

Astronomy 150: Killer Skies



Last Class (Lecture 36):
Alien Threats/Review

Exam3: Wednesday!

Music: Life on Mars – David Bowie

Online ICES



- Anonymous ICES forms are available online, so far 156/286 (~55%!) students have completed it.
- I **appreciate** you filling them out!
- Let's try to do better than 60%!
- **Please** make sure to leave written comments. I find these comments the most useful, and typically that's where I make the most changes to the course.
- This is a newer course, so comments are especially welcomed. Keep in mind constraints of a gen-ed though.

Exam 3



- Exam 3 in this classroom on Dec 8th, regular time
- 40 Multiple choice questions
- Will cover material from Lecture 26 to last day.
- May bring 1 sheet of paper with notes
 - Both sides
 - Printed/handwritten/whatever.. I don't really care
- Major resources are lecture notes, in-class questions, and homeworks
- Created and posted a new study guide

Question



Are you going to fill out an ICES form before the deadline?

- a) Yes, I did it already.
- b) Yes, sometime today.
- c) Yes, I promise to do it before the deadline of Dec 9th!
- d) No, I'm kinda a loser.

Outline

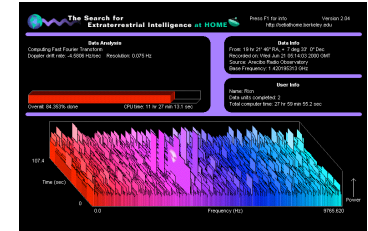


- SETI
- Colonizing the Galaxy may not take too much time.
- Where are they?

How to Communicate with ET?



- If ETs are out there, how do we go about detecting our neighbors?
- Are we seriously sending out messages now?
- No.
- We are relatively a young civilization, with radio technology for only a hundred years.
- Right now, we are mostly a passive “lurker” civilization.



The NASA Search



The most ambitious search was planned by NASA on the 500th anniversary of the *Discovery* of America– Oct 12, 1992.



<http://www.teslasociety.com/exposition2.jpg>
<http://www.sailtexas.com/columbusships.html>



The NASA Plan



- 2 prong approach using both Targeted Search and Sky Survey
- Sky Survey:
 - NASA’s 34 m tracking telescopes in CA and Australia.
 - 6 year plan covering 1-40 GHz with 16 million channels of 20 Hz each and 30 different settings.
 - Would only detect very strong signals.
- Targeted Search:
 - Cover 800 suitable stars within 75 lyrs.
 - 16 million channels with 1 Hz bandwidth
 - 1-3 GHz range and very good sensitivity!



The NASA Search



- “In 1993, Nevada Senator Richard Bryan successfully introduced an amendment that eliminated all funding for the NASA SETI program.
- The cost of the program was less than 0.1% of NASA's annual budget, amounting to about a nickel per taxpayer per year. The Senator cited budget pressures as his reason for ending NASA’s involvement with SETI.”



The NASA Search



- “The Great Martian Chase may finally come to an end. As of today millions have been spent and we have yet to bag a single little green fellow. Not a single Martian has said take me to your leader, and not a single flying saucer has applied for FAA approval.”



<http://www.planetary.org/html/UPDATES/seti/history/History12.htm>
http://www.seti.org/about_us/faq.html



<http://www.planetary.org/html/UPDATES/seti/history/History12.htm>
http://www.seti.org/about_us/faq.html

The SETI Institute

- An independent institute that was working with NASA on their SETI project.
- Once NASA cut funding, they went ahead with a more modest version of a targeted search— Project Phoenix.
- Funded by private donors.



http://www.seti.org/seti/our_projects/project_phoenix/overview/overview.html

Project Phoenix



- Just finished up in 2004.
(<http://www.seti.org/seti/projects/project-phoenix/faq.php>).
- About 2-3 weeks a year of telescope time to scan a total of 800 stars (out to 240 lyrs) for a total of 11,000 hours.
- Best survey to date, but no ET signals.



Allen Telescope Array



- UC Berkeley and the SETI Institute, with majority of funding from Paul Allen, are building the ATA.
- 350 antennas that are 6.1 m in diameter, planned.
- Currently have 42 antennas



Allen Telescope Array



- Smaller dishes– larger field of view.
- But LOTS of them.. planned
- With advanced electronics it will cover 1-10 GHz with many channels.
- Can image a few stars per field.



