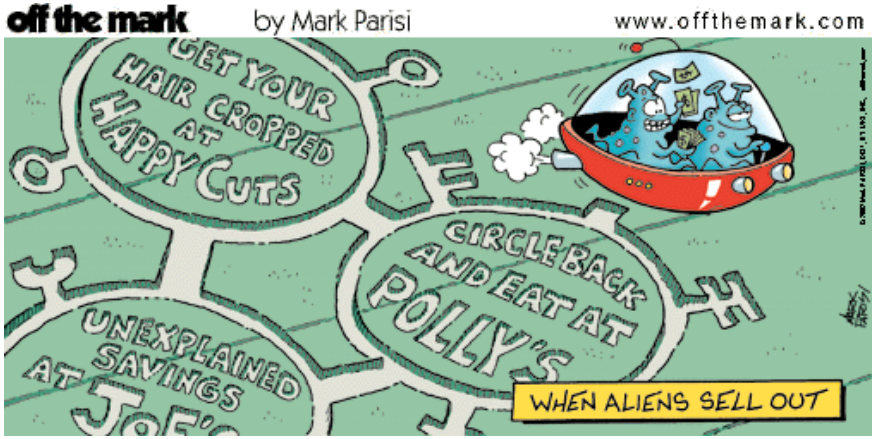
Astronomy 230



Music: Space Oddity – David Bowie

Last Class!:
Review, ICES, and UFOs

Outline

- Review
- What conclusions can we draw from this class?
- What are UFOs?
- Pseudoscience.
- No evidence!
- Final words.

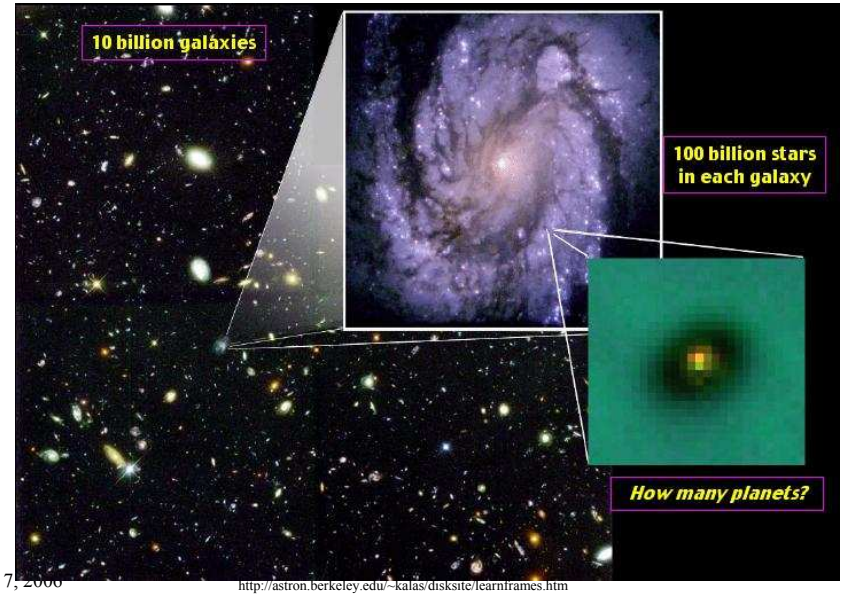
Final

- December 11th @1:30-4:20pm in this classroom
- Designed to be a 2-ish hour exam, but allowed 3 hours.
- Will consist of 40 multiple choice/ true-false questions (2 points each), 5 small essay questions (10 points each), and 2 large essay question (40 points each).
- A total of 210 points graded out of 200 points.
- A normal-sized sheet of paper with notes on both sides is allowed.
- Multiple-choice is heavily weighted toward the last half of the course.
- Bring a calculator for easy math.

Review of Life

Not inclusive study material.

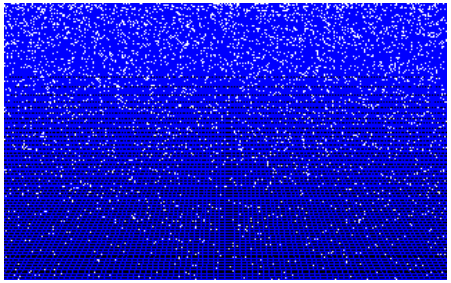
The Universe: Some Facts to Help you Live in it



http://astron.berkeley.edu/~kalas/disksite/learnframes.htm

Big Bang

- Big Bang!
  - 13.7 billion years ago.
- Creation of primarily hydrogen & helium via BBN at t=3 seconds.
- Don't forget dark matter and dark energy.
- Still expanding and cooling
  - The rate of expansion is known
- It is BIG
  - As far as we are concerned, it is infinite in any direction
- Our place in the Universe is not special
  - Extension of the Copernican revolution
- The center of the Universe is everywhere or nowhere!



