time!

Seasons?

A G type star?

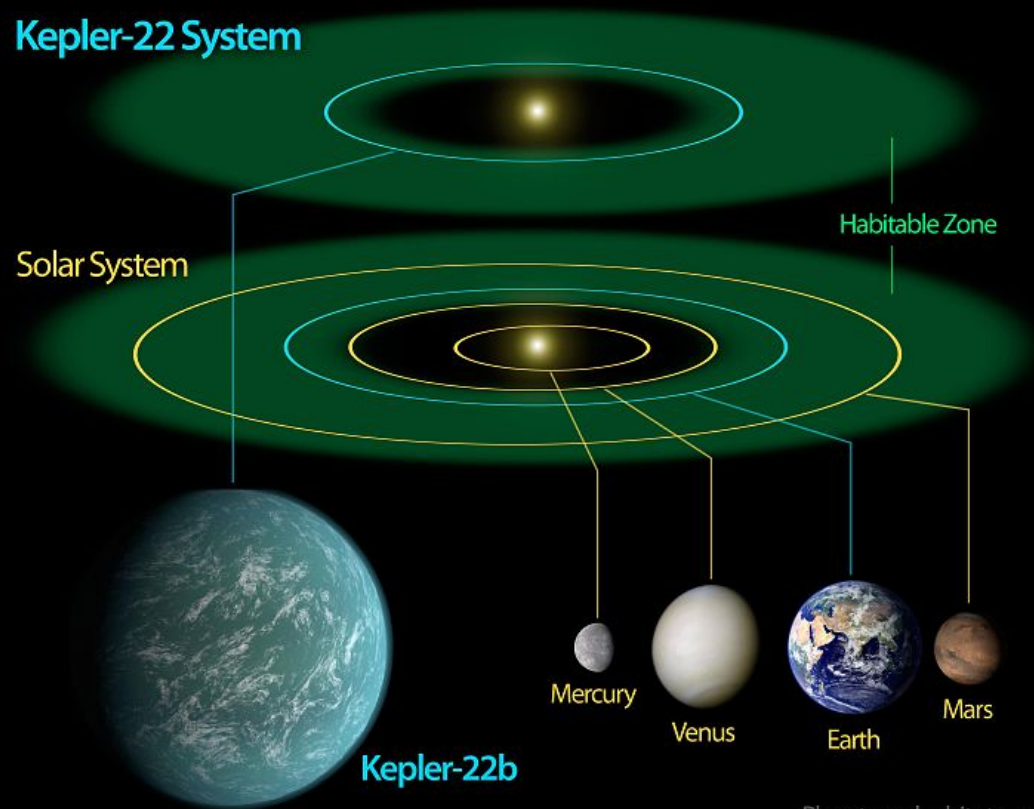
*Is Earth special?*



# Habitable Zone

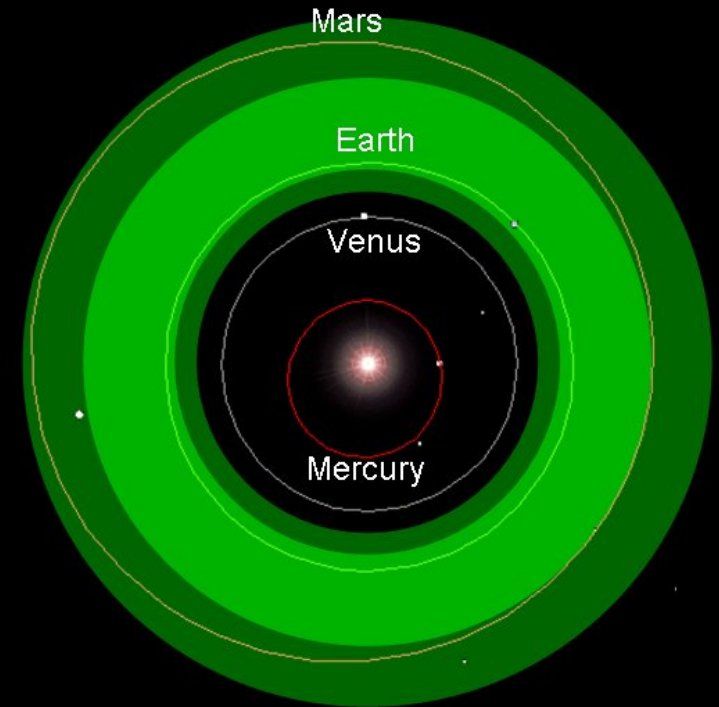
The region around a star where a planet with sufficient atmospheric pressure can maintain liquid water on its surface.