Allen Telescope Array



- 100% SETI (with science on for the ride)
- Will increase search to 100,000 or 1 Million stars.
- Is now observing!
- <http://www.seti.org/ata/>
- FUNDING IS AN ISSUE!



Allen Telescope Array



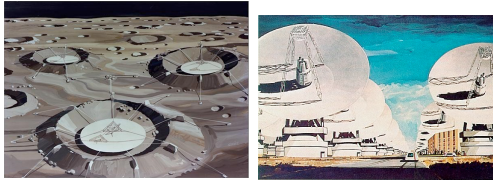
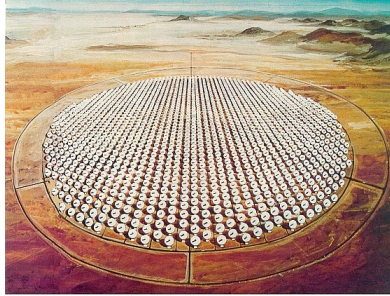
See the telescope in action:

<http://atacam.seti.org/maincam-index.html>

The Future?



- Cyclops – 1000 telescopes each 100 m in diameter.
- Resembles a giant eye.
- Could detect leakage transmission at 100 ly.
- Could detect a 1000 MW transmission at 1000 lyrs.
- Bucco Bucks– \$50B and 10-20 yrs to build.



<http://www.astrourf.com/lombry/ovni-bioastronomie-et.htm>

We attempted Contact



- The first real signal sent was in 1974 by the Arecibo telescope (20 trillion Watts of power).
- ET should be able to arrange data into a picture.
- Sent toward the globular cluster M13 which is 21,000 lyrs away.
- Not very likely to have life.. too old, not many heavy elements.

Decode what?

- Now, we wait.....
- If they're looking, a SETI experiment will detect this.
- But human experts had trouble decoding it.



ARECIBO Nov. 16, 1974 Trans

0 0 0 1 1 1 1 0 0 0 NUMBERS
 1 0 0 1 1 0 0 1 1 0 1-10
 10 11 10 1 0 1 0 1 0 1 (right to left)
 T1000: ATOMIC NUMBERS FOR LIFE
 10110 (from right to left) Hydrogen 1;
 10110 Carbon 6; Nitrogen 7; Oxygen 8;
 10100 Phosphorus 15

Right to left
 00011 00011 00011 00011 Deoxyribose;
 00001 01000 00000 00001 ADENINE;
 01011 00011 00110 01011 THYMINE;
 01000 01000 Deoxyribose;
 00000 00000 Phosphate;
 10000 10000 Phosphate

00011 00111 00011 00011 Deoxyribose;
 00001 00000 00100 00001 CYTOSINE;
 01011 01110 01000 01011 GUANINE;
 Deoxyribose;
 01000 11 01000 Phosphate;
 00000 11 00000 Phosphate;
 10000 11 10000

NUMBER OF 11
 BASE PAIRS 11
 IN HUMAN DNA 10
 4,294,441,822 11
 NUCLEOTIDES;
 DOUBLE 10
 DNA-HELIX 11
 VISUAL REP 10
 OF A HUMAN 11
 BODY 01
 11
 10 110110
 111111
 111011
 110111
 110111
 111111
 111111

1110 POPULATION 110111
 IN 1974
 4,292,853,750 111111
 OF HUMAN 9' 9.6" 11

VISUAL REP OF SOLAR SYSTEM
 (right to left) Sun; Mercury; Venus;
 Earth; Mars; Jupiter; Saturn; Uranus;
 Neptune; Pluto

VISUAL REPRESENTATION OF
 ARECIBO TELESCOPE IN
 PUERTO RICO (1974)

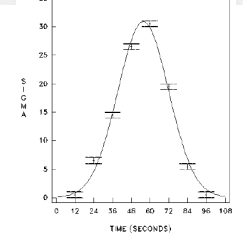
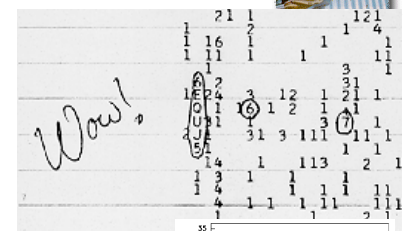
ACTUAL DIAMETER OF ARECIBO
 TELESCOPE 1004.52 Feet

