

Astronomy 330: Extraterrestrial Life

TR 11:00-12:20
Astronomy 134



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Office Hours:
by appointment or email

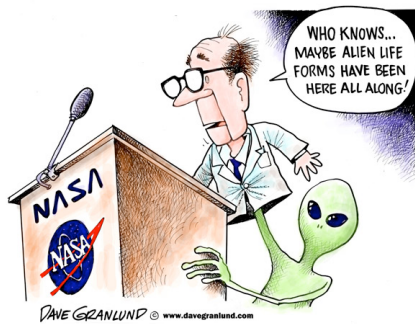
This class (Lecture 1):
Search for ET Life
Next Class:
Introductory Astronomy

<http://eeyore.astro.illinois.edu/classes/astro330h/spring15/>

<https://learn.illinois.edu/course/view.php?id=10593>

Music: *Pets* – Porno for Pyros

ASTR 330: Extraterrestrial Life



Are we alone?



The Hubble Deep Field— This sums up the course in a way. Almost all of these are galaxies.

Are we alone?



- a) No, the Universe is teeming with Life!
- b) No, there is life in the Universe, but it is rare.
- c) Yes, there is no evidence of life elsewhere.
- d) We do not know, but it seem unlikely.
- e) We do not know, but it seems reasonable.

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UFO #1



Slow moving aircraft



UFO #2



aircraft flying in formation



UFO #3



high flying aircraft



We are inundated with the idea of aliens....

Are we alone?



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Aliens?



We have been bombarded by aliens in the media– all types.

No surprise that **close to half** of all Americans believe in aliens.

What do you think? Why?



Are we alone?

What do you think? Why?

Are we alone?



How can we address this question in a scientific manner?

Drake Equation

Frank Drake

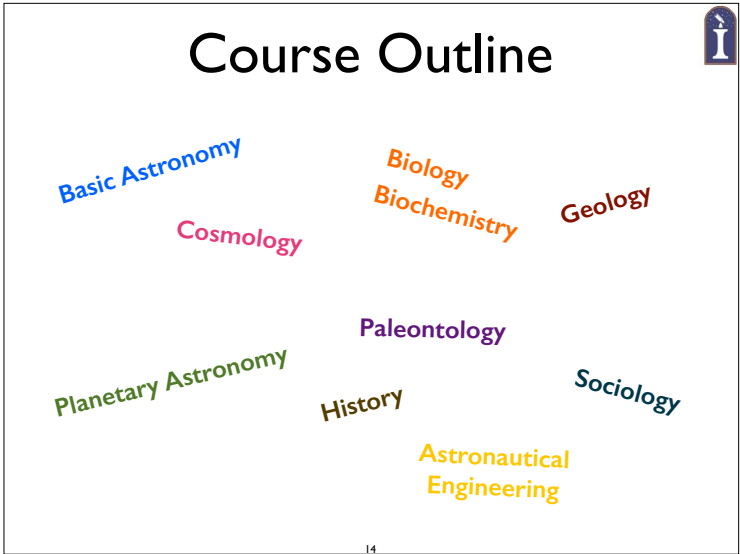


$$N = R_* \times f_p \times n_e \times f_l \times f_i \times f_c \times L$$

# of advanced civilizations we can contact in our Galaxy today	Star formation rate	Fraction of stars with planets	# of Earthlike planets per system	Fraction on which life arises	Fraction that evolve intelligence	Fraction that communicate	Lifetime of advanced civilizations
stars/yr	systems/star	planets/system	life/planet	intel./life	comm./intel.	yrs/comm.	



The Hubble Deep Field— This sums up the course in a way. Almost all of these are galaxies.



Class Websites

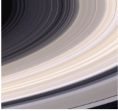


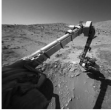
Astro330 CH --- Spring 2015 --- Main Page
ceyore.astro.illinois.edu/classes/astro330h/spring15/

ASTRONOMY
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Astronomy 330 :
Extraterrestrial Life
(Campus Honors)
Spring 2015
TR 11:00-12:20
134 Astronomy Building

Announcements:
Welcome to ET Life!

