

ET: Astronomy 230



HW 7 due today!

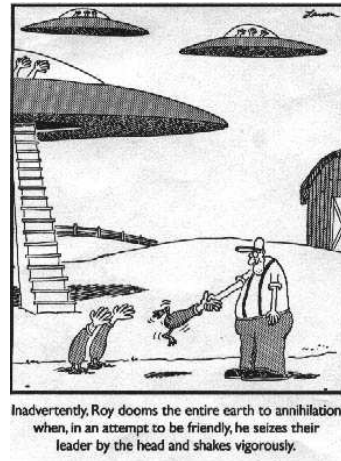
This Class (Lecture 29):

Cultural Evolution

Next Class:

Nick Warren
Jeff Greenswag
Jennifer Brown

Music: *Intelligent Guy* –
Butthole Surfers



Inadvertently, Roy dooms the entire earth to annihilation when, in an attempt to be friendly, he seizes their leader by the head and shakes vigorously.

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Outline



- Will a civilization develop that has the appropriate technology and worldview?
- Requires knowledge of quantum mechanics and astronomy.
- The most important shift for humans was the Copernican revolution.
- From center of the Universe to not special.

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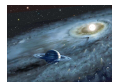
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= 1.6

Intelligent Life
/decade

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	Rate of star formation	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
	10 stars/yr	0.38 systems/star	0.11 planets/system	0.5 life/planet	0.75 intel./life	comm./intel.	yrs/comm.

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Backdrop of Civilization



- Origin of modern H. sapiens is disputed, but the genetic and linguistic evidence points toward a spread of humans across Eurasia then the Americas.
- We share a common gene pool, but genetic drifts and selection for local environments created genetic differences among groups.
- These differences have little to do with the concept of race, which has been showed by genetic studies to be a meaningless concept.
- The greatest genetic and linguistic variations are found in Africa, supporting the “out of Africa” idea.



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<http://www.poptur-sources.net/img/out-of-africa.jpg>
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Cultural Evolution



- Once humans spread across the globe, the primary method for evolutionary change shifted from biological to cultural evolution.
- Anatomically modern H. sapiens evolved 100,000 yrs ago, but the first modern behavior did not appear until 40,000 yrs ago– e.g. cave painting.
- Regardless, there has not been any significant biological evolution for the last 40,000 yrs– e.g. brain increase.



http://www.codcottage.freemove.co.uk/images/hand_castillo_spain.jpg

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Cultural Evolution



- The rest is cultural– from hunter-gathers to cell-phone-users.
- Cultural evolution was fast.
- Is cultural evolution needed for ET? Why would a ET culture try to communicate?
 - Capability (suitable technology) and interest (worldview?).



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Hunting and Gathering



- Until 10,000 years ago, H. Sapiens functioned completely as hunter-gathers.
- Small nomadic tribes with few possessions.
- Except for shortages, a fair and easy life
 - No midterms
 - Only working about 4 hours a day
 - But, no way to create surpluses or free members for other roles.
 - When things go bad, they really go bad.



http://www.cnn.com/WORLD/9511/safrica_bushmen/

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Agriculture



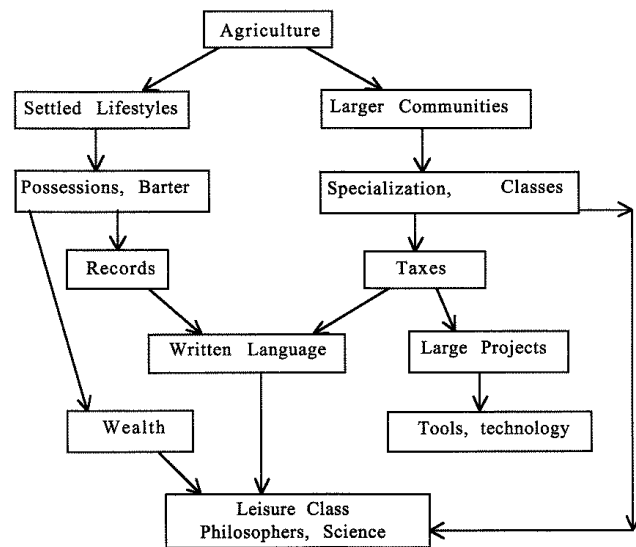
- Tribal societies– 100s of people into villages
- Due to agriculture, larger and larger communities and new societal organizations.
- Began about 10,000 yrs ago, around the dead sea.
 - Mixed hunting with harvesting of wild wheat and barley.
 - Storage, planting, and seed selection.
 - Mutant varieties took over and hunting decreased.
 - 1000 years later, animal domestication.
- Provided long-term settlements for cultural evolution, information, tools, and energy sources.