101001 = 2430 | 12.6 cm * 2430 =
 011111 30,618cm = 1004.52'

<http://amo.net/Contact/>

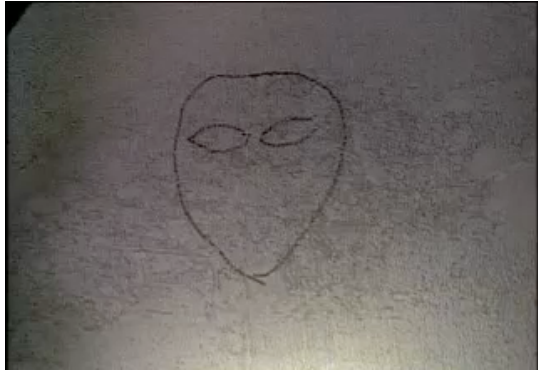
The Wow Signal

- Aug. 15, 1977, Jerry Ehman was looking through the data when he recorded the Wow! signal.
- A major signal in the telescope– 30σ detection!
- Stayed around for >72 seconds.
- Unlikely to be noise, but never seen again.
- "Even if it were intelligent beings sending a signal, they'd do it far more than once."
- Used in X-Files



<http://www.bignep.org/wow.htm>
 Gray & Marvel 2001, ApJ 546, 1171

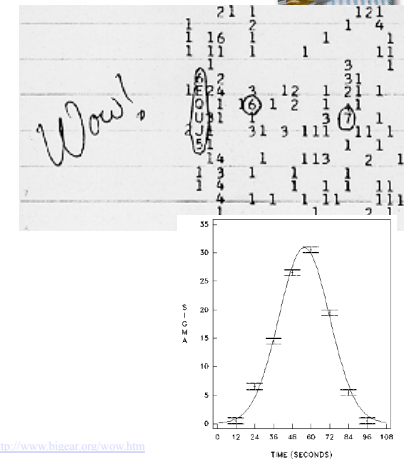
Wow! in pop culture



The Wow Signal: Facts



- Narrowband signal: one channel only
- Signal observed in only one (of two) horns
- Signal observed only once ("Big Ear" or other observatories)
- No measured modulation



<http://www.bigear.org/Wow30th/wow30th.htm#otheranal>

<http://www.bigear.org/wow.htm>
Gray & Marvel 2001, ApJ 546, 1171

Does ET Love Lucy?



- Another possibility is to look for unintentional leakage signals.
- Leakage, as it "leaks" from the planet's ionosphere.
- We can not currently detect this, but maybe other civilizations can.
- What leakage do we have? TV, FM Radio, radar



<http://www.time.com/time/time100/scientist/profile/farnsworth.html>

Contact



"If humans were the only life in the Universe it would be a terrible waste of space."

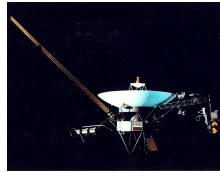
Vega (251yr) calls us back, but how can we be sure that we're listening?

Our leakage radiation is actually decreasing with cable, fiber optics, direct satellite, etc. Civilizations may not spend much time in that phase.

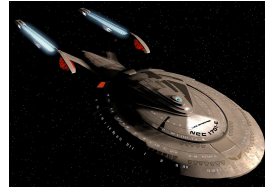
<http://www.youtube.com/watch?v=SRoj3jK37Vc>



Interstellar Travel



- But, what if all communication with ET fails?
 - Wrong frequencies.
 - Everyone is listening and no one is broadcasting.
 - We fail to recognize the signal.
- We can go visit them or the microbes. “To boldly go...”
- BUT, the distances are huge!
- Nearest star is 4.3 ly away or around 4×10^{13} km!
- **40,000,000,000,000 km! 40 TRILLION km!!!**
- Our fastest object, Voyager would take nearly 100,000 years