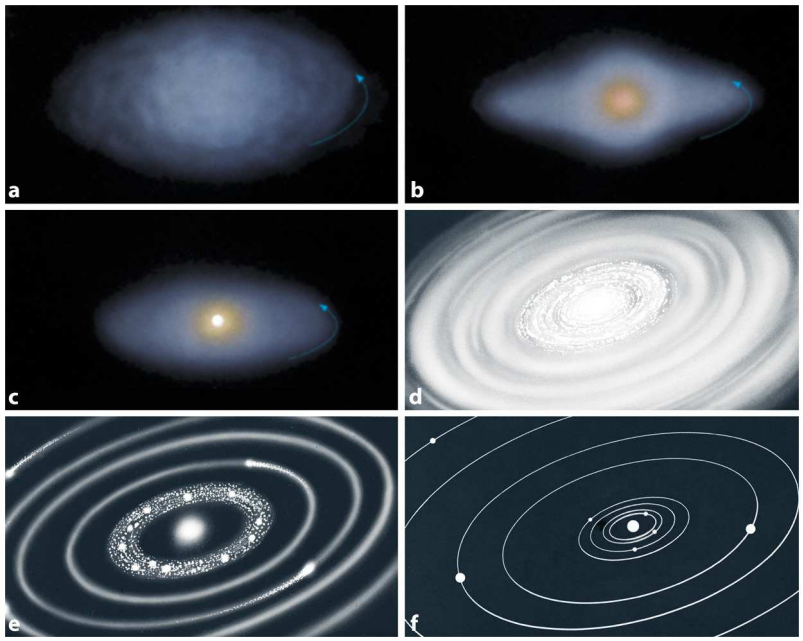
First and Second Stars

- Besides H into He, the first stars also create carbon and oxygen.
- As they age to the red giant phase, they produce sulfur, phosphorous, silicon, and finally iron.
- The star explodes and scatters the elements into the galaxy.
- The second stars form in the ashes of the first, forming most of the Universe's Nitrogen through the CNO cycle, then explode.
- Molecular clouds form from these elements.
- We are made from star stuff!

Galaxies

- Galaxies formed from the seeds of dark matter, the first stars.
- Remember that you have to have mucho heat and pressure to overcome the nuclear strong force.
- Hydrostatic equilibrium (gravity pressure pushes in – heat pressure pushes out).
- There are perhaps tens to hundreds of billions of galaxies
  - Each with hundreds of billions of stars

Formation of the Solar System 4.6 billion years ago



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Planet Formation in the Disk

Heavy elements clump

1. *Dust grains* collide, stick, and form planetesimals. All orbit in the same direction and in the same plane.
2. Gravity Effects: Big planetesimals attract the smaller planetesimals. Collisions build-up inner planets and outer planet cores.
3. Collisions can also account for odd motions of Venus (backwards), Uranus (rotates on its side), and Pluto (high inclination of orbit). Period of high collision in the system.

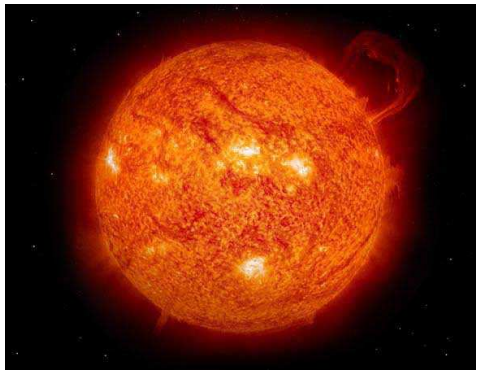
n_e

Proto-Earth

- The hot proto-Earth heated up the ices on dust grains– mostly water, carbon dioxide, and nitrogen– the Earth's first atmosphere.
- The water condensed to form oceans and much of the CO_2 was dissolved in the oceans, unlike Venus and Mars.
- No oxygen, no ozone layer.
- UV light, lightning, radioactivity, and geothermal heat, provided energy for chemical reactions.
- Perfect place for carbon chemistry.

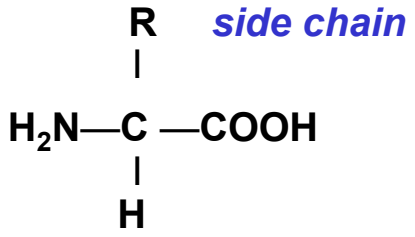
Our Sun

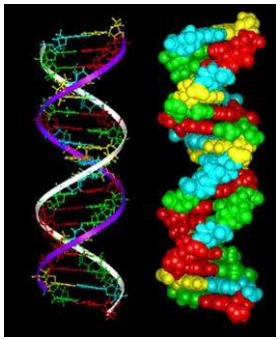
- Is a fairly typical star
  - Has lived for 5 billion years
  - Will probably live another 5 billion
  - But life on Earth will get hot in about a 1 million years.
- Properties of *Good* Suns?