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<http://www.ffa.org/medialibrary/index.html>

The Importance of Agriculture



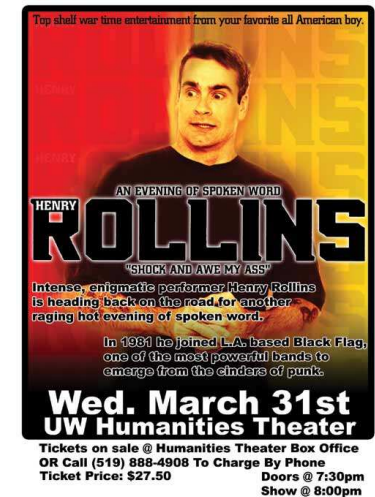
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Language and Information



- Limited size for brain, due to birth canal size, so limited bits of info.
- Need to develop extra-somatic (outside the body) information storage techniques.
- First method to store information from another person was spoken language.
- Crucial development.



<http://www.feds.uwaterloo.ca/posters/henryrollins.jpg>

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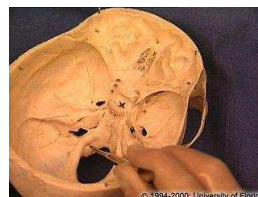
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Language and Dis-Information



- But the origins of language are not well understood— no fossils.
- Probably in hunting parties for large prey.
- The control of the tongue is through the hypoglossal canal (hole) in the skull. In humans it is twice as large as chimps.
- First arose about 400,000 yrs ago in Australopithecines.

Hypoglossal Nerve



<http://members.aol.com/paroleinfo/PRESSURE.HTM>

<http://imc.gsm.com/integrated/haonline/haonline/ha/mgs/00000/3000/600/3604.jpg>

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Writing



- Oral language is clearly limited.
- Development of written language provided a powerful, new source of info storage.
- Earliest appearance was in Sumer— present day Iraq (8500 BCE).
- Probably started from economic need— barter or receipts.
- Common by 3000 BCE.
- Written records of taxes and a ruling class— the rise of civilization.
- Move from symbols to syllabic language developed by 1500 BCE.



MS 3008
Account of commodities, Sumer, ca. 3200 BC.
The earliest continuous writing known

<http://www.nb.no/baser/schoyen/4/4.4/441.html>

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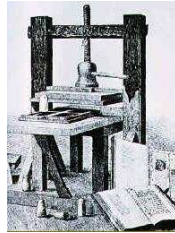
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Extrasomatic Storage Leaps



- Printing press (1456) – number of books jumped from 10,000 to 10 million in 50 yrs.
- Telegraph (1844)
- Radio (1895)
- Television (1936)
- Computers (1950s)
- Internet (1970s)
 - Huge extrasomatic storage: Well above brain storage



Does all of this increase the “intelligence” of our species?

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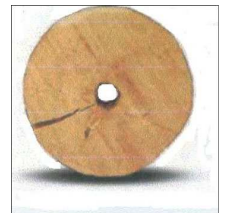
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From Rocks to Metal



- Stone tools (silicates) started with H. habilis about 2 Myrs ago.
- Agriculture developed at the end of the stone age.
- First pottery (still silicates) around 7000 BCE.
- First metal (copper) in 6500 BCE, mostly ornamentation.
- The wheel was invented in 6500 BCE.



