Astronomy 230

Section 1– MWF 1400-1450
106 B1 Eng Hall

This Class (Lecture 26):
Cultural Evolution
Erin Miller

Next Class:
Megan Davis
Brian O'Neil
Robert Pfaff

HW #5 Due on Oct 29th!

Presentations on Nov 1st!

Layla Ryan
William Delanoy
Adam Valluzzi

Music: *Human* – Human League

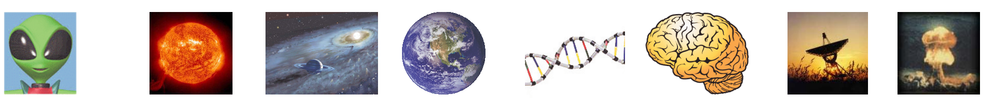
Outline

- 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.

Drake Equation

= 7.7

intelligence /decade



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

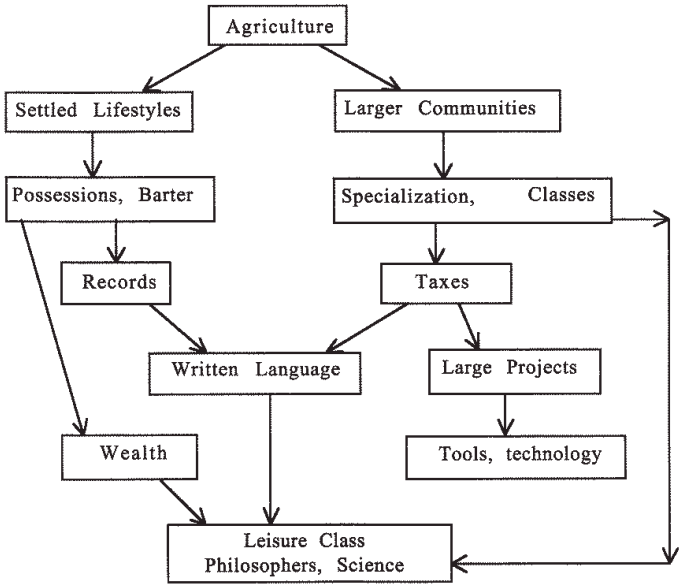
N	R_*	f_p	n_e	f_l	f_i	f_c	L
# of advanced civilizations we can contact	Rate of star formation	Fraction of stars with planets	# of Earthlike planets per system	Fraction on which life arises	Fraction that evolve intelligence	Fraction that commun-icate	Lifetime of advanced civilizations
	25	0.34	.396	0.54	.425		
	stars/ yr	systems /star	life planets /system	life /planet	intelligence /life		

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.

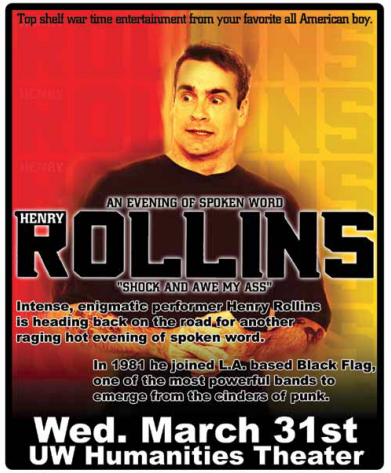
http://www.ffa.org/media/ffaim/index.html

The Importance of Agriculture



Language and Information

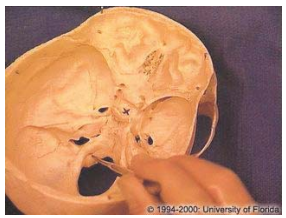
- Limited size for brain, due to birth canal size, so limited bits of info.
- Need to develop extra-somatic (outside the body) information storage techniques.
- First method to store information from another person was spoken language.
- Crucial development.



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

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.



