Astronomy 230

Section 1– MWF 1400-1450
106 B1 Eng Hall

This Class (Lecture 42):
Review

Next Class:
Final Exam

FINAL EXAM is Dec 18th in this room 1:30 to 4:30pm!

That's 1330-1630.

OR Weds Dec 15th in the Astronomy classroom (#134) in the Astro building 1:00-4:00pm.

Music: *Princes of the Universe* – Queen

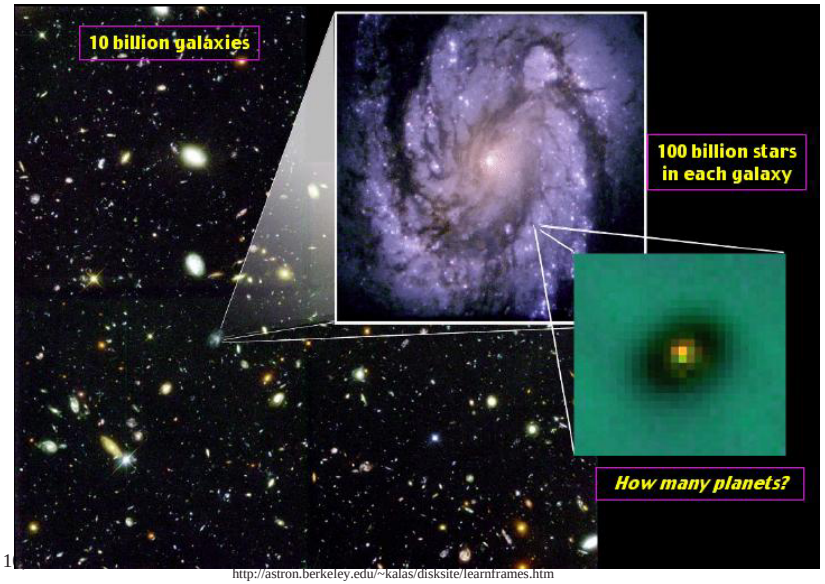
Final

- Designed to be a 2-ish hour exam, but allowed 3 hours.
- Will consist of 30 multiple choice/ true-false questions (2 points each), 6 small essay questions (10 points each), and 2 large essay question (40 points each) .
- A total of 208 points graded out of 200 points. So a possibility of 8 extra credit points.
- You can bring a normal-sized sheet of paper with notes on both sides.
- Multiple-choice is heavily weighted toward the last half of the course.

Review of Life

Not inclusive study material.

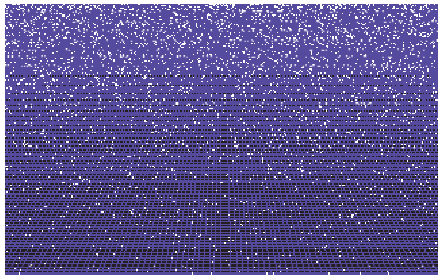
The Universe: Some Facts to Help you Live in it



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!



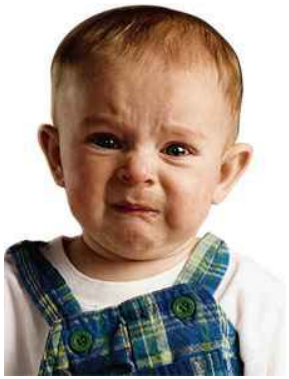
Galaxies

- Galaxies formed from the seeds of dark matter, mostly hydrogen.
- The first stars formed from huge clouds of hydrogen.
- Fusion starts– turning hydrogen into helium,
- 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

R_*

But Life?

- As far as we know, we expect that we are typical in many ways to the other planets around other stars, in other galaxies.
- One aspect of the study of extraterrestrial intelligent life is to determine if ***life*** is a typical phenomenon.
- Our best guess is that most other galaxies have <u>at least one</u> planet with intelligent life on it
  - As the Milky Way has at least one planet with Intelligent Life.
- So, there ought to be hundreds of billions of intelligent civilizations in the Universe!
- But we focus on our Galaxy.



