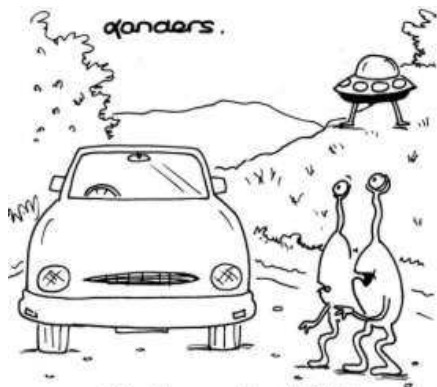


Astronomy 230



What do you do with it ?
I think you're supposed to get in the back
of it and make moaning noises !

This class (Lecture 22):
Cultural Evolution

Jake O'Keefe
Brandon Eckardt
Kevin Quinn

Next Class:
Evolution of World View
Ken Sampson

Music: *Human* – Human League

Nov 9, 2006

Astronomy 230 Fall 2006

Drake Equation

That's 0.26 intelligent systems/decade

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
communic-
ate

Lifetime of
advanced
civilizations

15
stars/
yr

0.5
systems/
star

2.7×0.134
= 0.36
planets/
system

0.095
life/
planet

0.1
intel./
life

comm./
intel.

yrs/
comm.

Nov 9, 2006

HW 3



- **Brandon Eckardt:**
<http://www.crystalinks.com/ets.html>
- **Edward Espiritu:**
<http://crossroad.to/Quotes/spirituality/aliens.html>
- **Aylin Selcukoglu:**
<http://www.theonion.com/content/node/29451/print>

Nov 9, 2006

Astronomy 230 Fall 2006

Presentations



- **Jake O'Keefe:**
Physical Limitations to Finding Alien Life
- **Brandon Eckardt:** Panspermia
- **Kevin Quinn:** Faster than Lightspeed?

Nov 9, 2006

Astronomy 230 Fall 2006

Outline



- From intelligence to communication
- Will a civilization develop that has the appropriate technology and worldview?
- Requires knowledge of quantum mechanics and astronomy.

Nov 9, 2006

Astronomy 230 Fall 2006

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.



Nov 9, 2006

Astronomy 230 Fall 2006

<http://www.popular-science.net/img/out-of-africa.jpg>

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

Nov 9, 2006

Astronomy 230 Fall 2006

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?).



Nov 9, 2006

Astronomy 230 Fall 2006

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/finals
 - 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/

Nov 9, 2006

Astronomy 230 Fall 2006



Agriculture



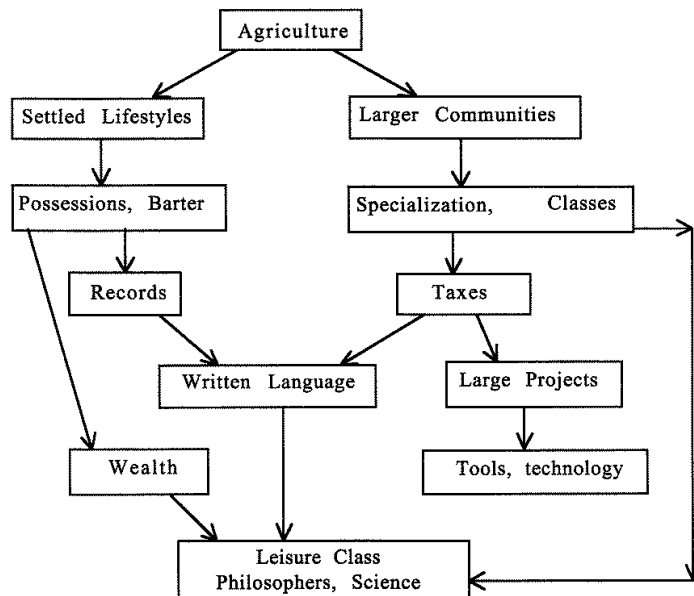
- Tribal societies– 100s of people into villages
- Due to agriculture, larger and larger communities and new societal organizations.
- Began about 10,000 yrs ago, around the dead sea.
 - Mixed hunting with harvesting of wild wheat and barley.
 - Storage, planting, and seed selection.
 - Mutant varieties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