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

http://imc.gsm.com/integrated/haonline/haonline/ha/imgs/00000/3000/600/3604.jpg

Writing

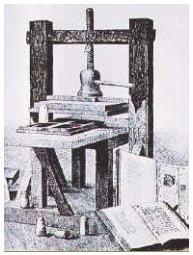
- Oral language is clearly limited.
- Development of written language provided a powerful, new source of info storage.
- Earliest appearance was in Sumer– present day Iraq (8500 BCE).
- Probably started from economic need– barter or receipts.
- Common by 3000 BCE.
- Written records of taxes and a ruling 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

Extrasomatic Storage Leaps

- Printing press (1456) – number of books jumped from 10^4 to 10^7 in 50 yrs.
- Telegraph (1844)
- Radio (1895)
- Television (1936)
- Computers (1950s)
- Internet (1970s)
  - Huge extrasomatic storage: Well above brain storage



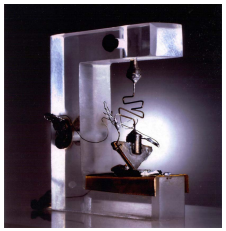
Does all of this increase the "intelligence" of our species?

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.
- 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.

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



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.
- 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).

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.

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).

Technology Development

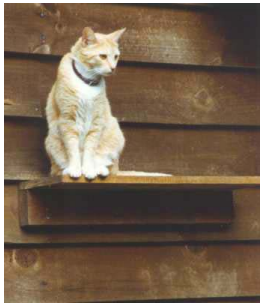
- Our sample of one, makes it difficult to determine if technological development (to communication ability) is a fundamental step from intelligence.
- Does it depend on the planet– water/desert dominated?
- How would metal poor planets develop?
- Does the competition of civilizations matter?
- Is there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

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?

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

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?

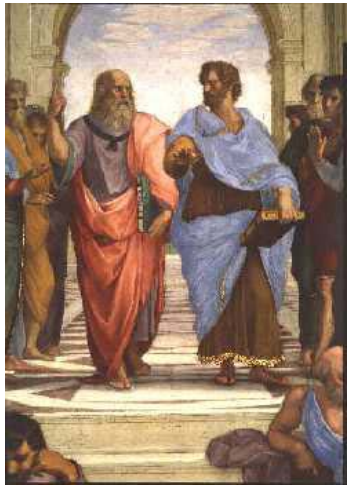
Our First View

- 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.
- 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.

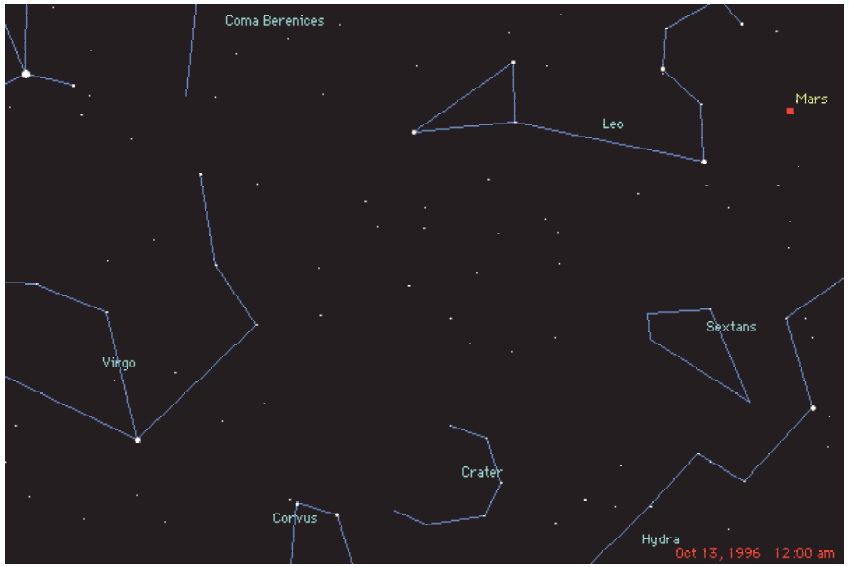
http://www.internationalenglish.co.uk/courses.htm

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?



Mars Moves WRT the Stars!