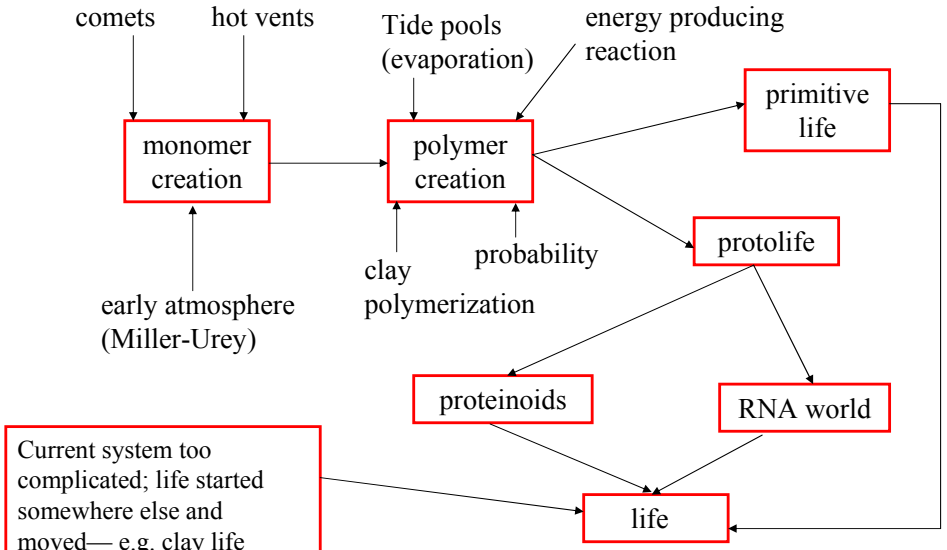
Life on Earth

- Most important components are
  - Proteins/enzymes
    - Polymers made of amino acids strung together.
  - Nucleic Acids (DNA or RNA)
    - Polymers made of sugars (deoxyribose or ribose), a phosphate, and nitrogenous bases.
- In life on Earth, they are so closely linked that it is hard to figure out which came first.
- We do know that life began about 3.8 billion years ago, soon after the large bombardment.



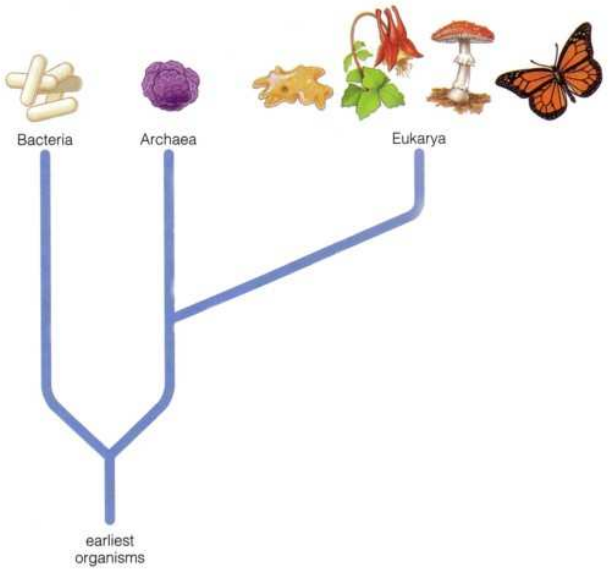


Pathways on Earth



First Life

- Oldest fossils are from around 3.8 Byrs ago
- Before 1.5-2 Byrs ago, only prokaryotes fossils.
- All macroscopic life only arose in the last 600 Myrs– 1/6th of the history of life on Earth.



Making Oxygen: First Air Pollution

- Cyanobacteria changed the world!
- From 3.5 to 1.8 Byrs ago.
- Then the first Eukaryote appears.
- A new energy extraction method is available
  - Aerobic (using oxygen) metabolism
  - More complex life.
  - Created ozone layer (dry land now an option).

Chain of Life

- 1 Byrs ago: first multi-celled organisms.
- 500 Myrs ago: First boned creature– first fish.
- 400 Myrs ago: First amphibians.
- 300 Myrs ago: Many animals.
- 200 Myrs ago: Dinosaurs.
- 100 Myrs ago: Birds, mammals, flowering plants.
- 65 Myrs ago: Mass extinction– new chance for mammals.
- 5 Myrs ago: First humanoids.
- 5 Months ago: Beginning of Astro230

Development of Civilization

- About 10,000 yrs ago, development of agriculture was crucial.
- Allowed larger communities for cultural evolution, information, tools, and energy sources.
- Only so much storage in DNA and brain, need extrasomatic storage– language, writing, etc.
- Currently in silicon age.
- Advanced civilizations need more types of energy to help solve problems that arise from civilization.

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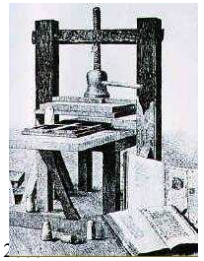
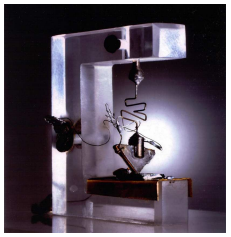
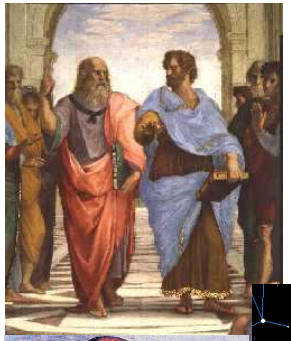
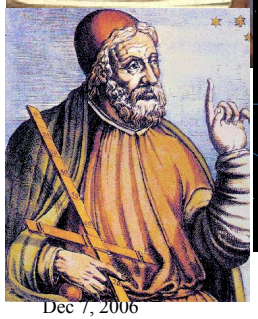
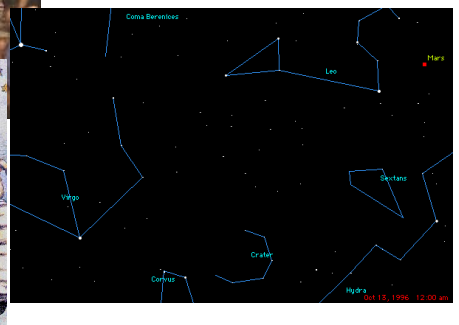


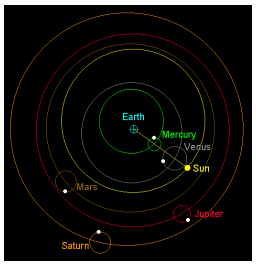


Worldview



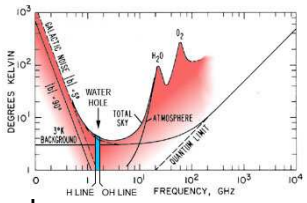


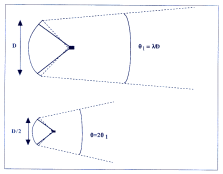


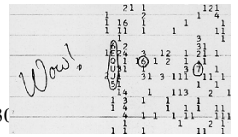


Galactically Aware

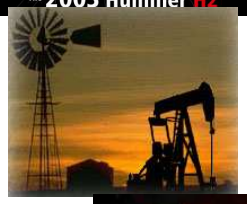
- Evolution of our world view.
- Realization that extraterrestrial life is possible.
- The urge and technology to communicate.
- SETI problems
  - The cosmic haystack
- To date, no proof of extraterrestrial intelligence.
- Hopeful, but skeptical with an open mind.



