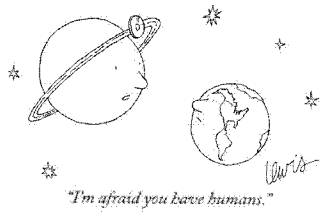


Life



Wednesday, December 2

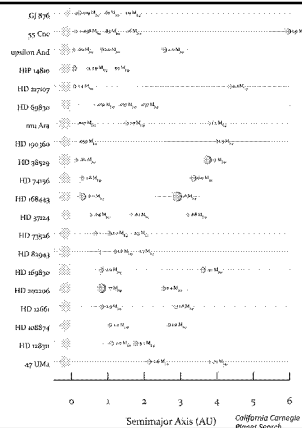
Please remember to fill out your SEI online.
Visit www.sei.osu.edu if you have questions.

Fri, Dec 4: Past, Present, & Future
Problem Set #8 returned (I hope).
Practice mini-exam handed out.

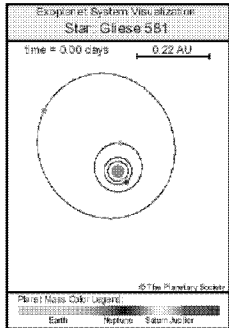
Tue, Dec 8, 9:30 am
Final Exam
Comprehensive
Same format as midterm

Over 400
exoplanets have
been discovered.

including multiple
planet systems →



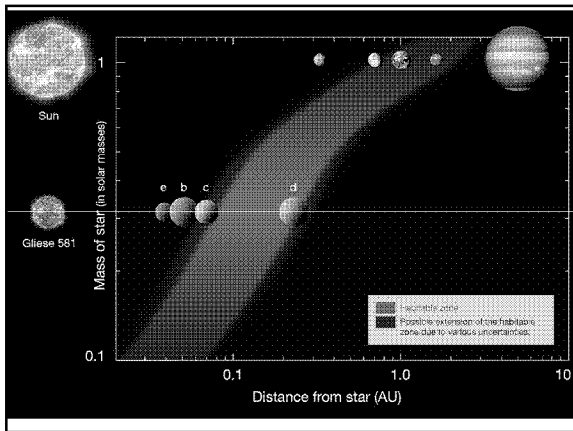
One interesting system: Gliese 581



Star:
dim 'red dwarf'

Inner planet:
 $a = 0.03 \text{ AU}$

Outer planet:
 $a = 0.22 \text{ AU}$



The outer planets are in the "habitable zone" or "Goldilocks zone".



Closer, it's too hot for liquid water.
Farther, it's too cold for liquid water.
Within the zone, it's "just right".

Why do we care about water (H₂O)?



It's an abundant molecule.

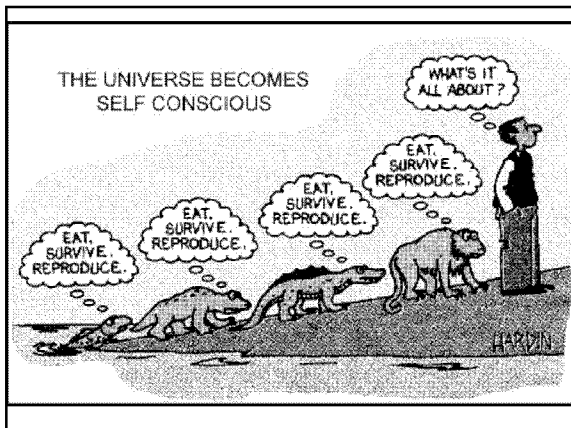
The most common atoms are: H, He, O.
Helium doesn't form molecules.
Molecules made with H & O: H₂, O₂, H₂O.

Why do we care about water (H₂O)?



Liquid water is required for life on Earth – including **your** life.

This brings us to the question:
"What is life?"





A being is alive if it eats, survives, and is produced by reproduction.

Eating (or metabolism): using energy to move or grow.

Survival: responding to surroundings in such a way that metabolism doesn't stop.

Reproduction: making children that resemble their parent(s).



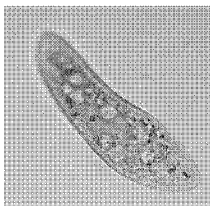
A living being is intelligent if:

It asks the question, "What's it all about?"

It uses tools to manipulate its surroundings.

It uses complex language to communicate with other intelligent beings.

Living beings on Earth are made of one or more cells.