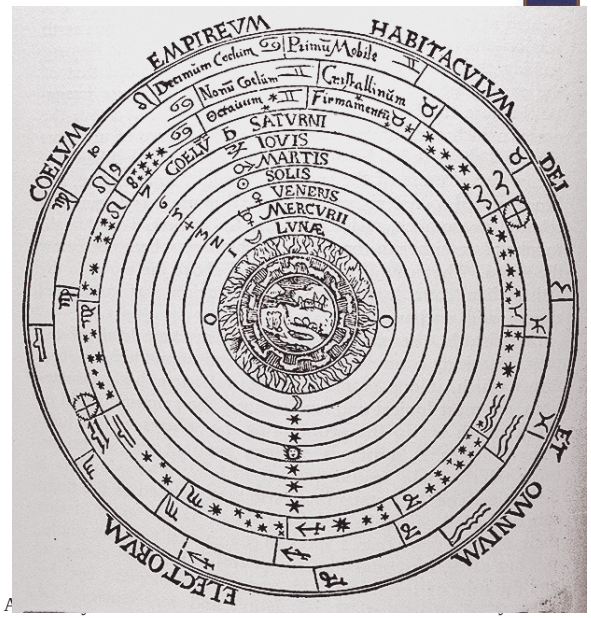
E A S T

W E S T

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

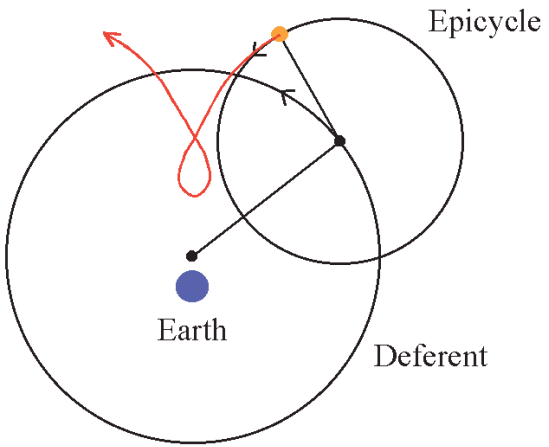


Ptolemy (140 AD: `p` is silent)

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

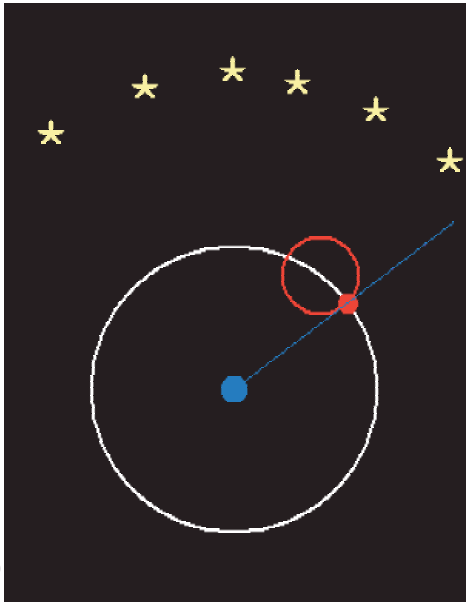
Ptolemaic system

- Geocentric
- Nice circular motion



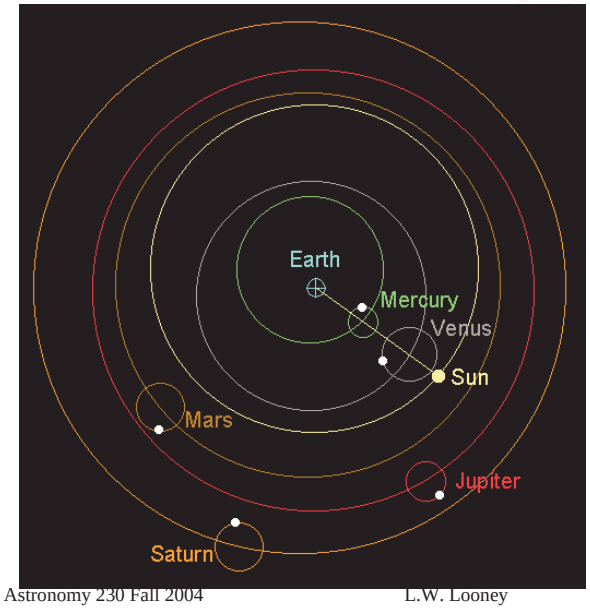
Ptolemaic system

Yes, it can explain retrograde motions



Ptolemaic system

Overall system of the Solar System.

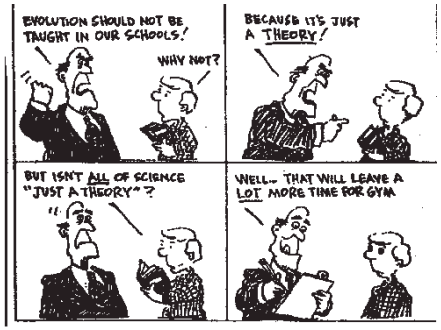


Ptolemy's Geocentric Cosmology:

Is it a Scientific Theory?