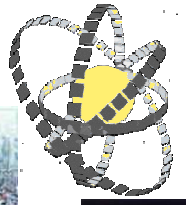




Lifetime



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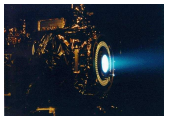
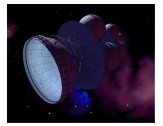
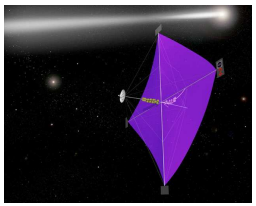
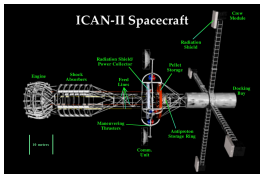
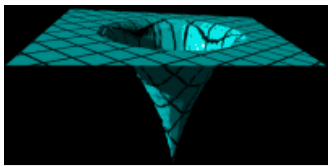
Rocket Man



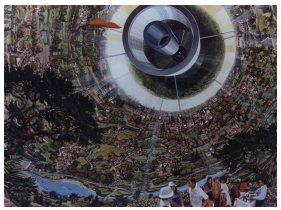

- Chemical rockets okay for local flights, but not for interstellar travel.
- Other options:
  - Ion drives
  - Fission
  - Fusion
  - Antimatter
- Maybe still not good enough for interstellar travel, maybe need
  - Solar sails
  - Other.

The Fermi Paradox

- Our Drake equation result is high, suggesting that ETI is common.
- Then, "Where are they?"
- **No** evidence of visitation.
- Problems?
  - Them
  - Us?
- Mindsets?
- "Extraordinary Claims Require Extraordinary Evidence"
- Let's keep thinking about it!
- The truth is out there.




Review

- What are the five biological attributes of life, and what do they mean?
- What is the Drake Equation, and what do the terms mean?
- What is the origin and use of the four main biological elements H, O, N, and C? Why are they important to life?
- What is Big Bang nucleosynthesis?
- How does fusion happen? What is the nuclear strong force?
- Describe the Early Universe. Why do we believe in the Big Bang?
- What do we think will happen to the Universe? Explain the role of Dark Energy.

Review

- What are the properties of a first generation star? What do they make?
- What are the properties of a second generation star? What do they make?
- Describe the techniques that astronomers use to search for planets around stars? What are the limitations?
- Describe the processes for forming a star and its planets.
- What determines if a planet is in the Habitable Zone?
- What will happen to our Sun? What timescales may affect our civilization lifetime?
- What does "left-handed" life mean?
- What are monomers and polymers? Examples?
- Discuss DNA and RNA. How do they function to assemble proteins that carry the genetic code?

Review Questions

- What is a protein? What's it made of?
- What is a nucleic acid? What's it made of?
- What are possible scenarios for synthesis of monomers and polymers?
- What was the Miller-Urey experiment and why is it thought to be important for life? Include the role of a reducing atmosphere in your discussion.
- Two theories exist to explain the transition of polymers to life. Discuss one of these theories.
- Discuss the various ideas for transition to life from the important polymers– primitive cells and protolife (protein protocells and RNA world).
- Besides chemical processes, life could arguably use the nuclear strong force, the electromagnetic force, or gravitational force. Describe a life form based on one of these mechanisms for non-chemical life.

Review Questions

- Describe a possible life form on Venus, Mars, Jupiter, Europa, or Titan.
- Compare and contrast Eukaryotes and Prokaryotes.
- Discuss some properties of an Archea.
- What is the best way to pass on mutations to the next generation?
- How can the age of a fossil be determined by radiocarbon dating (Carbon-14). Does radiocarbon dating have any limitations? Why is this important to the study of life?
- How did ancient life on Earth change Earth?
- Discuss extrasomatic information storage and why it is necessary for advanced civilizations.
- Why did the rise of mammals occur?
- Describe the evolution leading to H. sapiens from the hominid ancestor 5 Myrs ago.

Review Questions

- Discuss the cultural evolution of humans. What was the pivotal development?
- Describe the evolution of our worldview.
- List and discuss three of the factors that could end a technological civilization.
- How can we communicate with ET's? List some of the considerations for long wavelength communication.
- What is SETI? How is it currently funded?
- What was the "Wow" signal and was it important?
- Why is SETI difficult? What are the "Cosmic haystack" of parameters that SETI must search?
- What are unintentional leakage signals.

Review Questions

- Compare and contrast a large and small radio telescope for use in SETI.
- Discuss a few of the SETI projects.
- List a few techniques for terraforming Mars.
- What are the implications of the special theory of relativity to space travel?
- How does a rocket work? What are some of the propulsion systems (i.e. chemical)?
- Define the 4 main quantities to describe rocket science.
- Which fuels provide the best specific impulse?
- Project Orion was the first serious study of interstellar flight. How was it supposed to work?