## Kepler-22 System



Planets and orbits to scale

## Sun's habitable zone



- Conservative
- Optimistic

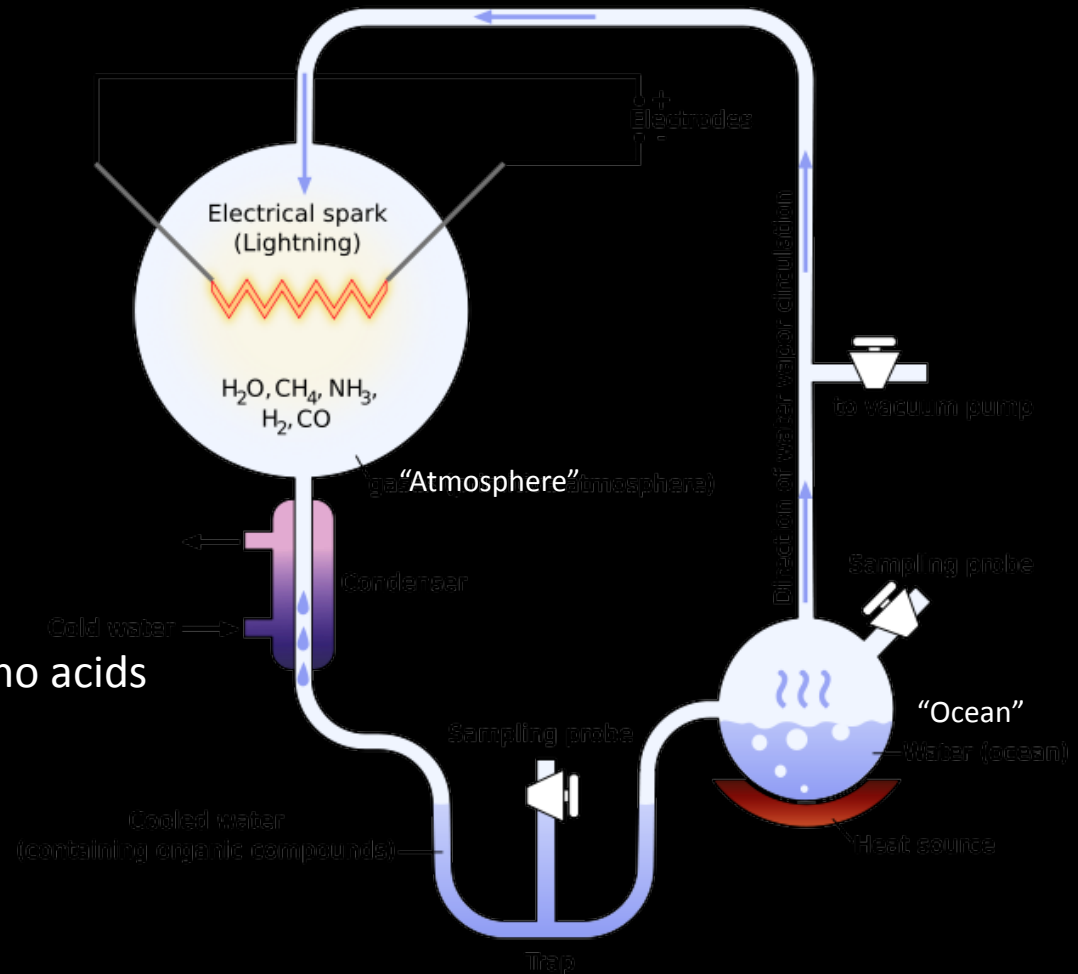
# Miller-Urey Experiment (1952)

Sterilized loop of flasks and tubes,  
into which were placed:

Water ( $H_2O$ )  
Methane ( $CH_4$ )  
Ammonia ( $NH_3$ )  
Hydrogen ( $H_2$ )

Electrical spark passed through  
vapors to simulate lightning

Within a week the 20 common amino acids  
found in life on Earth were formed.  
(But no nucleic acids.)



# History of Life

4.6 billion year since Earth was formed, and then...

