



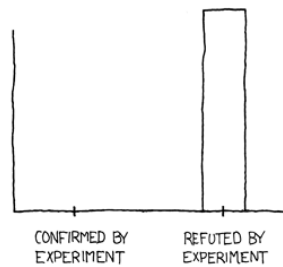
# Extraterrestrial Life

Last Class!!!:

Visitations

Music: The Fermi Paradox– Hank Green

CLAIMS OF SUPERNATURAL POWERS:



**HW #7 (The Last Question): Wednesday, May 6th**

**Peer Grading of articles: Friday, May 8th**

**Final Exam: Friday, May 15th (May 20th the latest)**

## Drake Equation

**That's 2560 advanced civs!!!**

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	stars/yr	0.8	systems/star	$4 \times 0.47 = 1.88$	planets/system	0.2	life/planet	0.3	intel./life	.95	comm./intel.	1000	yrs/comm.

30 stars/yr × 0.8 systems/star × 1.88 planets/system × 0.2 life/planet × 0.3 intel./life × .95 comm./intel. × 1000 yrs/comm. = 2560 advanced civs

With 2560, need to look volume of 1000 light years to find 1 advanced civ.

## Weird Consequences of Going Fast



Special Relativity introduces some counter-intuitive results

**Time Dilation:** Moving clocks *run slow*

Twin Paradox

**Length Contraction:** Moving objects contract along direction of motion

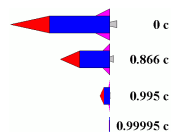
Ladder in the Barn

**Mass Increase:** Moving objects become more massive

Energy demands grow as speed increases

Shielding required to protect against interstellar dust

At 99% c, 5.5m of shielding erode every year



## Question



Your best friend is going on a near light speed trip and you're on the Earth. As she flies by, you see her clock (readable from Earth). For every second that passes on the Earth,

- a) Exactly 1 second passes on the rocket.
- b) Less than a second passes on the rocket.
- c) More than a second passes on the rocket.

iClicker

x

## Question



Your best friend is going on a near light speed trip. When at rest you measure her spaceship to be 100 feet long. Now, she's in flight and you're on the Earth, and you measure her spacecraft to be

- a) Exactly 100 feet long.
- b) Less than a 100 feet long.
- c) More than a 100 feet long.

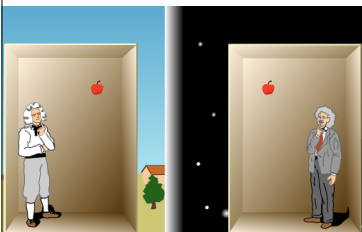
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## Space Time



Special Relativity: Space and Time are linked

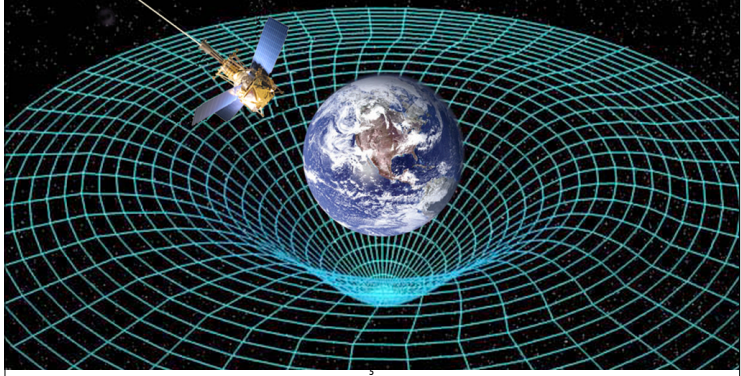


General Relativity: Matter affects Spacetime

Gravity: Spacetime affects Matter

# Space Time

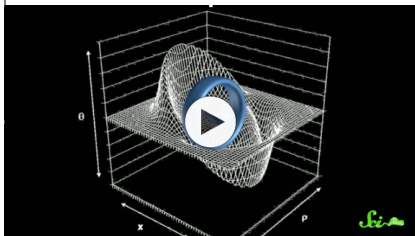
Clocks runs more slowly on Earth than in outer space!



## To Boldly Go ...

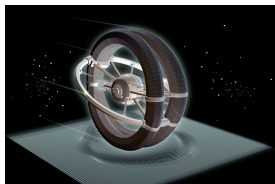


## Warp Drives

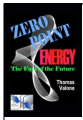


Warp Drive

Change Spacetime



Negative Energy: Current models require enormous quantities

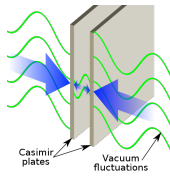


# Zero Point Energy

Sea of virtual particles inhabit subatomic world

1948: Hendrik Casimir

Two 1 meter plates  
1 micron distant  
Attractive Force = 1.3mN  
Weight of 130 mg



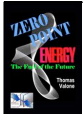
Force out of nothing!



Harness this power for propulsion?



x



# Dark Energy

Repulsive force pushing spacetime apart

Dark Energy



Power Source for Warp Drive?