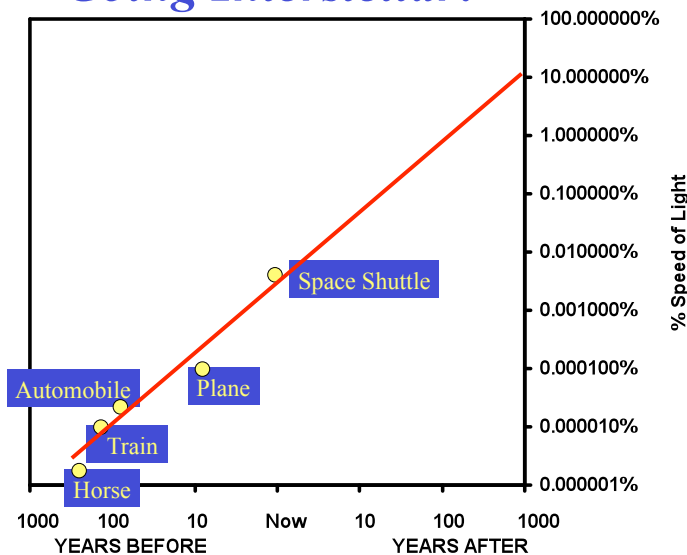


Problems to Overcome?



1. Space is Big.
 - Nothing we can probably do about this one.
2. Time.
 - Because of #1, interstellar travel would take a lot of time.
 - But arguably do-able.
 - Maybe lifetime is expanded, generation ships, suspended animation, or intelligent robots.
3. Cost
 - Right now, colossal budget of a few trillion dollars. Impossible now, but in the future?
 - Medieval blacksmiths could have made an oil tanker, but too costly. 500 years later, piece of cake.
 - In future, cost of interstellar travel may also go down.

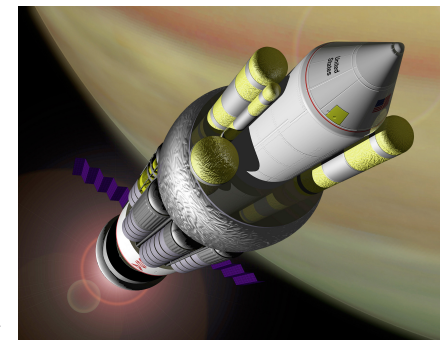
Going Interstellar!



Project Orion



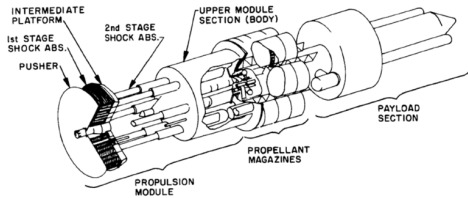
- A spacecraft powered by nuclear bombs— nuclear fission.
- Idea was sponsored by USAF in 1958
- Physicist Freeman Dyson took a year off from Princeton to work on idea
- Sounds crazy now... but a real project



Project Orion



- You dropped hydrogen bombs wrapped in a hydrogen rich jacket out the rear of a massive plate.
- Detonate 60 meters away, and ride the blast-- an atomic pogo stick.
- 0.1 kton bomb every second for take off, eventually tapering to one 20 kton bomb every 10 sec.



http://en.wikipedia.org/wiki/Project_Orion_%28nuclear_propulsion%29

Project Orion



- Limited to about 0.10c.
- But, it is a “dirty” propulsion system.
- A 1963 treaty banned nuclear tests in the atmosphere, spelled the end of "Orion".
- Still argued to be the best rocket we could build today.



<http://www.daviddarling.info/encyclopedia/O/OrionProj.html>

Getting Off the Earth



- Interstellar trips will have to be in spacecraft that are built in orbit.
- Launching off the Earth is too prohibitive
- Need in orbit or on Moon construction facilities
- Possible solutions:
 - Space elevator
 - Space gun

Future: Warp Drives?



- Due to great distance between the stars and the speed limit of light, sci-fi had to resort to “Warp Drive” that allows faster-than-light speeds.
- Currently, this is **impossible**.
- It is speculation that requires a revolution in physics
 - It is science fiction!
- But, we have been surprised before...
- Unfortunately new physics usually adds constraints not removes them.