3.8 billion years of simple cells (prokaryotes)

3.4 billion years of photosynthesis

2 billion years of complex cells (eukaryotes)

1 billion years of multicellular life

600 million years of simple animals

550 million years of complex animals

500 million years of fish and proto-amphibians

475 million years of land plants

400 million years of insects and seeds

360 million years of amphibians

300 million years of reptiles

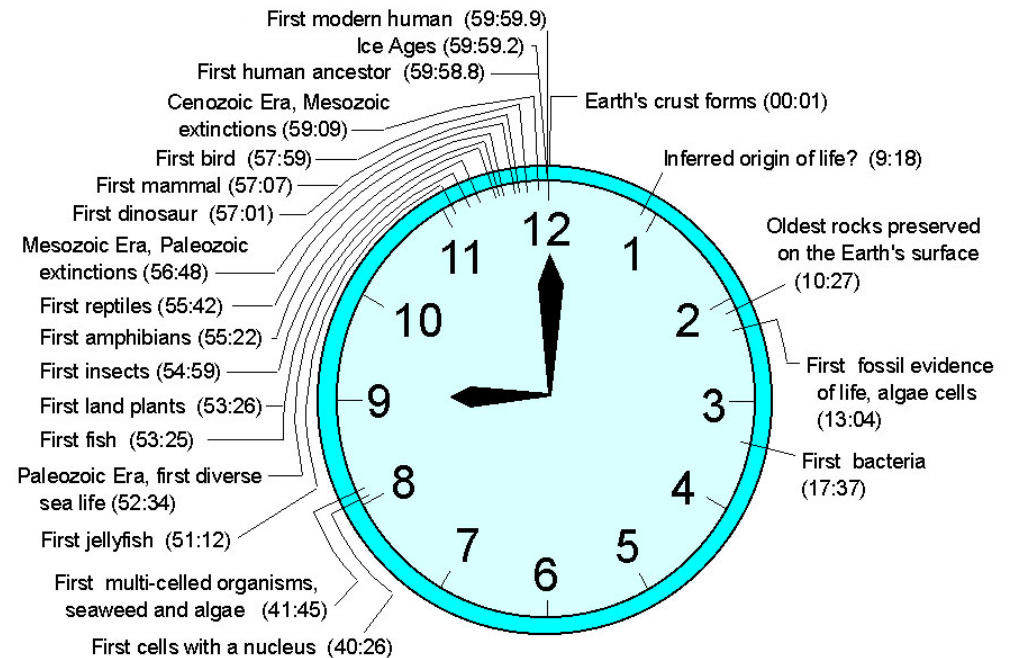
200 million years of mammals

150 million years of birds

65 million years since the dinosaurs died out

2.5 million years since the appearance of the genus Homo

200,000 years of anatomically modern humans



4.6 billion years in one hour

Dana M. Krempels, Ph.D.  
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Department of Biology

# Life from Mars?

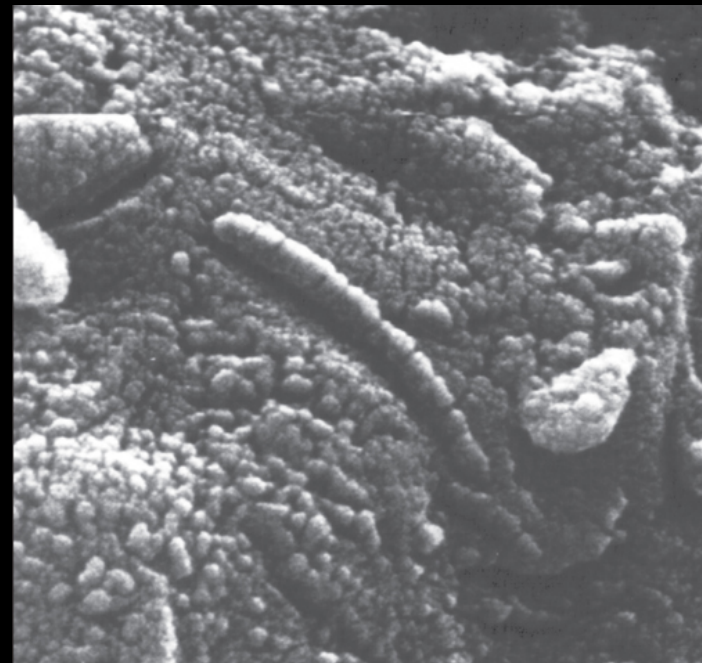
LIFE ON  
MARS

Meteorite collected in Antarctica in 1984,  
later recognized as originating on Mars



The idea that life originated elsewhere and  
then came to Earth is called “panspermia”

Carbonate deposits found in 1994  
suggestive of fossilized microorganisms



Other investigators offer other interpretations,  
so the results are not definitive.

