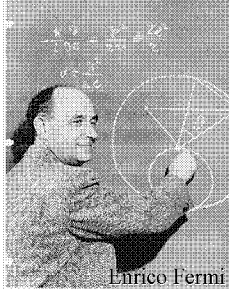


Tuesday, November 30
The Fermi Paradox: "Where is Everybody?"



The Fermi Paradox Key Concepts

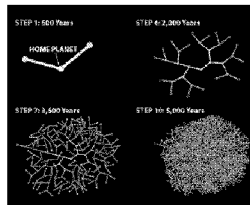
- 1) The Fermi Paradox asks, "Where are the intelligent aliens?"
- 2) Perhaps our civilization is the most advanced in our galaxy.
- 3) Perhaps advanced aliens aren't interested in contact, or are deliberately hiding.

Colonization of the Galaxy is an exponential process; once it starts, it rapidly finishes.

The time to colonize the Galaxy is ~100 Myr with conservative assumptions:

Starships travel at 1% the speed of light.

A colony waits thousands of years before starting new colonies.



A number of possible solutions have been proposed to explain the Fermi Paradox.

- 1) Advanced civilizations are extremely rare.
(There's *at most* one per galaxy.)
- 2) Civilizations exist, but haven't colonized the Galaxy.
(For some reason, they're unable or unwilling.)
- 3) Civilizations *have* colonized the Galaxy.
(For some reason, we are unaware.)

1a) Advanced civilizations are extremely rare because... they seldom develop. (**Rare Earth hypothesis**)

Perhaps we're a product of extremely unlikely circumstances.

We're in the right part of our galaxy.

We're around the right kind of star.

We have a relatively benign impact environment.

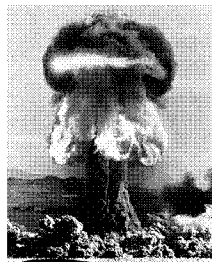
The Earth has a large moon that stabilizes its rotation.



1b) Advanced civilizations are extremely rare because... they destroy themselves. (**Doomsday hypothesis**)

Advanced technology can be dangerous, both because of deliberate aggression & because of inadvertent screw-ups.

- Nuclear war.
- Biological war.
- Accidental contamination.
- Environmental catastrophe.
- Nanotechnology catastrophe.

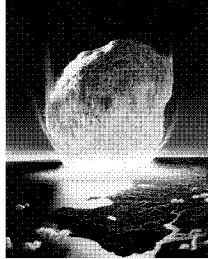


1c) Advanced civilizations are extremely rare because...
Nature destroys them.

(Inhospitable Universe hypothesis)

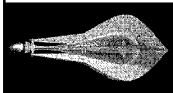
The geological record of the Earth gives evidence of numerous mass extinction events.

Perhaps life on Earth squeaked through all of them by good luck.



2a) Civilizations haven't colonized the galaxy because...
it's very hard.

Sending huge "arks" between stars is an enormous investment in resources.



Robots are cheaper.
von Neumann machines: self-replicating.
Bracewell probes: equipped with artificial intelligence.

Bracewell probes can engage in **dialogue** with the inhabitants of a planetary system.



Bracewell probes can be hidden in places inaccessible to beings that haven't developed technology.

2b) Civilizations haven't colonized the galaxy because... they don't want to.

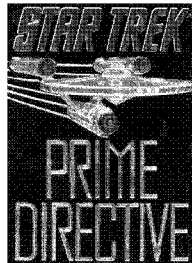
This is at odds with human history. Although individuals and communities adopt "monastic" lifestyles, this has never been true of our whole species.



3a) Civilizations *have* colonized the galaxy, but... they aren't telling us. ("**Prime Directive**" hypothesis)

Perhaps the Earth has been designated as a "nature preserve".

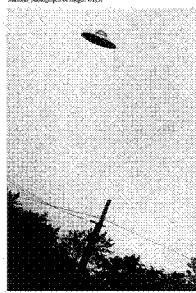
On Earth, there are many examples of "fatal impacts" between human cultures – perhaps we are being protected.



3b) Civilizations *have* colonized the galaxy, but... human governments are covering up. ("**UFOs are spacecraft**" hypothesis)

Fuzzy photographs and anecdotal accounts aren't strong proof; are governments hiding better evidence?

Is any government capable of long-term, leak-free cover-ups?



3c) Civilizations *have* colonized the galaxy, but...
we haven't noticed.



Perhaps aliens live among us,
covertly monitoring our culture.

Perhaps aliens use a form of communication that we
haven't developed yet, so our radio and microwave
"eavesdropping" is useless.

Tomorrow's Lecture:
Life As We **Don't** Know It

Final Exam:
Tuesday, Dec. 7, 1:30 pm