<http://www.angelfire.com/country/veneti/images/OldestWheel.jpg>

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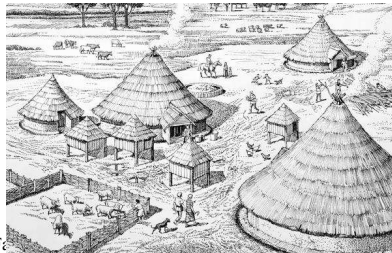
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From Rocks to Metal



- Copper tools in 4000 BCE.
- Animal drawn vehicles & sailboats in 3300 BCE.
- Bronze (copper and tin) tools in 2800-1000 BCE (the Bronze age).
- Iron first showed up in 1500 BCE.



http://www.museumoflondon.org.uk/MOLsite/learning/who_are_you/teachers/images/citizenship/iron_age_settlement_no192.jpg

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From Rocks, to Metal, to Rocks



- Next real step was developing energy sources.
- The industrial revolution.
- Modern technology based on electronics, crucial to our ability to communicate to ET.



<http://www.learnhistory.org.uk/cpp/industrial-revolution-children-labor.jpg>

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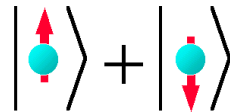
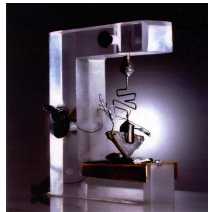
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From Rocks, to Metal, to Rocks



- Transistor in 1948.
- Microchip in 1959.
- We went back to silicon!
- We are arguably in the “silicon age”.
- This implies knowledge of electromagnetisms and quantum mechanics.



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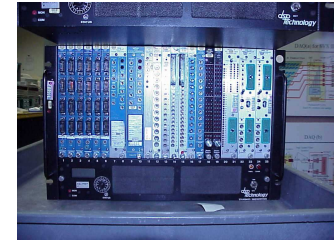
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Cultural Evolution



- What do we mean by cultural evolution?
- Is that like natural selection?
- Since technology has developed out of it, we can conclude that technology was a desirable trait that is likely to develop on any planet with competition between cultures.



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Cultural Evolution



- Or can we?
- If so, then would have to say that cultural evolution follows a punctuated equilibrium model.
- Or, episodic progress with long periods of dark ages.
- Like species, the fate of civilizations has been extinction, but their technology was adopted by others (cultural diffusion).

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Evolution?



- The main point is how likely is it that technological civilizations exist on other planets?
- Hard to determine on Earth, but there are some points:
 - Agriculture arose independently in Mexico and probably China, Andes (potatoes), and eastern US (sunflowers).
 - Written language independently in China and the Americas, maybe India and Egypt.
 - But, the wheel was not invented outside of Sumer.
 - For recent developments, the world was in too much contact to distinguish.

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Questions: Variations of Civilization



- What if the Americas had invented gunpowder?
- What if the Americas had large animals of burden?
- What if the germs of Europe were less dangerous than the germs of the Americas?
- Similar examples of cultural devastation in the Pacific Islands.
- Often cultures are wiped out from *Guns, Germs, and Steel* (by Jared Diamond)– manifestations of geography.

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Technology Development



- Our sample of one, makes it difficult to determine if technological development (to communication ability) is a fundamental step from intelligence.
- Does it depend on the planet– water/desert dominated?
- How would metal poor planets develop?
- Does the competition of civilizations matter?
- Is there a dependence on psychology of the intelligence life?

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Technology



- Cultural evolution was fast.
- Especially after agriculture freed civilizations.
- Development of language.
- Increase of extra-somatic storage.
- We're living in a silicon age.
- Does the development of technology also include a correct worldview?

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Next Step



- Besides needing technology, intelligent life must have a **want** to communicate with extraterrestrial life.
- That means that it MUST believe in the possibility of other life.
- Requires civilization to undergo three steps:
 1. A correct appreciation of the size and nature of the Universe
 2. A realization of their place in the Universe
 3. A belief that the odds for life are reasonable. The beings of Qearth must have taken their Qastro 230 class and came up with a good number of communicable civilizations in the Q'drake equation.