See §27.3



# Fermi's Paradox — “Where is everybody?”

In a lunchtime conversation in 1950 about the possibility of intelligent extraterrestrial life which could travel faster than light, physicist Enrico Fermi estimated that if there is any, we should have been visited many times in our history.

But since there is no clear evidence of such visits, he asked “Where is everybody?”

**Note 1: his estimate assumes the possibility of traveling faster than light!**

(Note 2: supposed evidence highlighted on the *History Channel* is not credible.)

The “Zoo Hypothesis” is that advanced civilizations exist but choose not to contact us, to allow us to evolve naturally. Kind of like the “Prime Directive” in Star Trek.



# Drake Equation

In 1960 astronomer Frank Drake came up with a “simple” way to estimate the possible number of civilizations that might give off radio signals.

$N$  = the number of civilizations in our galaxy  
which may give detectable radio signals

$$N = R^* \cdot f_p \cdot n_e \cdot f_l \cdot f_i \cdot f_c \cdot L$$

$R^*$  = the average rate of star formation per year in our galaxy

$f_p$  = the fraction of those stars that have planets

$n_e$  = the average number of planets that can potentially support life,  
per star that has planets

$f_l$  = the fraction of the above that actually go on to develop life at some point

$f_i$  = the fraction of the above that actually go on to develop intelligent life

$f_c$  = the fraction of civilizations that develop a technology which releases  
detectable signs of their existence into space

$L$  = the length of time for which such civilizations release  
detectable signals into space

Sheldon and the  
Drake Equation



Using Drake's original numbers:

$$N = R^* \cdot f_p \cdot n_e \cdot f_l \cdot f_i \cdot f_c \cdot L$$

(Did you spot the error?)

$$= (10/\text{yr})(0.5)(2)(0.5)(0.01)(0.01)(10,000 \text{ yr})$$

$$= 10$$

Does not say anything about where they are in the galaxy, or if they are close enough to detect

Note that values become less certain as you move from left to right in the equation.

Best to think of the equation as a rough guide and just a way to organize thinking

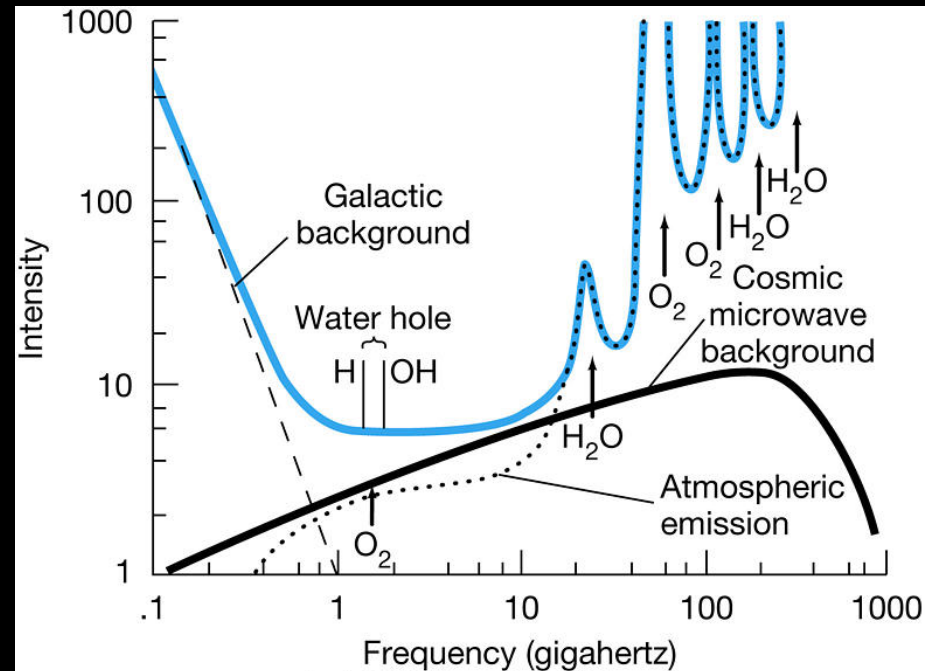
# SETI - Search for Extra-Terrestrial Intelligence

1960 – first directed radio search by Frank Drake at the National Radio Astronomy Observatory at Green Bank, West Virginia

2012 – the Allen Telescope Array (ATA), now under construction at the Hat Creek Radio Observatory in California, will have 350 antennas (42 now in place).