<http://www.filmjerk.com/images/warp.gif>

The future:



May bring us closer to the speed of light

- Right now we can travel through space at about $c/25,000$
- Maybe fusion-powered crafts could in the near future reach $0.01c$ or maybe even $0.10c$

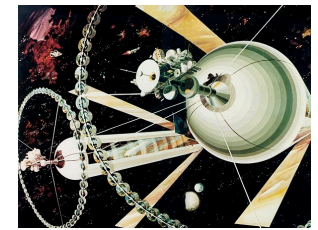
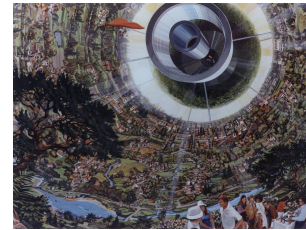


<http://www.jedisaber.com/SW/wallpaper/light%20speed.jpg>

1000 Years?



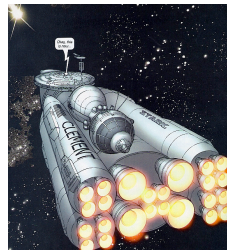
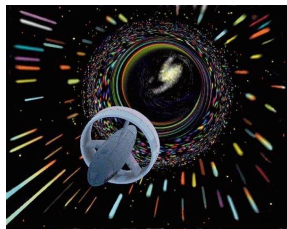
- So in 1000 years from now, we should be able to travel to other stars. But will we?
- It would be nuts to speculate on what will motivate our descendants (if any) 1000 years from now. But if interstellar travel really is easy and cheap, surely someone will give it a go?



Getting Out of Here



- Distances between stars are much greater than we can imagine– freaky big distances, plus difficult environment and time consuming makes interstellar travel hard to conceive.
- SciFi books and movies have dramatized space travel to make it seem possible
 - But, interstellar travel **may never happen**



Galaxy Colonization



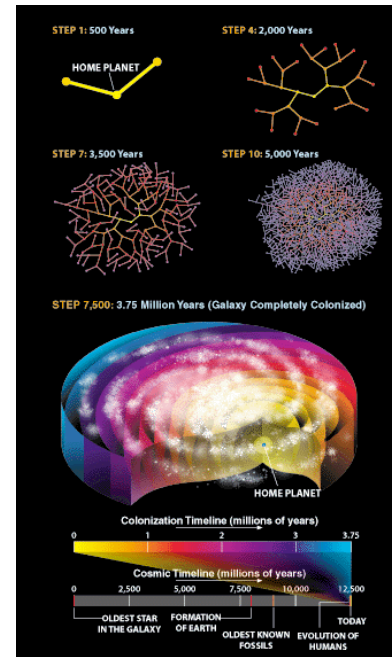
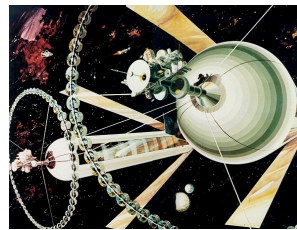
- If the average Drake equation estimate is roughly right, there could be civilizations that are 1 billion years old!
- Think of the accomplishments.
- Even if interstellar travel is limited to $0.1c$, civilizations with advanced telescopes could send colonizing craft to new “Earth-like” planets.



How long to colonize the Galaxy?



- With 0.1c, we can travel 10 light years in 100 years
- Can reach the nearest star in 43 years
- How long to colonize the Galaxy?



Optimistic

Every 500 years, the colonization craft makes it to the next suitable solar system—small delay.

Colonization only takes about 4 million years!

Slow Long Haul Space Travel



- Spacecraft that we can envision easily would take a lifetime to get to the nearest star.
- Colonizing missions would have to be multi-generation missions.
- Space colonies with propulsion systems would slow down things, so maybe it would take 1000 yrs or more for each trip.
- How many of you would sign up today?