 Instructor [Syllabus](#)
[Schedule](#) [Lectures](#)
[Exams](#) [Grades](#)
[Homeworks](#) [Links](#)



Leahie Longley
Last modified: Tuesday, 13-Jan-2015 09:38:30 CST

All lectures are posted here

Syllabus



Syllabus is on the website, but basically

Requirement	Percentage of Grade
Class Participation (will drop some)	20%
Presentation Synopsis	5%
Homework Assignments	20%
Presentation	15%
Articles	15%
Final	25%
Total	100%

Class Participation



Attend and participate in lectures

Peer Assessment

Presentations

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You should attend lectures and discussions. We will have random opportunities for your feedback, in the form of asking questions, "voting" on the possible outcomes of observations or demonstrations, or brainstorming answers to open-ended questions. To reward your participation in these activities, you will often be asked to turn in your response (worth 10% of your grade!). Although the number of these are not set, often they come upon me on a whim, we probably have these for every class, so some of these will be dropped.

Class Presentation



Your Presentation

- Peer Graded
- 10 minutes

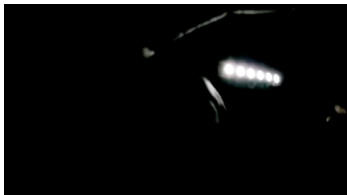
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Presentation Examples

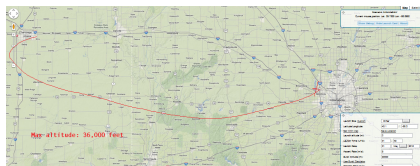


- Astronomical Pareidolia
- NASA & Sustainability
- Panspermia
- Communicating with Aliens
- Ancient Aliens
- Alien Life (Alternative Chemistry)
- Great SETI debate
- Space Colonization
- Aliens in Popular Culture

Presentation Example



UFOs at the UofI
by Spencer Gore &
Novarah Kazmi



Class Articles



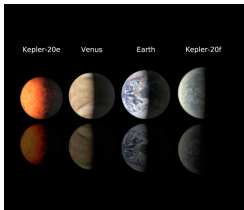
<http://EzineArticles.com/>
"I should've been more clear when I said to cut up your larger article into smaller, stand-alone articles."

- 2 Individual Articles
 - One science
 - One pseudoscience
- 750 Words, Submit PDF

ASTR330: Why Now?



It's a great time to take this course!



It's a great time to take this course! In 1995, we knew of 9 planets around 1 sun. Now, Jan. 2014, we know of over 1500 planets around numerous suns and the first Earth-sized exoplanets! In the near future, NASA missions may find life on Titan or Europa, evidence of life of Mars, or image Earth-like planets around nearby stars. In this course, you will get an understanding of arguably the biggest astronomical question of all time: **Are we alone?**

Mars or Earth?



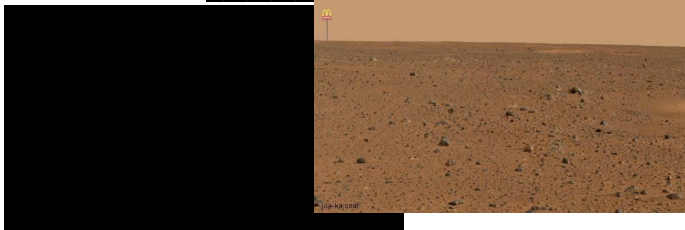
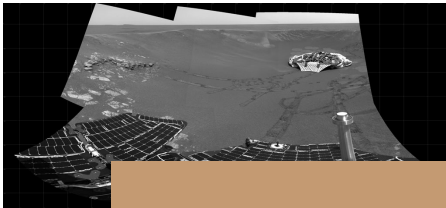
- a) A is Earth and B is Mars
- b) A is Mars and B is Earth.
- c) They are both Mars.

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Mars on right, Earth (Atacama desert) left.