Review Questions

- Why was Project Daedalus important?
- Discuss 2 of the 8 options for propulsion systems.
- What are the biggest problems for interstellar flight?
- How can we colonize the galaxy? Discuss long-haul spacecraft.
- Based on the class Drake Equation results, what are the class conclusions about life in our Galaxy?
- What is the Fermi paradox?

Review Questions

- Discuss the two statements:
  - The Earth has been visited by ETs.
  - The Earth has not been visited by ETs
- Define a UFO.
- Discuss why the class says there is no evidence of extraterrestrial visitation.
- What "proof" do "UFO researchers" provide?
- Explain Occam's razor.
- Discuss the Condon report's implications.

ICES Requested Topics

A. What did you like/dislike about my class? Be specific.
B. Is there a subject that should be discussed more/less in class?
C. Can you think of anything that can improve my class?
D. Should there be more/less homework? More/less in class activities?
E. Do you like the powerpoint slides being provided? Why?
F. If the movie *Contact* was shown out of class (i.e. some evening), would you come? Really?

Class Conclusions?

- There is no reliable evidence that leads us to believe that life exists somewhere else in the universe.
- As this class has shown, life is possible, but that is all we know now!
- May the future enlighten us!
- Still, let's use what we do know and see what sort of conclusions we can make.
- Is it possible that someone may see a UFO?

Fact 1

- It is possible that ETI life is abundant in our galaxy
  - With ~300 billion stars and plenty of opportunities for life to develop.
  - Our estimate for civilizations was **115** right now!
  - So, there are clearly arguments for common life.

Fact 2

- If ETI is abundant in our Galaxy, then we expect that, statistically, there exist or have existed ET civilizations that have achieved a technological capability greater than that which we now demonstrate– an advanced civilization!
  - The time to reach Type 0 status was about 4.5 billion years on Earth, but it could easily be only 3.5 billion years somewhere else
  - An intelligent civilization can do a lot in a billion years

Fact 3

- The distances and times associated with interstellar travel are great, but as far as we know, it is conceivably possible that a civilization conduct significant interstellar exploration, especially with enough time.
  - At very least, a more advanced civilization could have sent out nanoprobes across the Galaxy.

Fact 4

- It is possible therefore that an ET civilization has explored our region of the Galaxy, the Sun, and even our Earth at some point in its history
  - This is not pseudo-science but real logical consequences of abundant ETI.

Fact 5

- We have no reason to believe that this has not happened
  - We also have no reason to believe that it has.
  - It is an open question.

What are we left with?

- These are two distinct but still very significant claims
  - The Earth has been visited by ETs.
  - The Earth has not been visited by ETs.
- Neither of these statements has been validated.
- So, the only statement we can make is
  - We do not know whether or not the Earth has been visited by ETs.

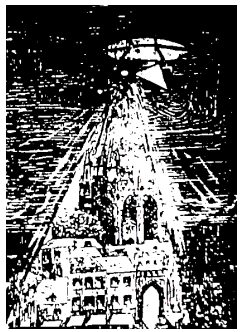
http://www.cgl.uwaterloo.ca/~csk/washington/graphics/logos/validated.gif

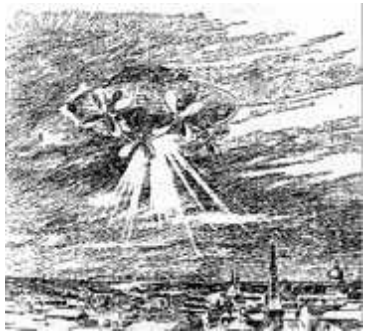
The ET Visitor Hypothesis

- So far no reliable evidence exists for ET visitation
- But, the idea that we have been visited and traces exist somewhere is a valid THEORY
  - Maybe improbable but still valid
- *Don't expect people to believe your theory unless it is substantiated with reliable evidence*

UFO Before

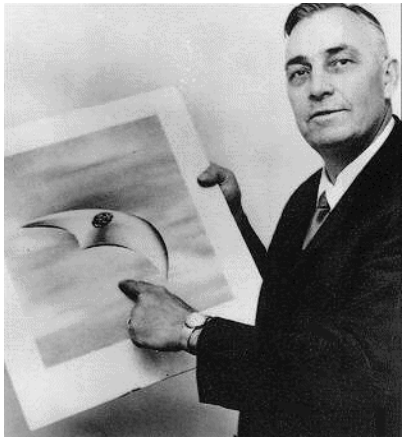
- First idealized UFOs around 1900.
- In Sacramento in 1896
- In England in 1906
- Blimp-like objects with search lights.





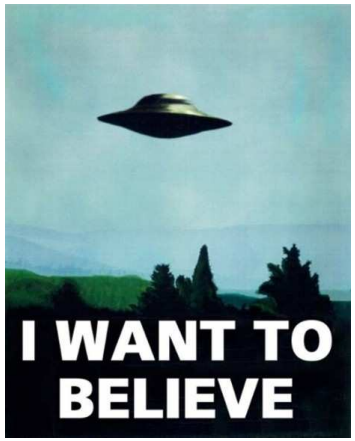
Flying Saucer

- Modern sighting phenomenon from Kenneth Arnold in 1947 who told reporters that while flying a private airplane near Mount Rainier, he saw nine objects that moved like "a saucer skipping across the water."
- He actually thought they were government projects.
- Picked up by the pulps, and the number of sightings jumped.