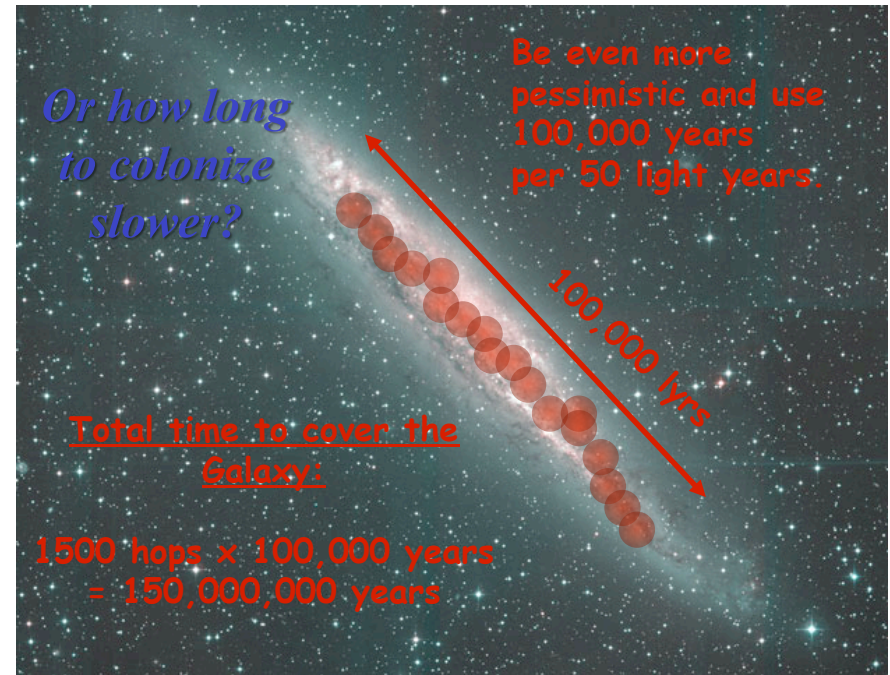
A) Yes B) No

Or how long to colonize slower?

Be even more pessimistic and use 100,000 years per 50 light years.

Total time to cover the Galaxy:

1500 hops x 100,000 years = 150,000,000 years



The Fermi Paradox



The Drake Equation - Even for a few hundred technical civilizations.

Only 150 million years to colonize the Galaxy.

WHERE IS EVERYBODY?????

The Fermi Paradox



- Given some ET civilizations, one of them must have developed earlier than we did.
- So “Where are they?”
- Even if interstellar travel is very slow and difficult, there has been a lot of time to do it.
- Furthermore, many of the objections to interstellar travel do not apply to artificial intelligence (intelligent robots.)



Timescales



- For pessimist: 150 million years to colonize the Galaxy.
- For optimist: 4 million years to colonize the Galaxy.
- This may seem like forever, but it is actually pretty tiny compared to the time it takes evolution (about 0.1%).
- So, if we believe our condition, there should only be one intelligent family of species in our galaxy - whoever reached intelligence first should have spread everywhere before anyone else reaches intelligence.
- This is the main point of the Fermi Paradox.

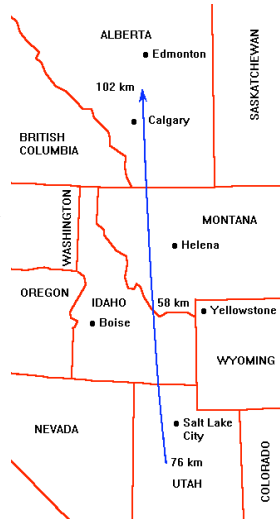
An Example: Meteor 1972



Yikes, a Near Miss



- A bus sized object entered atmosphere over Utah and exited over Canada
- Velocity of 15 km/sec
- Missed Earth by 58 km



But...



- Event was completely unexpected
- Crossed relatively sparsely-inhabited region
- Only visible for a *total* of 101 seconds
- Visible for no more than 30 seconds at any one spot



But...



- Nonetheless, we have dozens of clear photographs of this event
- Still we have no comparable images of UFOs.
- And today digital cameras and camera phones should make unusual events even more seen.



Problems?



Large number of sightings argues **against** alien spacecraft.

- Space is freaky big.
- There are extreme difficulties of interstellar space travel and the number of planets to explore.
- So, why would so many alien spacecraft be visiting the earth constantly?
 - There are other planets to check out.
 - What makes us so interesting?
 - We should not overestimate our significance.



Propulsion Detection



- Only if interstellar techniques become really easy will visits be possible.
- We would probably see them coming.
- Nuclear fusion and antimatter propulsion would produce copious gamma rays— easily detected.
- If a spacecraft decelerated from c within 1 AU of the Earth with mass $>$ few tens of grams would be detected.



<http://www.yougottareadthis.com/img/51-on-ufo.jpg>

Give Me Real Evidence!