Anti-Gravity Generator?

Harness this power for propulsion?

First what is it?

Patience is key?

Lifetime of civilization?



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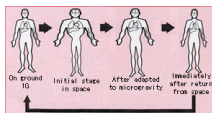


# Long Distance Travel

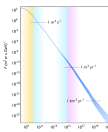


How will the human body survive space travel?

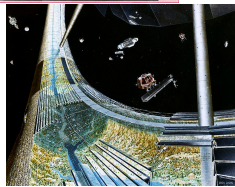
Weightlessness  
Fluid redistribution  
Effect of vision



Radiation



Psychology



Food & Water  
Wastes



Cryogenics?

x

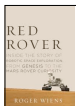


# Travel Problems to Overcome

1. Space is Big.
  - Nothing we can probably do about this one.
2. Time.
  - Because of  $c \neq \infty$ , 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.

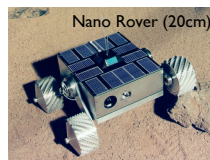
## Issues and Incentives

- Assume there is intelligent life out there.
- Will they try to travel to us?
  - Is it worth it?
  - Exploration?
- If a civilization has been around for 1 million more years than ours...
- But interstellar travel is **HARD!!!!**
- Back to thinking about autonomous probes..



## Probes

Robotic travel cheaper & Easier



Robotic exploration of nearby systems?

Identify habitable locations?  
Identify life forms?  
Terraform?

Self-Replicating?

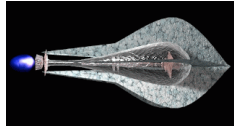
# Self-Replicating Probes



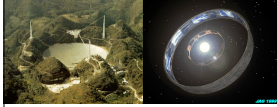
Single probe is dispatched to nearby star system



Exploration  
Communication  
Working  
Colonization  
Uplifting  
Policing



Scientific exploration  
Mine raw materials for reproduction



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# Berserkers

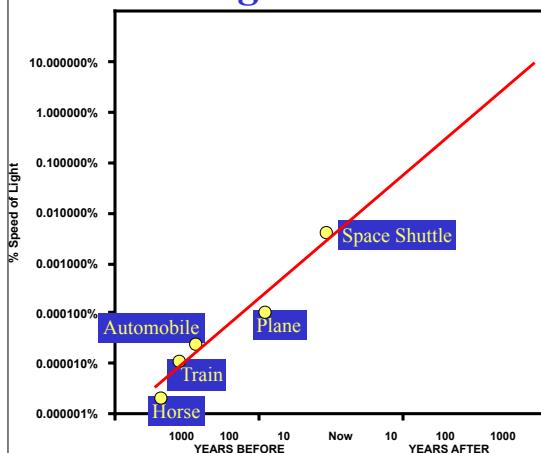


Galactic virus consuming raw materials, killing all life!



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# Going Interstellar!

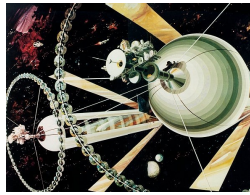


10% c is possible in the long-term

## 1000 Years?



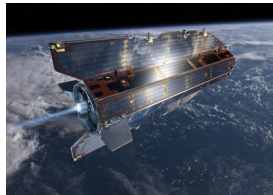
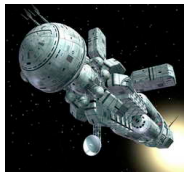
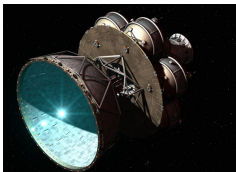
- So in 1000 years from now, we might be able to travel to other stars. But will we?
- It would be nuts to speculate on what will motivate our descendants (if any) 1000 years from now. But if interstellar travel really is easy and cheap, surely someone will give it a go?



## 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



In our discussions, we argue that with foreseeable technology 10% the speed of light is possible.

Is that enough to expect to see aliens on Earth?

## 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.
- How many of you would sign up today?



A) Yes B) No

# Galaxy Colonization

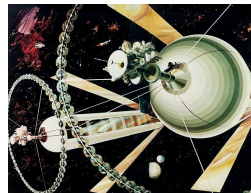


- If our Drake equation estimate is roughly right, there could be civilizations that are 1 billion years old!
- Think of the accomplishments.
- Even if interstellar travel is limited to 0.1c, civilizations with advanced telescopes could send colonizing craft to new “Earth-like” planets.
- That group regenerates for 500 yrs and sends out another craft.
- An advanced civilization could colonize the entire galaxy much quicker than you think.

