

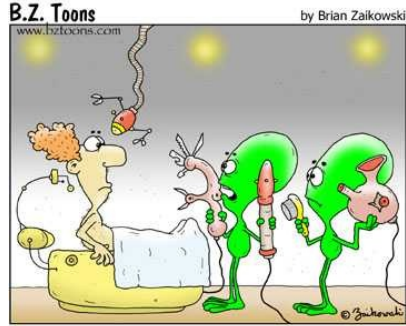
# Extraterrestrial Life



This class (Lecture 25):  
 Evolution of Worldview  
 Sean Sarcu  
 Saloni Sheth

Next Class:

Lifetime  
 Vincent Abejuela  
 Cassandra Jensen



This is our first day. Do you have any idea which one of these things is the rectal probe?

Music: Astronomy – Metallica

2 x 2 page pdf articles due next Tues

## Drake Equation

That's 2.7 intelligent systems/year

Frank Drake



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

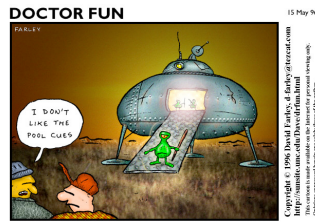
| # of advanced civilizations we can contact in our Galaxy today | Star formation rate | Fraction of stars with planets | # of Earthlike planets per system | Fraction on which life arises | Fraction that evolve intelligence | Fraction that communicate | Lifetime of advanced civilizations |
|--|---------------------|--------------------------------|-----------------------------------|-------------------------------|-----------------------------------|---------------------------|------------------------------------|
| 30   | 30 stars/yr         | 0.8 systems/star               | 4 x 0.47 = 1.88 planets/system    | 0.2 life/planet               | 0.3 intel./life                   | comm./intel.              | yrs/comm.                          |

## Worldview



Intelligent ET Life must want to communicate with us

This means they **MUST** believe in the possibility of us (and other ET life)



How to tell if alien life forms are potentially unfriendly

Requirements:

- 1) Understand size and scale of the cosmos
- 2) Realize their place in the cosmos
- 3) Believe the odds for life elsewhere are reasonable

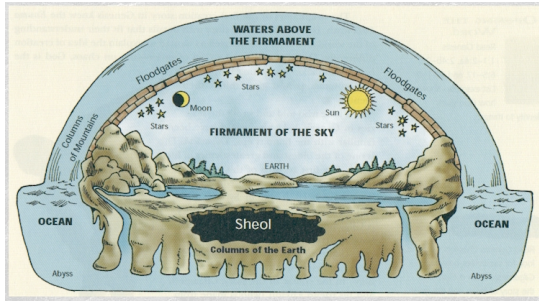
- Requires civilization to undergo three steps:
  1. A correct appreciation of the size and nature of the Universe
  2. A realization of their place in the Universe
  3. A belief that the odds for life are reasonable. The beings of Q'earth must have taken their Q'astro 330 class and came up with a good number of communicable civilizations in the Q'drake equation.

# Our Worldview



First worldview: Earth Centric

**Why?** Natural observations imply we are stationary



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# Ancient Astronomy



Separate Mythology from Astronomy

|                   |               |                   |                 |
|-------------------|---------------|-------------------|-----------------|
| <b>Astronomy:</b> | Time Keeping  | <b>Mythology:</b> | World Formation |
|                   | Calendars     |                   | Fortune Telling |
|                   | Crop Planting |                   | Mysticism       |
|                   | Harvesting    |                   |                 |

Calendars starting in 3800 BCE



Egyptian Calendar



Aztec Calendar



Assyrian Star Planisphere

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- The Mayans computed the length of year to within a few seconds (0.001%).