- Evidence:
 - A piece of a probe or spaceship
 - Some trace that can be uniquely linked to an ET probe
 - Biological material.
 - A reliable, logical calculation
- That is the same we require of ANY scientific investigation



<http://www.alien-ufos.com/images/ufos/miscuf04.jpg>

Other Ideas: Space Probed



- A single probe is constructed and dispatched to a nearby star system
- It surveys the system in an intelligent and exhaustive manner
- After which, the probe uses the energy and available raw materials of the system to reproduce itself.
- Often called a Neumann Space Probe



Neumann Space Probed



- Dispatches its “children” onwards to repeat its mission in other star systems
- The parent probe is then able to choose whether it wants to stay in the system or not, depending on what it found
- Armchair explorers



<http://www.biochem.wisc.edu/wickens/meetings.html>



Neumann Space Probe BERSERKERS!!!!!!



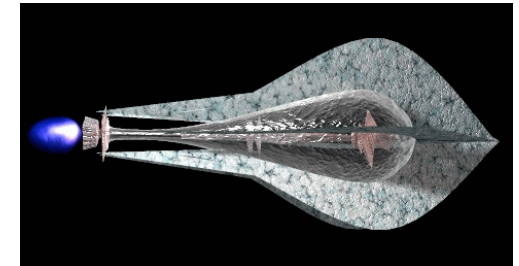
- Self-Replicating Devices
- Openly hostile to life forms
- Out of control
- Probe ecosystem?
- Programmed to evolve?



Neumann Space Probed



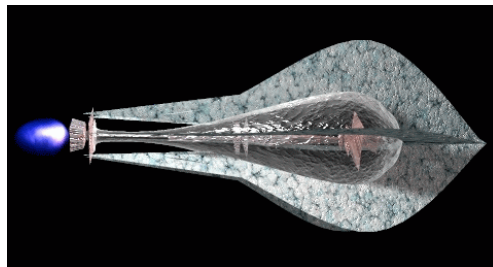
- What if it's armchair generals instead of explorers.
- Decide to change the galaxy by force?
- What if programming goes crazy, and the objects decide to ignore the explore part and focus on only the replicate part?
- Might be a larger possibility than we thought.



Mitigation



- I dunno.
- Send out our own probes?
- Make sure to get vaccinated for space flu?
- Destroy all life friendly planets in case they evolve after us?
- I prefer to just explore the Universe, and let's see what's out there!



Imagine

- Astronomers notice something bright in gamma-rays moving into the Solar System.
- The object is changing course!
- Contact! But it isn't responding to our hails.
- The object passes by the asteroid belt, but then starts to move out of the Solar System.
- Excitement dies down, but a year later, an asteroid starts to change orbit and move toward Mars.
- The asteroid has factories and "lands" on Mars.
- Robotic spiders are building more and more factories, and with our orbiting spacecraft, we watch.

Imagine

- Within a few years, the surface of Mars is picked clean, as micro-factories replicate huge numbers of alien robot-like organisms and spacecraft.
- A year later, objects start to lift off from Mars, and they are coming toward Earth!
- As they land, there is nothing we can do.
- They begin to destroy the surface of the Earth, making more replicates of themselves.
- As you are ripped apart for your heavy elements, you wonder why you didn't pay attention during the last few days of Leslie's class.

Top 10 Ways Astronomy Can Kill you or your Descendents



1. Impacts!
Splat.. Boom... Watch out for space rocks!
2. Solar Evolution.
MS to Red Giant to White Dwarf.
3. Coronal Mass Ejections
Cold winter days..
4. Supernova in your face!
Super sunburn.
5. Gamma Ray Burst.
From anywhere...

Top 10 Ways Astronomy Can Kill you or your Descendents




6. Rogue compact objects–White Dwarfs/Black Holes.
Black Holes don't suck, but if they hit you it sucks.
7. Galaxy Collisions.
Milky Way vs. Andromeda.
8. Cosmology!
This is the way the Universe ends..
9. Quasars. The Monster in the Milky Way?
It burnssss...
10. Aliens.
You're kidding right...

The End May be in Sight!



- There are cosmic hazards to life on earth.
- We may have experienced them in the past.
- Could explain lack of evident life in galaxy.
- Some of these WILL happen, and we shall have to leave earth eventually to insure the further existence of humans in our Galaxy.
- But for now, everything is fine, is fine, is fine, is fine, is fine....

A rectangular image of a starry night sky, filled with numerous stars of various colors (yellow, orange, blue, white) and some faint galaxies. The text "Thank You & Good Luck! 😊" is overlaid in a yellow, cursive font.

*Thank You &
Good Luck! 😊*