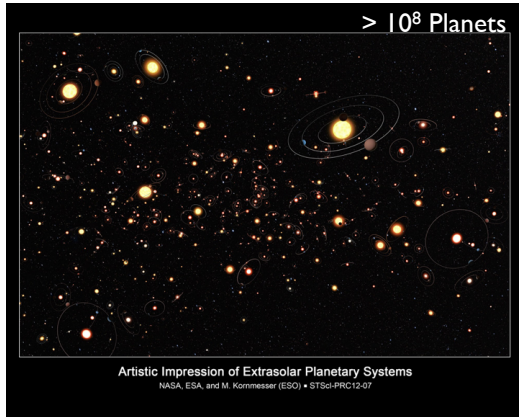
Roving on Mars:



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<http://mars.jpl.nasa.gov/msl/multimedia/videos/>
The team responsible for the Sample Analysis at Mars (SAM) instrument suite on NASA's Curiosity rover has made the first definitive detection of organic molecules at Mars. Organic molecules are the building blocks of all known forms of terrestrial life, and consist of a wide variety of molecules made primarily of carbon, hydrogen, and oxygen atoms. However, organic molecules can also be made by chemical reactions that don't involve life, and there is not enough evidence to tell if the matter found by the team came from ancient Martian life or from a non-biological process. Examples of non-biological sources include chemical reactions in water at ancient Martian hot springs or delivery of organic material to Mars by interplanetary dust or fragments of asteroids and comets.

Exoplanets

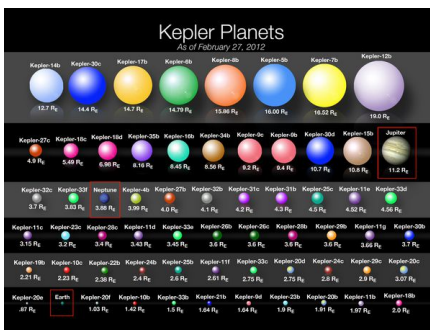


A new golden age of planet discovery! You are a new generation of humans with new knowledge that was not knowable a few decades ago.

This artist's illustration gives an impression of how common planets are around the stars in the Milky Way. The planets, their orbits, and their host stars are all vastly magnified compared to their real separations. A six-year search that surveyed millions of stars using the microlensing technique concluded that planets around stars are the rule rather than the exception. The average number of planets per star is greater than one. Image Type: Artwork

Credit: [NASA](#), [ESA](#), and M. Kornmesser (ESO)

Kepler: Earth-Like Planets



Kepler Field of View

The Kepler mission will be looking continuously at over 100,000 stars in one region of the sky, in the Cygnus and Lyra constellations. The field of view is extremely large for an astronomical telescope. Most telescopes such as Hubble Space Telescope only view a small region at one time, about the size of a grain of sand held at arms length. Kepler covers a much larger field, about an hand at arm's length or 2 dips from the Big Dipper. The field of view is overhead at midnight in the middle of summer for those in the mid-Northern latitudes, and earlier in the evening in late summer and fall.

Credit: NASA Kepler Mission/Dana Berry

Kepler: Earth-Like Planets



Now over 1000 Kepler identified planets!
Some are very interesting... Earth-like



NASA Kepler's Hall of Fame: Of the more than 1,000 verified planets found by NASA's Kepler Space Telescope, eight are less than twice Earth-size and in their stars' habitable zone. All eight orbit stars cooler and smaller than our sun. The search continues for Earth-size habitable zone worlds around sun-like stars.

Two of the newly validated planets, Kepler-438b and Kepler-442b, are less than 1.5 times the diameter of Earth. Kepler-438b, 475 light-years away, is 12 percent bigger than Earth and orbits its star once every 35.2 days. Kepler-442b, 1,100 light-years away, is 33 percent bigger than Earth and orbits its star once every 112 days.

The Universe: Some Facts to Help you Live in it



Tell someone that there are 100 billion stars in our Galaxy and they will believe you. Tell someone a bench has wet paint and they will have to touch it.