# Greek Astronomy



Excellent astronomers

Catalogued stellar positions & brightness

Systematic & quantitative observations

Natural Philosophers



Developed competing cosmological theories:

Geocentric cosmology: Plato & Aristotle **Winner**

Heliocentric cosmology: Aristarchus

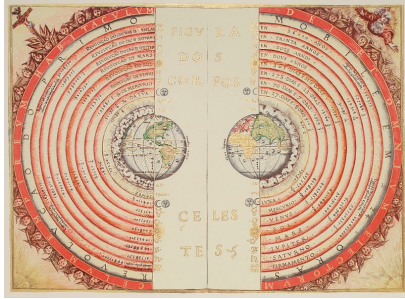
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# Dogma of Ignorance



Ptolemaic (Geocentric) model adopted by Christianity

Implies no ET life



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# Dogma of Ignorance



Science in Europe stagnated for centuries

SN 1054 ignored in Europe

Went against the *Unchanging Universe* **Heretical!**

Recorded in China, Arabia, India, and Americas



Crab Pulsar



Song Dynasty



Chaco Canyon

How would this dogma affect an ET civilization?

# Heliocentric Model



Nicolas Copernicus (1473-1543)

Sun at center of Universe

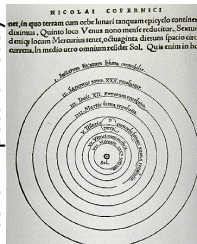
Stars must be very distant



Copernican Revolution

Beginning of scientific renaissance

Published posthumously



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# Giordano Bruno



Developed general cosmology:  
*Plurality of worlds*

Other stars were like the Sun with their own planets

These planets might have life of their own, possibly more advanced

Burned at the stake 1600 ACE for heresy

Considered a martyr for free thought



# Giordano Bruno



# Cosmological Models



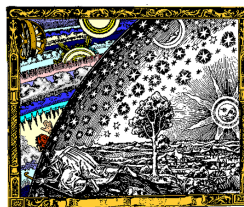
Different competing models:

Neither completely matched observations.



Johannes Kepler: Orbits were elliptical

Philosophical debate until new observations settled the debate.





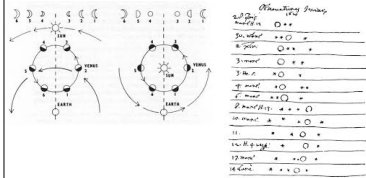


# Galileo Galilei



Systematically used telescope (not inventor)

- Moon has mountains and valleys
- Milky Way consists of faint stars
- Saturn is elongated
- Venus shows phases
- Jupiter has moons (Galilean Moons)



Proved Heliocentric Solar System

Led to *Physical Cosmology*

- Given that an intelligent civilization exists, what is the likelihood that it can (technologically advanced) and will want to (knows astronomy and thinks that its chances are good) communicate?
- Cultural evolution to technology and worldview are essential components of  $f_c$ 
  - Extra-somatic storage of info crucial.
  - Technology and innovation- quantum mechanics
  - Copernican revolution played an important role.
  - ET has to realize that they are not the center of the Universe and that there might be other life.
  - How fast were these accomplishments? What is fast?



## $f_c$



Given Intelligent Civilization



Calculate likelihood of communication



Two components:

Ability (necessary *technology*)

Desire (necessary *worldview*)

Were we *fast* or *slow*?

Cultural Evolution includes both components



We need ET civilizations to know they are not the center of the Universe and that other life might exist.

Is correct astronomy a requirement?



## $f_c$ : What ifs?



On Earth, interest and ability coevolved

Coincidence?

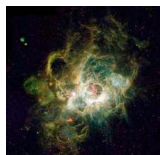
Alien Worldview?



Cloudy Skies?



Single Planet System



Interstellar Cloud



Galactic Bulge



Cluster of Galaxies

$f_c$



Are we typical? Inevitable:  $f_c = 1$  Fluke:  $f_c = 10^{-6}$

Historically, civilizations have not lasted, but knowledge and worldview persist.



Picked up by next civilization



Regional dark ages slow but not stop progress.

This term is about ability to communicate.  $f_c = ??$

## Drake Equation



Frank Drake

That's 2.56 Communicating life/year



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