Nov 9, 2006

Astronomy 230 Fall 2006

<http://www.ffa.org/media/comm/index.html>

The Importance of Agriculture

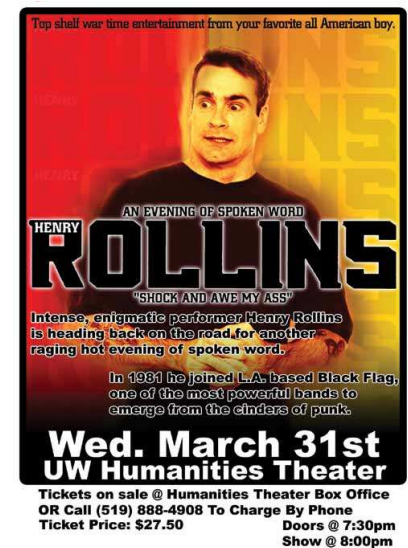


Nov 9, 2006

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>

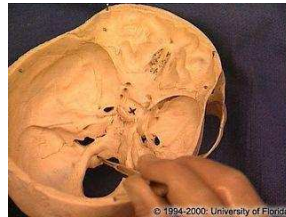
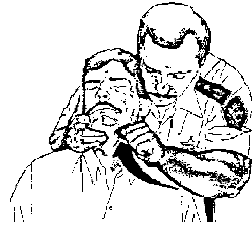
Nov 9, 2006

Astronomy 230 Fall 2006

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/imgs/00000/3000/600/3604.jpg>

Astronomy 230 Fall 2006

Nov 9, 2006

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

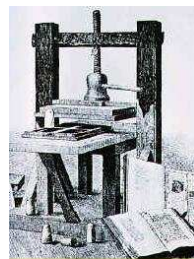
<http://www.nb.no/baser/schoyen/4/4.4/441.html>

Astronomy 230 Fall 2006

Nov 9, 2006

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?

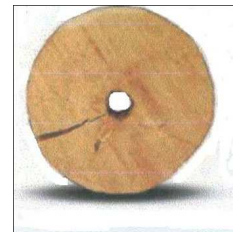
Astronomy 230 Fall 2006

Nov 9, 2006



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>

Astronomy 230 Fall 2006

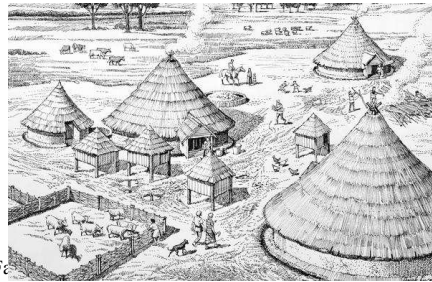
Nov 9, 2006



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

Nov 9, 2006

Astronomy 230 Fall

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>

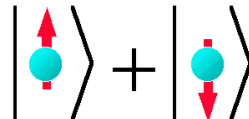
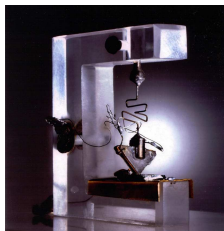
Nov 9, 2006

Astronomy 230 Fall 2006

From Rocks, to Metal, to Rocks



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



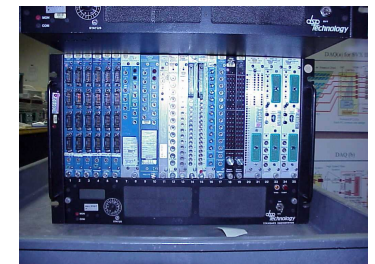
Nov 9, 2006

Astronomy 230 Fall 2006

Cultural Evolution



- What do we mean by cultural evolution?
- Is that like evolution's 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.



Nov 9, 2006

Astronomy 230 Fall 2006

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).

Nov 9, 2006

Astronomy 230 Fall 2006

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.

Nov 9, 2006

Astronomy 230 Fall 2006

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.

Nov 9, 2006

Astronomy 230 Fall 2006