<http://www.bybeeweb.com/cats/amelia-step.jpg>

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Big Questions



- Our capacity for interstellar communication arose at the same time as our interest in it. Coincidence?
- Can a society have a highly developed technology with an incorrect astronomy?
- What if the skies were constantly cloudy?
- What if their solar system had no other planets?
- What if they lived in a molecular cloud?
- What if they lived in a huge cluster of galaxies?

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Our First View



- The first concepts of the Universe were Earth-centered.
- How did we come to this point– Astro 230?
- First recorded cosmology was from the Babylonians.
 - The Universe is a large oyster, and we are inside.
 - But other aspects of their astronomy was advanced.
 - Regularity of astronomy for crop planting, harvesting, and accurate calendars back to the 3800 BC.



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<http://www.internationalenglish.co.uk/courses.htm>
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Our First View



- The Mayans computed the length of year to within a few seconds (0.001%).
- So early humans had a weird mixture of precise calendar astronomy with primitive concept of the Universe and mythological systems incorporating magic.



<http://www.mayasites.com/equinox.html>



<http://ephemeris.com/history/mayan-calendar.jpg>

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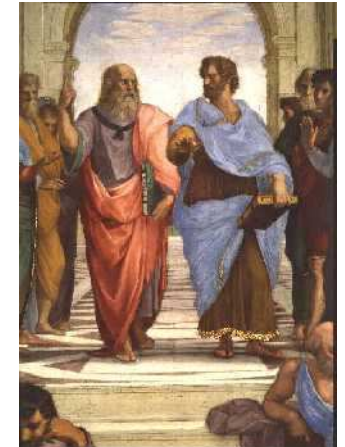
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Greek Astronomy



- Greeks were excellent Astronomers
 - Cataloged star positions & brightness.
 - Systematic, quantitative observations.
 - Natural philosophers.
- They observed that the stars, Sun, and planets revolved around the Earth.
- So Earth is center of Universe- **geocentric cosmology** (mostly from Plato and Aristotle).
- Even though other philosophers (Aristarchus) argued for a heliocentric cosmology.
- Perfect Spheres of motion?



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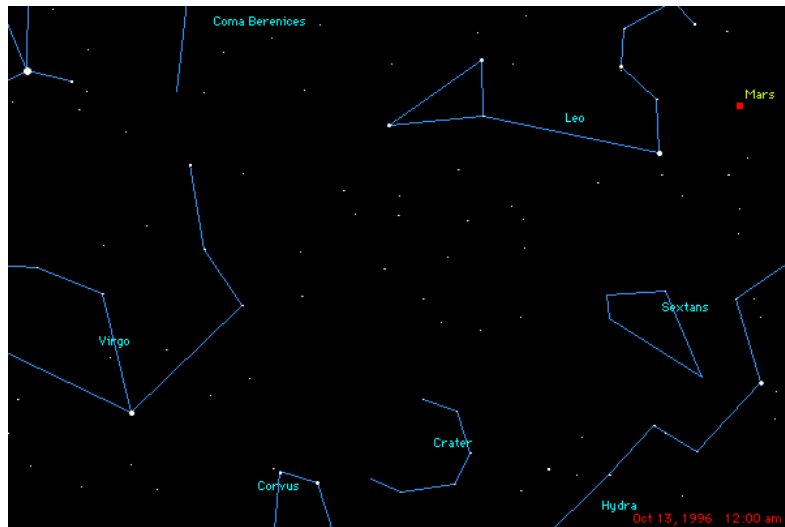
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Mars Moves WRT the Stars!