The “water hole”, between 1 and 10 GHz, has the lowest background noise, so best place to receive (or send) signals.

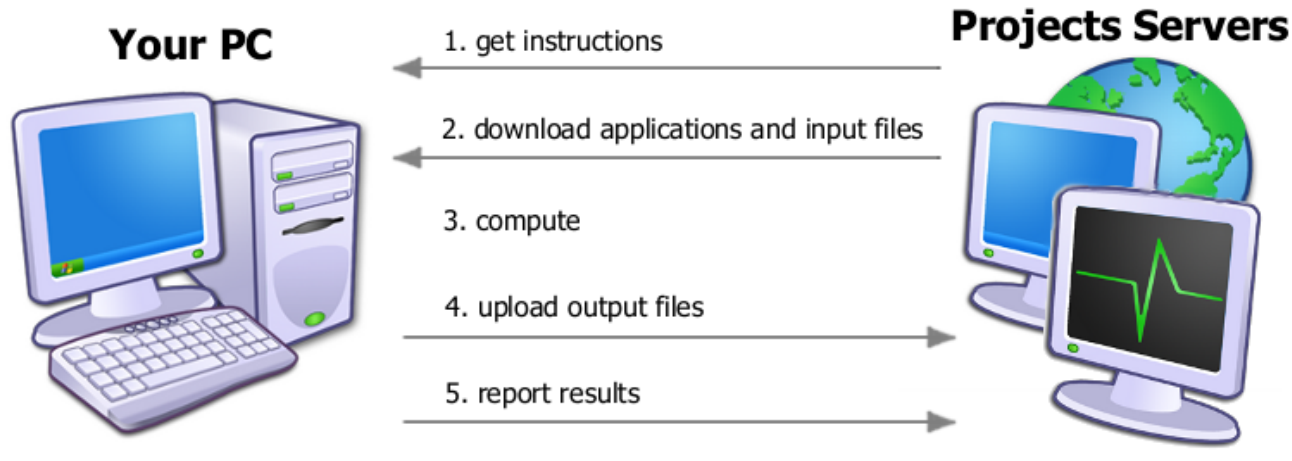


# SETI@home

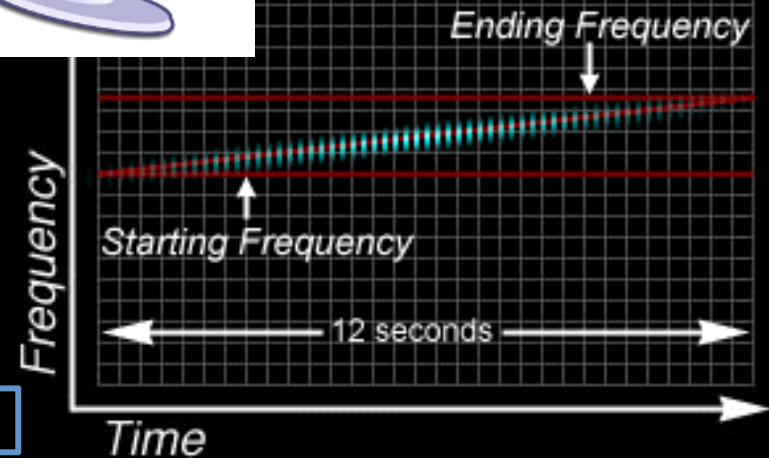
Data from Arecibo Radio Telescope are automatically scanned for narrow band signals on volunteer computers.



Arecibo Observatory,  
Puerto Rico



*"Chirped" and pulsed signal*



You can join the search!

<http://setiathome.berkeley.edu/>

Same software used by World Community Grid on Marist computers

# SETI Live

Presents radio frequency signals live from the SETI Institute's Allen Telescope Array while it is pointed at stars that, based on Kepler exoplanet discoveries, have the best chances of being home to an alien civilization.

<http://www.setilive.org>

**SETI LIVE** TALK TARGETS CLASSIFY ABOUT BLOG LOGIN / SIGNUP TELESCOPE INACTIVE

15 PEOPLE CLASSIFYING

2065766 TOTAL CLASSIFICATIONS

52224 TOTAL PEOPLE

37 CLASSIFICATIONS PER MINUTE

We're searching for interesting signals coming from the Kepler Field. Will we find life on another planet?

Start Searching

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