

## Phys 122: Life in the Universe

Prof. Margaret Hanson

“The discovery of life of any kind beyond Earth would forever change our perspective of how we fit into the universe as a whole, and would undoubtedly teach us much more about life here on Earth as well.”

From *Life in the Universe*, Bennett & Shostak

PLEASE SIT IN THE FIRST 12  
ROWS of the CLASSROOM ONLY

Why did you take *this* science class?



How many of you are curious about aliens?

We live in a unique time when we have the ability to discuss this topic in a *scientific context* for the first time.

In the next 50-100 years, we may very well know **The Answer**.

SIT IN THE FIRST 12 ROWS of the CLASSROOM ONLY

## Objectives of this course

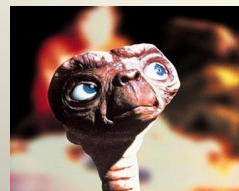
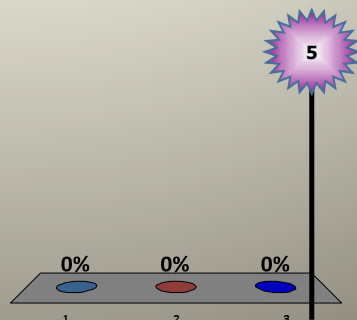
- Review relevant aspects of astronomy, geology, biology and chemistry to develop a **sound investigation** of life here and elsewhere in the universe.
- **Apply principles** of the scientific method, the nature of evidence and critical thinking to evaluate the possibility of, and current searches for, life on other worlds.

Class info is posted on BlackBoard & Syllabus link. NOTE: Exams(90%), quizzes (5%), in-class work (5%)

**NO MAKEUP: exams, quizzes, or class work!**

I registered my PRS transmitter on blackboard, brought it to class, turned it on, and set it to channel 80 (Ch, 80, Ch)

1. Yes, I'm certain of it
2. Not sure, but we'll soon find out
3. What's a PRS?



What do you believe about life beyond Earth (ET)?

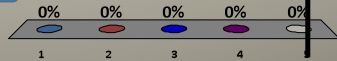
Everyone with a registered clicker, raise their hand. Those with clickers spread out just a bit. Everyone else: join a group where one person has a clicker with them today (keep groups even sized). Discuss then answer the following four questions as a group

Some form of life, perhaps single-celled, has or does exist elsewhere in our Galaxy.

1. Strongly Agree
2. Agree
3. Neutral
4. Disagree
5. Strongly Disagree



Mean =

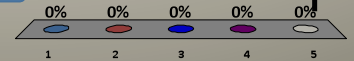


Intelligent life (like a dog or dolphin) exists elsewhere in our Galaxy

1. Strongly Agree
2. Agree
3. Neutral
4. Disagree
5. Strongly Disagree



Mean =

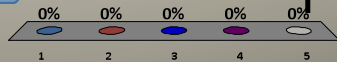


Extraterrestrial (ET), intelligent life knows about us on Earth.

1. Strongly Agree
2. Agree
3. Neutral
4. Disagree
5. Strongly Disagree



Mean =

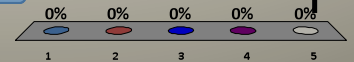


ET interacts with us and has directly affected humans at some time.

1. Strongly Agree
2. Agree
3. Neutral
4. Disagree
5. Strongly Disagree



Mean =

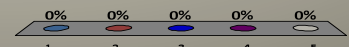


## Class Format

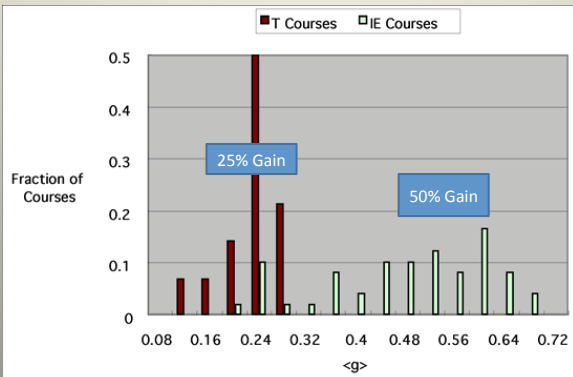
- Centered on **active learning** not passive
- What are passive activities?
  - Listening to lectures, esp. powerpoint slides filled with words
  - Taking notes
  - Reading the textbook and notes
- Research shows these activities are *ineffective* and *inefficient* for student learning

In a lecture class with an interesting, clear, engaging teacher, what fraction of material presented does a student typically recall?