E
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Motions of Planets



- So, over time the planets seem to move along the ecliptic from west to east over long time periods.
 - This is called **prograde** motion
- But once in a while, a planet appears to stop and reverses direction
 - Reverse direction is called **retrograde** motion (east to west).
- Planets move counter-clockwise (looking down at the north pole)

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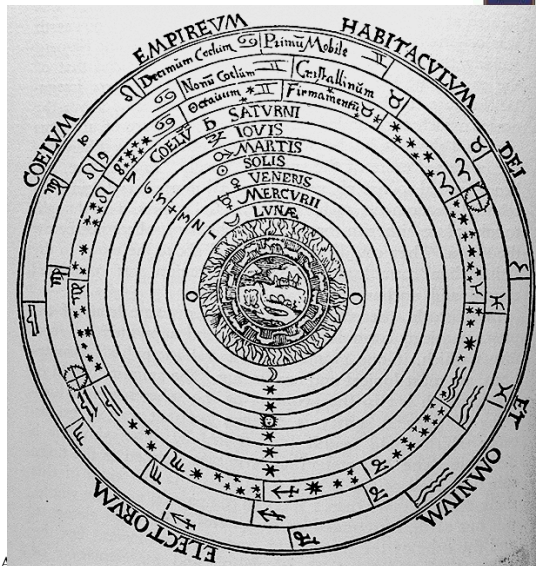
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How can we explain the Planet motion?



But for a **geocentric cosmology** you can't easily explain the retrograde motion of the planets.

Note: perfect circles



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Ptolemy (140 AD: 'p' is silent)



Took **geocentric** model with uniform circular motion to introduce the Ptolemaic system, or model, of the Solar System that explained **retrograde** motion



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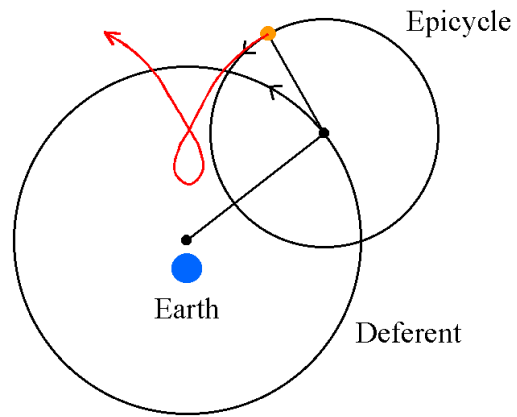
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Ptolemaic system



- Geocentric
- Nice circular motion



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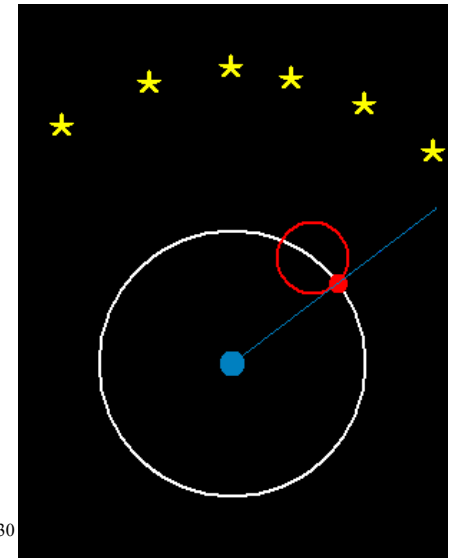
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Ptolemaic system



Yes, it can explain
retrograde
motions



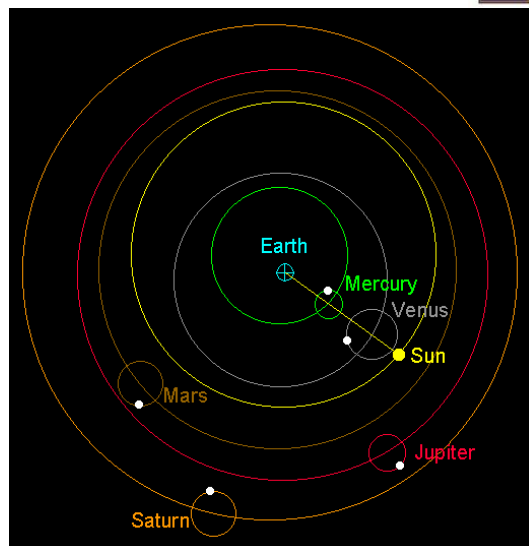
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Ptolemaic system



Overall system of
the Solar System.



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