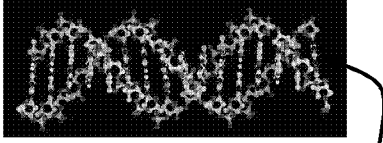
single-celled organism



ten-trillion-celled organism

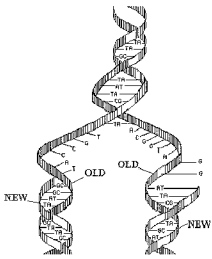
Cells contain polymers suspended in water.

A polymer is a long chain of smaller molecules hooked together.



Proteins, carbohydrates, fats, & DNA are polymers, made mostly of hydrogen, oxygen, carbon, & nitrogen.

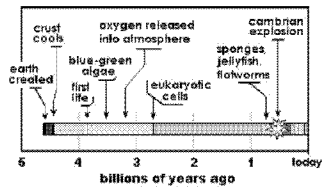
DNA polymers contain genetic information passed down from parents to children.



It's been said that a cell is just DNA's way of making more DNA...

Reproducing **information** is the key.

Here on Earth, DNA has been replicating itself for nearly 4 billion years.



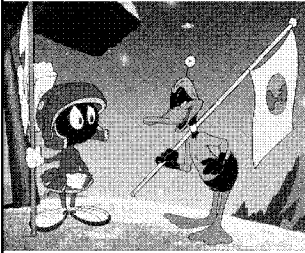
Life started shortly after the Earth's crust cooled enough for liquid water to exist.

Is Earth-like life (polymers in water) **common** on planets with liquid water, or **very rare**?



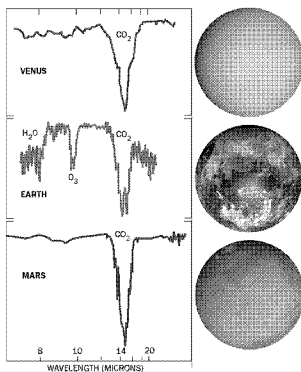
Just add water???

How can we find whether a planet in the "Goldilocks zone" harbors life?



Most forms of life are inconspicuous from a distance. (Sorry, Marvin!)

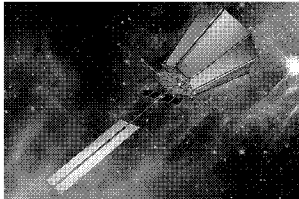
Spectra of planets:



Earth shows absorption lines of water & oxygen.

Earth shows the presence of water (essential for life-as-we-know-it) & oxygen (byproduct of life).

Exoplanets with similar spectra may have similar life.



NASA Terrestrial Planet Finder ("currently under study")

Intelligent life might be detected by the radio signals it sends out.



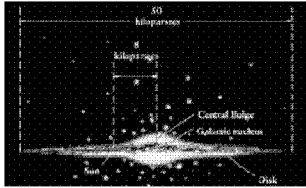
SETI (Search for ExtraTerrestrial Intelligence) hasn't found anything yet...

The Fermi Paradox:



Enrico Fermi (famous physicist) asked, "If intelligent aliens exist, where are they?"

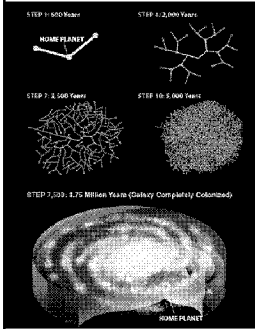
Why Fermi was puzzled:



Our galaxy is 160,000 light-years across.
Travelling at 30 km/sec, it would take
1.6 billion years to cross our galaxy.

This is less than the age of our galaxy.

Why hasn't an early-developing
civilization colonized the entire galaxy?



It's feasible with
technology a little more
advanced than ours.

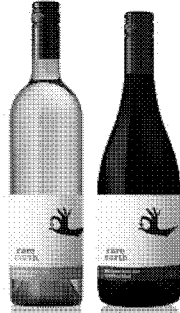
Just one civilization
could take over the
whole galaxy!

Possibility: Aliens have made Earth a
"wildlife refuge" where we can develop
without interference.



Possibility: We are the first intelligent beings to develop in the Galaxy.

Maybe life is rare.
Maybe intelligence is rare.



Possibility: Most intelligent aliens aren't interested in colonizing the Galaxy.





Friday's Lecture:



“Where do we come from?
What are we?
Where are we going?”