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!

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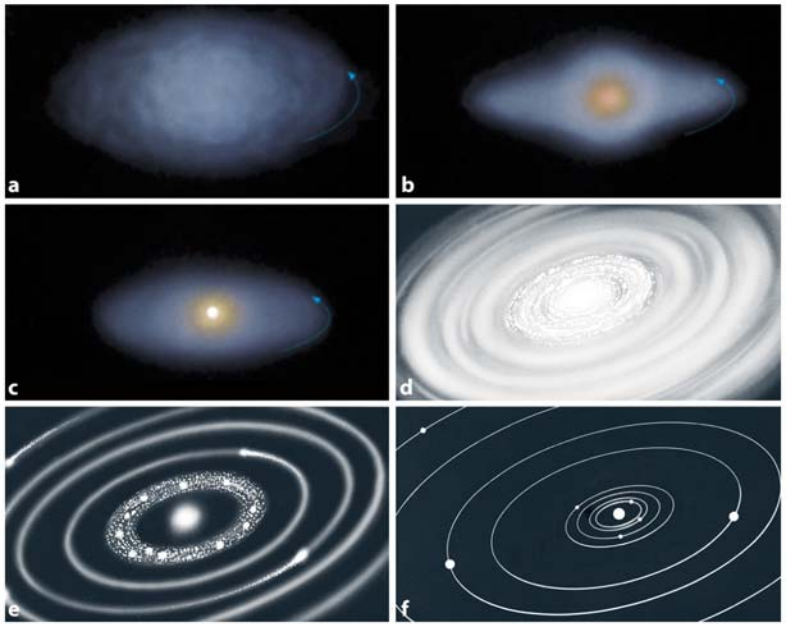
Formation of the Solar System 4.6 billion years ago



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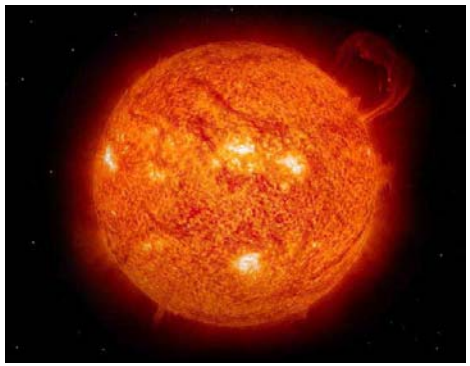
Our Sun

- 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?



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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.

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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.

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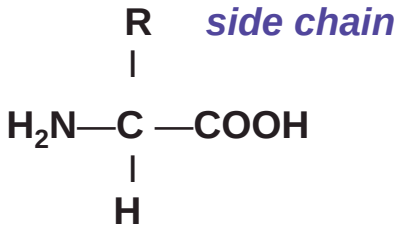
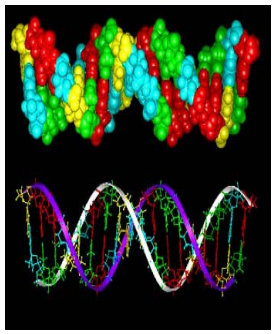
Life on Earth

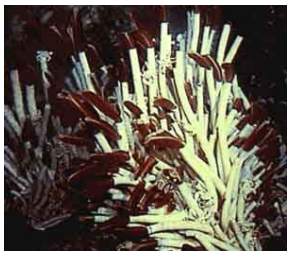
- Most important components are
  - Proteins or enzymes
    - Polymers made of amino acids strung together.
  - Nucleic Acids (DNA or RNA)
    - Polymers made of sugars (deoxyribose or ribose), a phosphate, and nitrogenous bases.
- In life on Earth, they are so closely linked that it is hard to figure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





Synthesis of Monomers

- Miller-Urey experiment? Could be, but atmosphere probably not a heavily reducing atmosphere.
- Area around undersea hot vents might work.
- Interstellar space?