UFOed

- The popularity is not very surprising
  - Jet planes first introduced at the end of World War II
  - Public aware of fast-moving aircrafts
- 50% of the public believe in the existence of UFOs as aliens visiting Earth.
  - Where there's smoke…
  - Not all of them can be wrong…



UFOs

- What is a UFO?
- Can all/any of these sightings be traced to ETIs?
- Stands for **U**nidentified **F**lying **O**bject.
- Was introduced as neutral bureaucratese term to replace the emotionally charged term "flying saucer"
- Originally, the term UFO did not have anything to do with extraterrestrials.
- Scheme did not work, and now UFO has all of the connotations that "flying saucer" originally carried.

http://www.screensavershot.com/misc/ufo-02a.jpg

Close Encounters?

Scientific approach– you gotta classify

Carl Jung

1. Nocturnal lights: bright lights
2. Daylight lights: usually cigar or disk-like shaped.
3. Radar-visual: those detected by radar
4. Close encounters of the 1st kind: visual sighting of an unidentified object.
5. Close encounters of the 2nd kind: visual sightings plus physical effects on animate or inanimate objects
6. Close encounters of the 3rd kind: sightings of occupants in or around a UFO.

UFO Study Problems

- Why are UFO sightings hard to explain?
- Sightings must be explained "after the fact" without complete information.
- Sightings are based on eyewitness accounts, which are notoriously unreliable.
- Inconsistencies are often ignored.
- Humans seem to have a psychological need to believe in superior beings (→religion?).
- Failure to find a "normal" explanation is not evidence for alien visits.

Occam's Razor

– *Pluralitas non est ponenda sine necessitate* [Latin]
– Given two equally predictive theories, choose the simpler.

Or

– *The simplest explanation is usually the best.*

We Need Hard Evidence?

- A probe or remains of a probe somewhere on our planet or in our solar system
- The remains of ET biological activity somewhere on our planet or in the solar system.
- ET clearly announce themselves.
- If you expect to have your scientific investigation received seriously, you have to follow simple logic and common sense
  – The rules for the scientific method are just logic and common sense

http://www.biochem.wisc.edu/wickens/jpgs/2001_spac_odd.jpg

UFO Phenomenon

- Some argue that we have proof:
  - UFO sightings.
  - Strange historical accounts or grand technological accomplishments of humans in the past.
  - Alien abductions.
- This all falls into the realm of pseudo-science.
- There has never been any concrete evidence of extraterrestrials having anything to do with UFOs.
- UFOs could be so very many things. Why assume automatically that there is an otherworldly explanation? But those who want to believe will do so even despite evidence to the contrary.
- In this class, we think that "**Extraordinary Claims Require Extraordinary Evidence**" - Carl Sagan.

Witness This

- In a court of law, testimony is used and it has to be judged for legitimacy
  - Bad testimony often gets judged as good and vice verse
- Science is not a court of law
  - We know that testimony can be flawed, so we can not rely on it as a reliable source of information
  - The mind can deceive or be deceived or it can relate observations accurately
    - We don't ever know which for sure

http://www.buttonhouse.com/catalog/aliens-ufo.html

Pictures

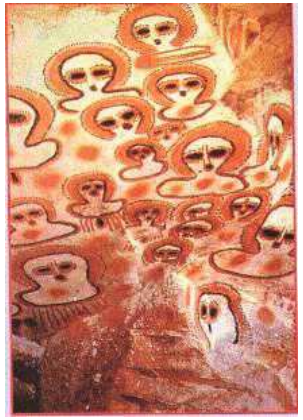
- Pictures are getting close to evidence…
  - What is in the picture?
    - It could be forged (photoshop-ed)
    - It could be a misprint
    - It could be real
  - We don't know.
- Even if we have a picture or a reliable sighting of, say, a space craft the most logical explanation is still that a human-made object was seen.
  - Occam's razor.
  - We know that governments work on advanced projects in secret.
  - Without evidence of ET life, this explanation is simplest.

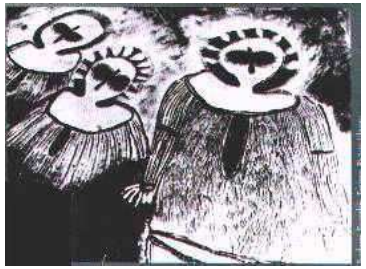
http://home.tiscali.be/mathias.appelmans/alien.jpg

Ancient ET Visits?

- There are a number of ancient images and artifacts that have been associated with UFOs by modern "UFO researchers".
- Let's look at some of those. They're easy to find on the web– too easy.
- If we can't really trust modern isolated photographs…maybe ancient or renaissance paintings?

Cave Paintings

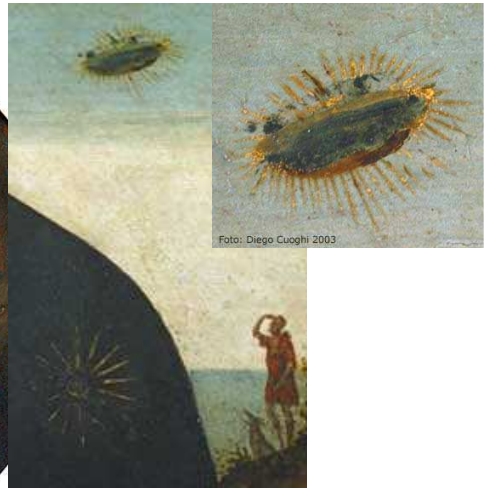




http://homepage.ntlworld.com/jackaram/

Images from an ancient eastern text Prajnâpârâmita - Suna

The Madonna with Saint Giovannino



Domenico Ghirlandaio– 15th century.