Astro 330: Sex in Space?



Course Prerequisites:

- 1) Open Mind!
- 2) Curiosity



We will approach this topic as scientists by employing common sense and logic.

We will confront the origin of life questions as scientists, but we will not condemn anyone's *beliefs*.

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Don't be scared of science. It is really just common sense and logic. Although not all scientist have those in any larger amounts than non-scientists.

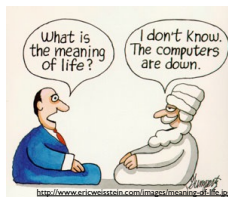
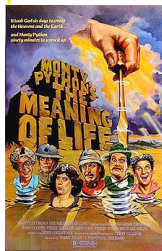
What is Life?



THE MEANING OF LIFE

WHAT IS THE MEANING OF LIFE? WHATEVER YOU WANT IT TO BE.

Sunlight + Geochemistry?



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This examination may bring us to some very depressing conclusions: What is life? Just sunlight plus geochemistry? If we decide that intelligent life is common in the Universe, how will that make us feel?

Experiment



If intelligent life is common in the Universe, how does that make you feel?

- a) I feel fine.
- b) I feel puny and insignificant.
- c) After class, I will bow down to my alien overlords.
- d) Ready to load up on ammo and head for the hills.

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Class Facts



~5 Billion years old
Early history erased

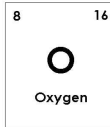
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We have no evidence of ET life. We don't know how life on our planet started. Earth's early geologic record (first 1/2 billion years) is GONE—erased by weather, geology. Clues to early life formation are gone. All we know is that life started quite fast on Earth.

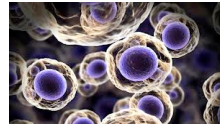
Class Facts



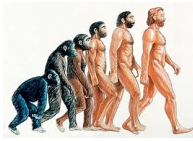
Microbial Life:
(3.5-4 Billion years ago)



(~2 Billion years ago)



Multi-celled Life:
(~1 Billion years ago)



(~ 5 Million years ago)

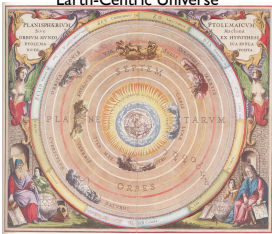
Faith \neq Science

But, we do have evidence for very early microbial life on Earth (about 3.5–4 billion yrs old). Oxygen atmosphere 2 billion years ago! First multi-celled life only 1 billion years ago. Humans are NEW on Earth (about 5 Myrs ago). Keep in mind that faith is not science. Faith is fine, but we have to keep in mind that in this class, "I just KNOW it!" is not an acceptable answer. We are investigating big questions scientifically.

Former Scientific Beliefs



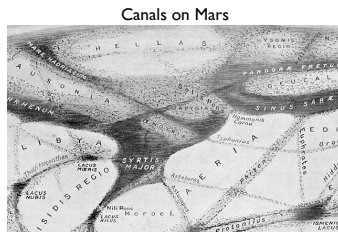
Earth-Centric Universe



Learn from past!



Eddington



Be Careful of Science though. Sometimes people make big claims in the name of science. Percival Lowell (~1913) thought he saw canals on Mars (optical illusion). Eddington (~1940) tried to make the fine structure constant ($\alpha=1/137.036$) a rational number. We need to learn from these mistakes.

Scientific Speculation



Meteorites are nonsense!



Ptolemaic Universe



Pope apologizes 350 years later

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But also learn to speculate. The French Academy of Sciences once pronounced that meteorites were nonsense. EVIDENCE and REASON can produce just as many thrills as dogmatic faith-based belief. The professors of Astronomy in the early 1600s were teaching a geocentric solar system. The Catholic church only forgave Galileo about his heliocentric solar system ideas in 1992!

Life on Earth



A miracle?

An accident?

Inevitable given laws of nature?