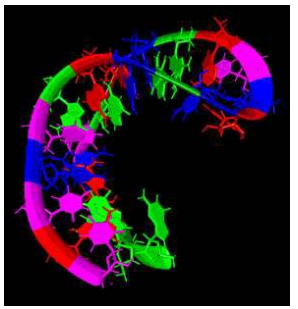


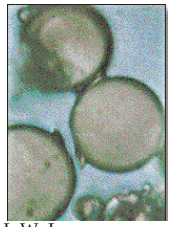
Synthesis of Polymers

- With monomers around, then you have to make the polymers.
- Maybe easier if the primordial soup quickly evaporates into a condensed soup.
- Polymerization in clay soils?
- An evaporating pool with geothermal energy?
- Polymerization of amino acids on the early Earth is plausible.
- Synthesis of nucleic acids seems to be much harder.

Transition to Life

- Most favored concept is the RNA world.
  - Dominance of the nucleic acids first.
  - An ecosystem of self-replicating RNA, but without capability for protein synthesis.
  - Naked genes.
  - Some RNA evolve enzyme ability, produce proteins
  - Eventually better protein enzymes are produced
  - Life.
- Or the proteins could have dominated– no info storage.
- Or life could have just happened with both nucleic acids and proteins together– primitive cells.





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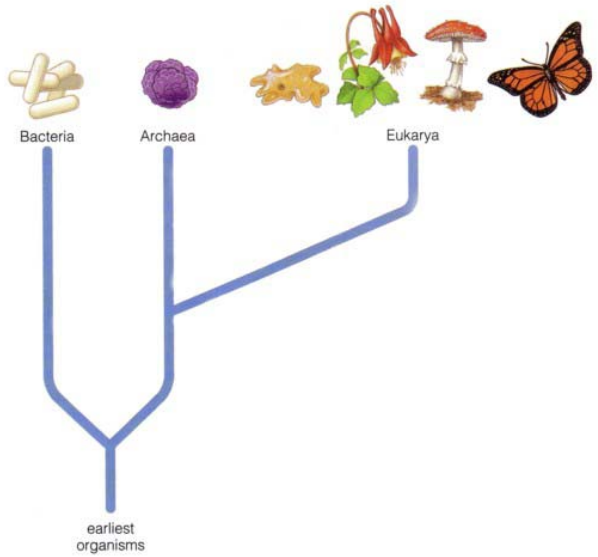
First Life

- 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.



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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).

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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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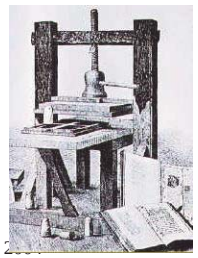
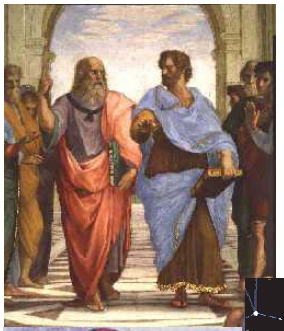
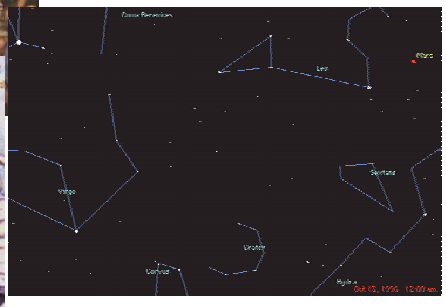
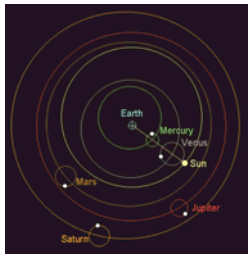


Worldview



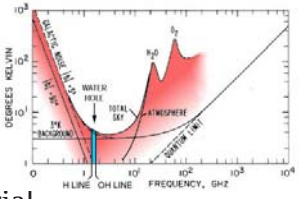


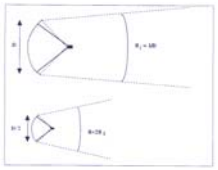
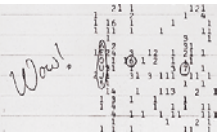




Galactically Aware

- 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.