Foto: © Diego Cuoghi, 2003

The Annunciation with Saint Emidius

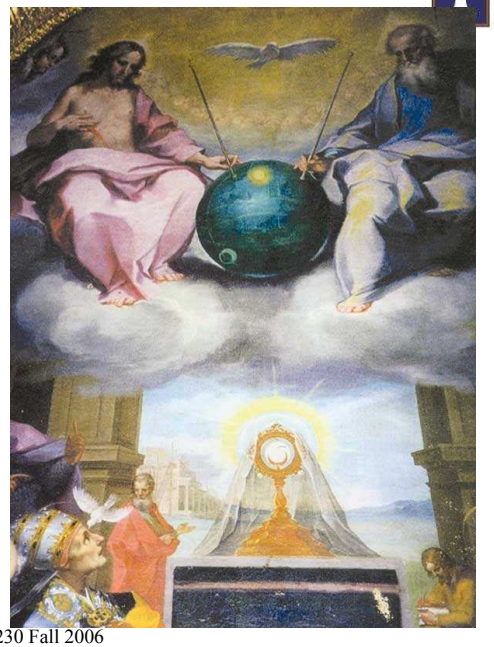
Carlo Crivelli– 15th century.

The Crucifixion

A fresco above the altar at the Visoki Decani Monestary in Kosovo, Yugoslavia– 14th century.

The Baptism Of Church

Aert De Gelder– 18th century.



http://homepage.ntlworld.com/jackaram/

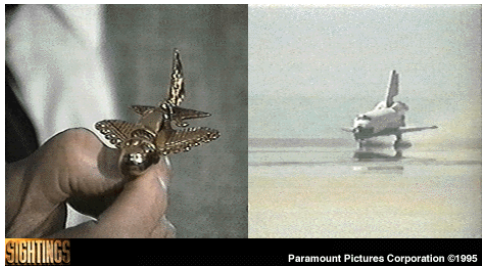
Symbolic Symbolism

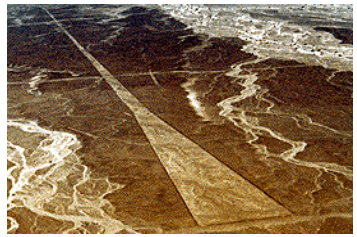
- Biblical references have become completely incomprehensible to modern man.
- The symbols were a way to express meaning to illiterate populace.
- Early humans needed a way to express symbols of god, weather, or whatever and the sky is magical.

http://www.sprezzatura.it/Arte/Arte_UFO_6.htm

Amazing or Ordinary?

- We have no reliable evidence that ET's helped to build the pyramids or any other amazing artifacts.
- We do have plenty of evidence of humans doing extraordinary things when working in concert
  - What is the most logical explanation?



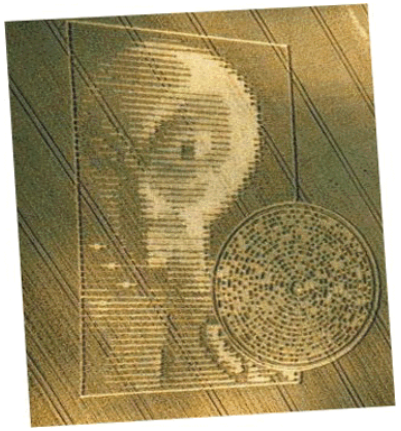


http://homepage.ntlworld.com/jackaram/
http://www.aegypten-online.de/images/giza/pyramid.jpg

Pseudoscience

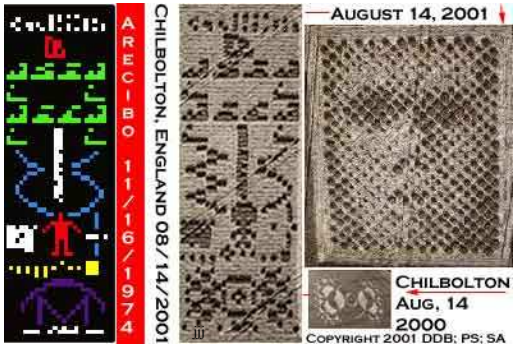
- Although there are numerous examples of interesting paintings, drawings from the middle ages or ancient times can not sensibly be used as evidence of UFO visitation!
- The most logical explanation is that people saw something in the sky (a comet or meteorite or clouds) and let their imaginations run wild.
- Strange sights do not mean aliens.

Crop Circles



- Clearly shown to be man-made structures.
- No one has seriously studied them.

http://www.enterprisemission.com/glyph.htm



Give Me Real Evidence!