Principle of
Mediocrity



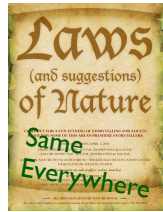
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There's nothing terribly special about the astronomical, geological, physical and chemical circumstances on Earth; most likely nothing special about biology either

Major Premise of Course



Homogenous
& Isotropic



Life Life Life Life

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The Universe is homogenous and isotropic. The laws of nature are the same everywhere. So we can apply the lessons learned from life on Earth to extrapolate about life in space. Life probably should have repeated elsewhere, given the same circumstances. The Universe is freaky big!

Course Goals



Are we alone?

- Understand the Scientific View of Life
- Conceptualize the Concepts Behind this Question
- Extrapolate to the Future of this Field
- Make Informed Policy Decisions
- Scientific Approach to any *Discovery* of ET Life

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After completing this course

Have we been visited by ETs?



*Extraordinary Claims
Require
Extraordinary Evidence!*

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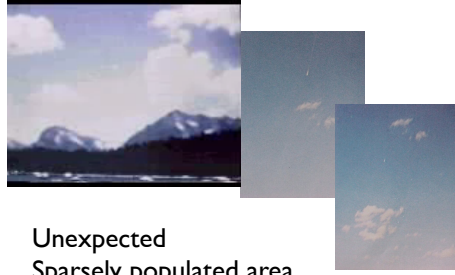
An Example: Meteor 1972



<http://www.uwgb.edu/dutchs/>

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Near Earth Grazer



Unexpected
Sparsely populated area
~100 seconds total duration
~30 seconds visibility

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15 km/s at 58 km. Bus sized.

Experiment



Before answering, take a picture of the classroom with your phone or any other camera you may have available right now.

- I took a picture.
- I could have taken a picture but did not have a suitable device
- Why are we taking a picture?

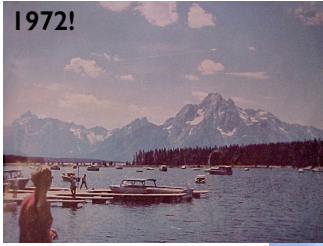
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So where is the Beef?



1972!



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Nonetheless, we have dozens of clear photographs of the Utah event. Still, we have no comparable images of UFOs.

And today digital cameras and camera phones are ubiquitous— which should make unusual events even more seen.

Perhaps we shouldn't look for Aliens?



TV analog signals



Several intentional signals

Earth is brighter than the Sun in radio

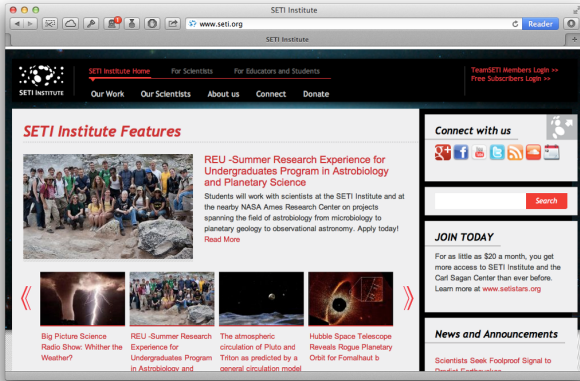
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65 years or so of broadcasts.. see Stephen Hawking's documentary...

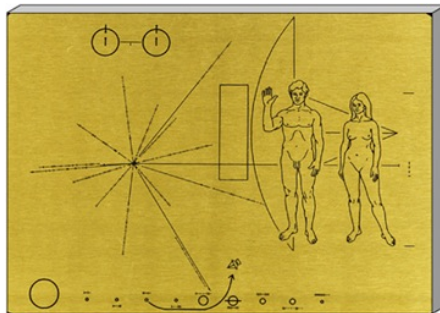
SETI: Listening for ET



Radio good for communications
18-21 cm
SETI Search: Passive or Active



Voyager: Message is out.



<http://voyager.jpl.nasa.gov/spacecraft/sceneearth.html>

Voyager: Message is out.



Next Time

Basic Astronomy

Our Eight Planets