1. 90%
2. 70%
3. 50%
4. 25%
5. 15%

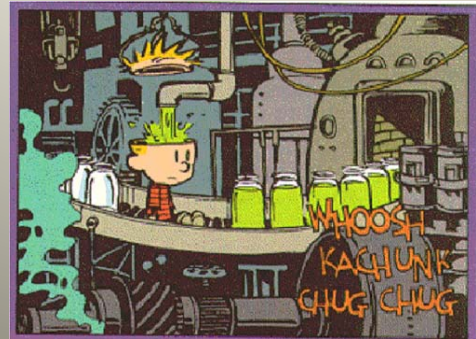


## Fractional gain in knowledge



red = traditional green = interactive engagement

What can students do to learn the overwhelming number of facts and concepts in a typical science course?

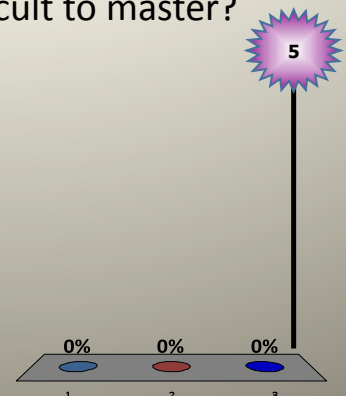


## Class Format

- Students read material before class, guided by study questions, then take the on-line, pre-class quiz.
- In class students will have the opportunity to master the learning objectives, working with other students and the professor as resources.
- Students will have their mastery tested throughout the time in class with PRS.
- **A key to learning is making connections between old and new material and actively engaging your brain.**

## Which of today's Learning Objectives seem most difficult to master?

1. Describe benefits of studying life on Earth before searching elsewhere?
2. Provide 3 pieces of evidence from Biology, Astronomy & Geology suggesting life may exist elsewhere
3. Compare/Contrast the goals and methods of SETI with astrobiology.



## First, we will learn about life on Earth

In your group, discuss and answer these questions:

1. What *is* life? What are its characteristics?
2. Would we know ET if we found it?
3. How does understanding life on Earth help us in a search for life elsewhere?

## Why would we expect ET Life?

In fact, evidence from several branches, together, support the notion that ET life *MIGHT* exist.

To investigate this question, we will consider: Biology, Astronomy, Chemistry, and Geology/Planetary Science in this course

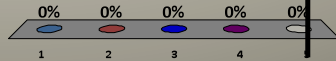
Nothing thus far found in any respected branch of science indicates it can NOT exist.

*“Absence of evidence is not evidence of absence”.*

Carl Sagan

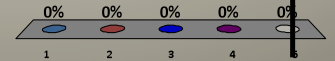
## What does astronomy tell us regarding searches for ET?

1. We need to travel in space to search
2. The physical laws are the same everywhere
3. The universe is geocentric
4. Life exists elsewhere
5. 1 & 4 are correct



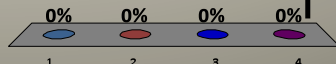
## What has geology-planetary science told us with regards to ET life?

1. Life requires plate tectonics
2. We live in a Geocentric universe
3. Exoplanets exist
4. How planets form and evolve
5. 3 & 4 are correct



## What tells us that biology might be universal (exist elsewhere)?

1. Photosynthesis is abundant
2. Building blocks of life are naturally found universally
3. Life is seen to emerge everywhere
4. Life is seen to re-emerge on Earth.



## Where might life exist in our Solar System?

- Mercury?  
Thumps up



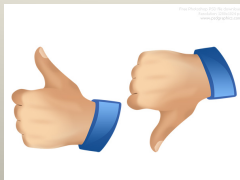
or Thumps down?



Seems unlikely

## Where might life exist in our Solar System?

- Venus?



Seems unlikely

## Where might life exist in our Solar System?

- Mars?



3.5 Billion years ago, the Earth and Mars were nearly identical in properties. This is the time when life formed on Earth.

## Where might life exist in our Solar System?

- Jupiter?



Probably not on Jupiter, but the moon, Europa, looks to be very promising to host life presently.

Below its icy surface it is thought to harbor an large ocean of liquid water.

## Where might life exist in our Solar System?

- Saturn?



The moon, Titan, is often studied as a prototypical 'Early Earth', because of all the hydrocarbons and organics.

But its really, really, really cold (not likely to host life).

## Astrobiology

Astrobiology is a newly recognized science which merges other traditional fields of astronomy, chemistry and biology.