- Evidence:
  - A piece of a probe or spaceship
  - Some trace that can be uniquely linked to an ET probe
  - Biological material.
  - A reliable, logical calculation

- That is the same we require of ANY scientific investigation

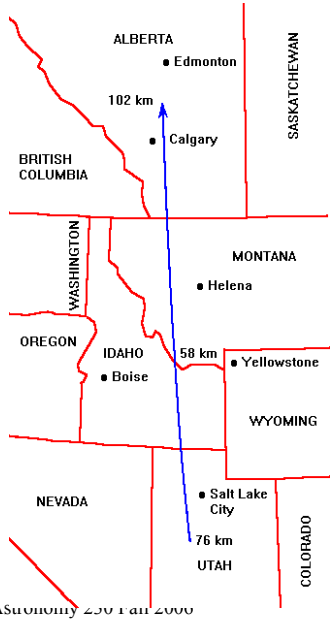
http://www.alien-ufos.com/images/ufos/miscufo4.jpg

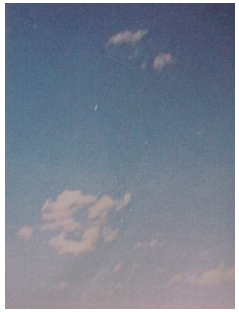
An Example: Meteor 1972

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

Yikes, a Near Miss

- A bus sized object entered atmosphere over Utah and exited over Canada
- Velocity of 15 km/sec
- Missed Earth by 58 km





But…

- Event was completely unexpected
- Crossed relatively sparsely-inhabited region
- Only visible for a *total* of 101 seconds
- Visible for no more than 30 seconds at any one spot
- Nonetheless, we have dozens of clear photographs of this event
- Still we have no comparable images of UFOs.
- And today digital cameras and camera phones should make unusual events even more seen.

Problems?

The large number of sightings argues **against** alien spacecraft.

- Space is freaky big.
- There are extreme difficulties of interstellar space travel and the number of planets to explore.
- So, why would so many alien spacecraft be visiting the earth constantly?
  - There are other planets to check out.
  - What makes us so interesting?
  - We should not overestimate our significance.

Propulsion Detection

- Only if interstellar techniques become really easy will visits be possible.
- We would probably see them coming.
- Nuclear fusion and antimatter propulsion would produce copious gamma rays– easily detected.
- If a spacecraft decelerated from c within 1 AU of the Earth with mass > few tens of grams would be detected.

http://www.yougottareadthis.com/img/51-on-ufo.jpg

Condon Report

- There were numerous government studies on the topic of UFOs– some very biased.
- The main one of importance was the only scientific study of UFOs called the Condon report (1969).
- "The report concludes that there is no evidence to justify a belief that extraterrestrial visitors have penetrated our skies and not enough evidence to warrant any further scientific investigation."

Conspiracy or Science Disinterest?

- Government Cover-up?
  - Motive to avoid alarm? 50% already think that aliens have landed anyway.
  - But, U.S. Government notoriously unable to keep secrets known by many for a long time
  - All other governments need to participate in a large-scale conspiracy
- Scientific disinterest?
  - Stems from lack of real evidence, not disinterest
  - If there was serious evidence, or the chance to obtain serious evidence, scientists would **jump** at it

Some Real Facts

- The fact that the majority of humans live in cities with very little familiarity with the sky goes a long way to explaining most UFO sightings.
- How many of you have ever seen ball lightning?
- The planet Venus is mistaken for a UFO all the time because it is very bright, is often viewed low to the horizon and therefore experiences atmospheric scintillation which makes its color change rapidly.

http://www.meteoros.de/ufo/venus.htm

Some Real Facts

- Have you ever seen a stealth fighter or bomber in flight?
- What about swamp gas?
  - decaying organic matter turns gaseous and on extremely rare occasions takes on certain properties of luminescence
- Insect swarms flying through electric fields?
- All of these things are in the sky and most people have no idea what they are looking at when they see them.

Alien Abductions

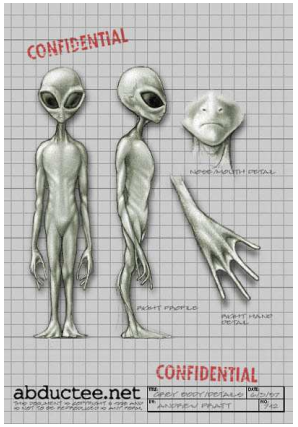
- Alien abduction stories bare a resemblance to post traumatic stress disorder.
- People experience something horrible in their lives and their brains suppress the memories.
- The memories remanifest in dream-like states where the mind is highly susceptible to confabulation and fantasy.
- The stories often involve elements that sound like a condition called *sleep paralysis*.

Alien Abductions

- When you are in REM sleep and are dreaming your body paralyzes the major voluntary muscles so that you cannot injure yourself while you dream.
- Sometimes we can fall into dream states before we have become completely unconscious. Our bodies become paralyzed and we can even dream in the state, but yet we are also partially awake. It's called *waking dreams* it's a real and studied phenomenon.

Expect to See

- Descriptions of aliens do not reflect the expected diversity of life elsewhere, but do reflect psychological biases of observers. Descriptions are almost always humanoid and usually male



Your Call

- We have no reliable evidence to support actual ET contact.
- We have evidence that people historically make up stories about things they imagine to be linked to a light in the sky
  - So, what is the most logical explanation?

Open Your Mind?

- Yes, as we have justified, it is possible that an ETI civilization has visited the Earth at some point in its history
- It is a legitimate scientific question to investigate this
- **We need legitimate scientific evidence in order to believe this theory**

Bottom-line

- We have probably not been visited by aliens; there is **no** evidence.
- To me, alien reports are images of human psyche.
- But, our Drake equation estimate suggest that extraterrestrial life is common.
- So the Fermi Paradox: "Where are they?"
- I would argue that we keep trying to figure out the Universe, look at the concept of extraterrestrial life with a critical eye, fill in our gaps of knowledge, and the search is on.