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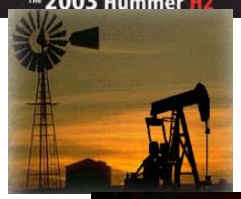
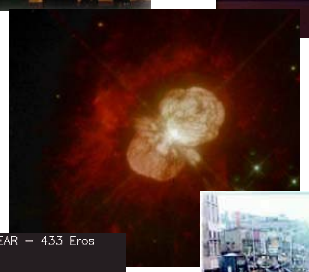
Lifetime







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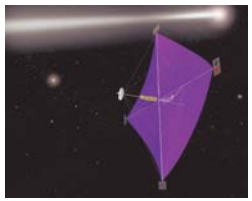
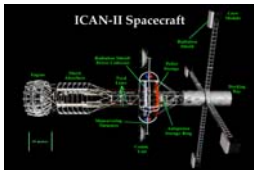
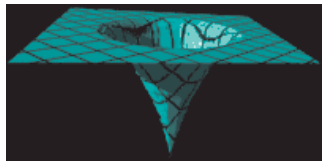
Rocket Man


- 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 Questions

- What are the five biological attributes of life, and what do they mean?
- What is the Drake Equation, and what do the terms mean?
- Derive your own personal Drake Equation result with facts from the class. What does it imply about ET life?
- What is the origin and use of the four main biological elements H, O, C, and N?
- Describe the Early Universe. Why do we believe in the Big Bang?
- What are the properties of a first generation star? In particular, describe which heavy elements they made and how they did it.

Review Questions

- What are the properties of a second generation star? In particular, describe which heavy elements they made and how they did it.
- What does the presence of complex molecules in interstellar space tell us?
- Describe a techniques that astronomers use to search for planets around stars?
- Describe the processes of forming a star and its planets.
- The planets and the Sun formed from the same interstellar cloud. Discuss reasons why the chemical abundances of the inner planets are different than the outer planets.

Review Questions

- How did the Earth probably acquire its moon?
- What will happen to our Sun?
- Why does our theory of the origin of the solar system and the current extrasolar planets not completely agree?
- What will happen to the Milkyway?
- What will happen to the Universe?
- Two theories exist to explain the transition of polymers to life. Discuss one of these theories.
- What is the closest star to the Earth?

Review Questions

- What determines if a planet is in the Habitable Zone?
- What is a protein? What's it made of?
- What is a nucleic acid? What's it made of?
- Discuss nucleic acids and proteins, and how they are related in life on Earth.
- How do nucleic acids function to assemble proteins that carry the genetic code?
- Discuss the monomer synthesis of the important monomers of life.
- 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.

Review Questions

- Discuss the polymer synthesis of the important polymers of life.
- What is one possible scenario for the synthesis of polymers on the early Earth? Include the probability of getting 200 of the 20 relevant amino acids in the correct order for constructing a protein.
- 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.
- How can the age of a fossil be determined by radiocarbon dating. 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 ETI? 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?
- What is a possible interstellar mechanism from general relativity?
- How can we colonize the galaxy? Discuss long-haul spacecraft.
- What are the classifications of civilization types?
- Based on the class Drake Equation results, what are the class conclusions about life in our Galaxy?

Review Questions

- Discuss the two statements:
  - The Earth has been visited by ETs.
  - The Earth has not been visited by ETs
- Define a UFO.
- What is a close encounter?
- 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.