Its efforts concentrate on:

1. Study the conditions supporting the origin and existence of life.
2. Searching for these conditions beyond Earth.
3. Searching for evidence of life elsewhere

## The Search for ExtraTerrestrial Intelligence (SETI)

SETI is a collective name for activities to identify signals from intelligent life. This requires ET to create detectable, artificial signals.

Its efforts concentrate on:

1. Selecting frequency and direction of electromagnetic radiation to do a search.
2. Building telescopes and powerful algorithms to sort out an ETI signal from cosmic noise.

## Who pays for this research?

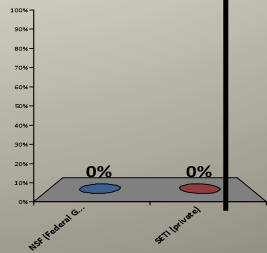
- NASA and the National Science Foundation (Federal Government) funds research in astrobiology.
- The SETI Institute, which is privately funded, supports and funds equipment and searches for ET intelligence.  
(NASA did support ETI searches until 1994)

## You need funds for your project. Where will you send your proposal?

In your group, look over each of the proposal descriptions and decide which funding agency, NSF or SETI are more likely to provide you with the money to do your project. Then vote with the PRS on the agency you will submit your proposal to.

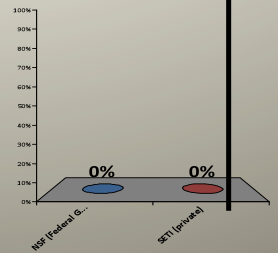
You wish to build a new spectrometer to study light from nearby stars and determine if it has planets orbiting it. Where would you ask for money?

1. NSF (Federal Gov't)
2. SETI (private)



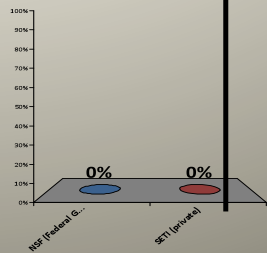
You wish to build a new spectrometer which can study the light from nearby stars and determine if its planets have any oxygen in their atmosphere.

1. NSF (Federal Gov't)
2. SETI (private)



You wish to build a radio telescope to point at nearby stars, to search for unnatural radio pulses

1. NSF (Federal Gov't)
2. SETI (private)

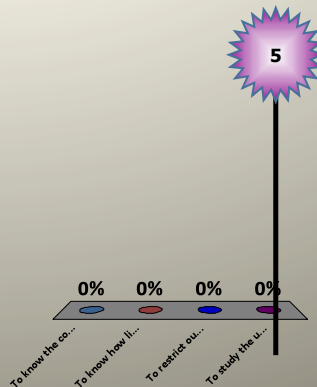


Let's check your understanding of today's learning objectives..

Please work alone in answering these questions.

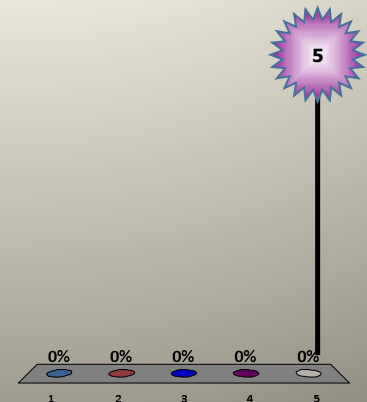
1. Why study Earth life before searching for ET life?

1. To know the conditions where life has formed
2. To know how life forms everywhere
3. To restrict our searches to Earth-like life
4. To study the uniqueness of Earth life



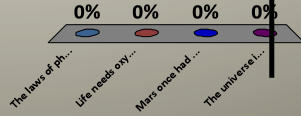
2. What is **not** a required characteristic for life?

1. Reproduction
2. Metabolism
3. Evolves
4. Movement
5. Genetic material



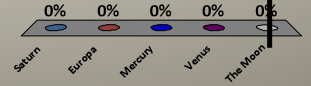
### 3. Astronomy tells us that

1. The laws of physics are universal
2. Life needs oxygen
3. Mars once had life
4. The universe is young.



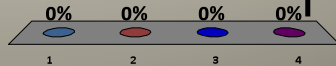
### 4. Where might life exist NOW in our Solar system?

1. Saturn
2. Europa
3. Mercury
4. Venus
5. The Moon



### 5. The goal of SETI is

1. To detect exoplanets
2. Space travel
3. Discover oxygen in a planet's atmosphere
4. Find evidence of intelligent ET life



### To do list for Thursday's class

- Read and understand how to use the syllabus
- Read assigned pages in the textbook while answering study questions and objectives.
- Take the on-line quiz through the classes BlackBoard site (by 6:30am class day)
- Register and bring PRS transmitter to class