Yes! …and an accurate one too

- Data: Sun/moon/star motions
- Tentative Model: circular orbits
- Prediction: uniform motion on sky
- New data: retrograde motion
- Refined model: epicycles
  – explains data!



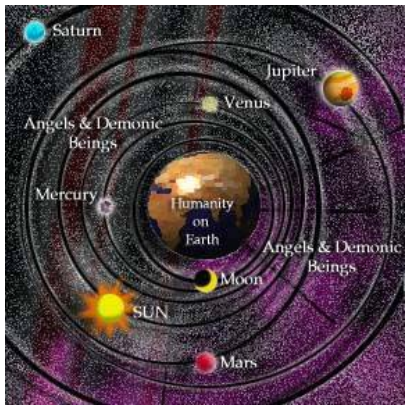
Result: Ptolemaic system (theory)

- *Strength*: accurate fit of data
- *Weakness*: predictions for new data?

http://home.comcast.net/~fsteiger/theory.htm

More Ptolemaic Problems

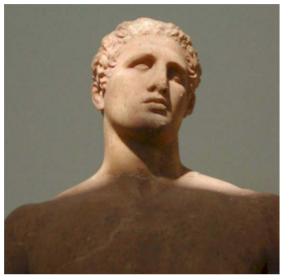
- Each planet acted independently of others
- There was no universal rule governing the planets motion
- Nonetheless, for a 1000 years this model ruled western thought
- However, by the late middle-ages astronomers felt that it was too complex, and a search began for a system with simple underlying principles



http://gbgm-umc.org/umw/bible/images/ptolmai2.jpg

Lessons: Were the Greeks Stupid?

- Not at all!
  Developed sophisticated, successful model
- But built in prejudices about the world
  not just geocentric but egocentric



What about scientists today?
Still can fool ourselves! (And have!)
But: *scientific method* is tool:

- To keep from fooling yourself
- To correct yourself when you have

My guess:

80% of the material in this course will stand the test of time

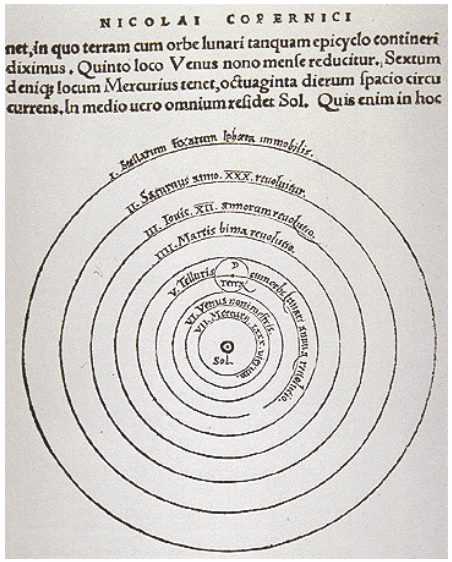
- Compare baseball: 30% success good
- but also: 20% of course is wrong/incomplete!
  - Which 20%? Don't know! Would fix it if we knew! So…
  - You have to learn all of it!

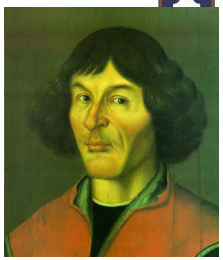
http://www.farhorizon.com/europe/images/images-greece/head_of_Greek_god.jpg

Power of Ignorance

- Heliocentric model was absorbed by Christianity.
- If Geocentric, then of course no ET life.
- St. Augustine (420 AD) incorporated Neo-Platonism. He listed as a temptation to avoid: "a mere itch to experience and find out"
- Also said, "Nor do I care to know the course of the stars."
- The European worldview degenerated for years.
- No one in Europe mentioned the supernova of 1054 (Crab Nebula), unlike China. People were afraid to notice it and be described as a heretic.
- Could an ET civilization reach technology with that sort of attitude?

Copernicus (1540) resurrected the heliocentric model





- If Earth moves, then stars have to be very far away.
- Was rejected on theological and philosophical grounds.
- 1616, the Church listed it as heresy.