## How long to colonize the Galaxy?



- With 0.1c, we can travel 10 light years in 100 years
- We can reach the nearest star in 43 years
- Allow each new colony 500 years to duplicate the technology
- Colonies could spread out about 50 light years every 3,000 years

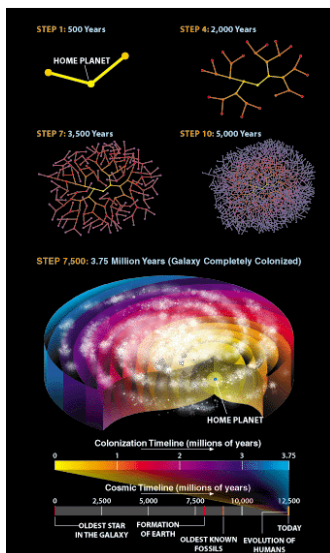


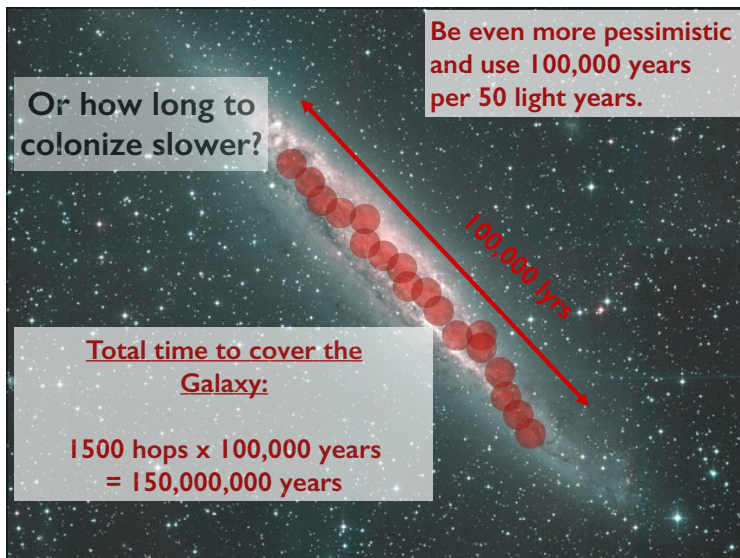
## Optimistic



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

Then, it only takes about 4 million 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 civs, 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.)





## Life on Earth is of One Type?



- Life got started on Earth pretty quickly. To some, this suggests that life forms easily, whenever conditions are right.
- So why are all creatures on Earth descended from the same microbe?
- You can tell from the similarities in our DNA and cells that all living things come from the same ancestors. Why?
- The average time needed to spread over the Earth was much less than the average time to evolve.

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## 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.
- Where are they?

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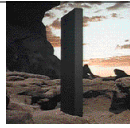
## Limits



- So, if we go back to two alternatives - a galaxy packed with billions of intelligent life-forms, and a cold and lonely empty one, Fermi is suggesting that the truth lies closer to the second alternative.
- Does this seem reasonable?
- There may be a few (or a few hundred) intelligent species out there.
- But if there really were billions, we would have surely have been visited?



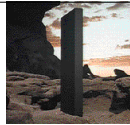
## Where is Everyone?



- **They are around, but we can't tell yet**
  - They are too advanced or alien to recognize or detect
  - They don't bother with us (or traveling or broadcasting)
  - Do civilizations hide to avoid a "galactic scourge?"
  - They are keeping us "quarantined" (the "zoo" or prime directive hypothesis)
  - They've been here (or are here), and we don't know it
  - They are not "technical" in a way we can understand.



## Where is Everyone?



- **They are not around**
  - Some factors in Drake equation may be much smaller than we believe – life, or intelligent life, is very rare
  - Rare Earth
  - They wipe themselves out too quickly
  - Other factors wipe them out too quickly
  - Life hardly ever develops technical civilizations
  - There is very little life out there
  - We are among the first to develop
  - Interstellar travel is even harder than we thought

## Malevolent Species



If you communicate, you die?

Others extinct?

Or just afraid to talk?

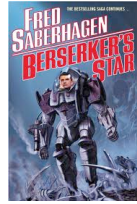
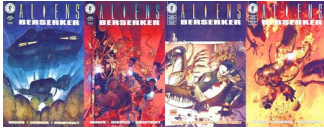
Maybe fear us?



# Looking for Probes



Maybe we should be looking for probes?



Probes in the Solar System?

Waiting for sentence?

What will they do?

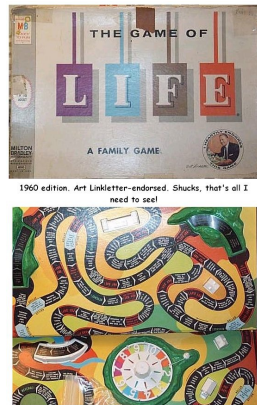
Meet-n-Greet?  
Shoot to kill?

x

## Maybe Life is Hard



1. Maybe colonization is much more difficult than we assume. Might expect robotic probes first, which slows down the process.
2. Maybe travelers prefer to explore more than colonize. Overpopulation is not the issue.
3. Are planets suitable for life? If one of the 20 amino acids is missing on that planet, food is a problem.
4. By colonization timescale, the space creatures may prefer to stay in space—weightlessness evolution. Comfy clothes.



<http://www.wesclark.com/am/life.jpg>

## Class Conclusions?



- There is no reliable evidence that leads us to believe that life exists somewhere else in the universe.
- As this class has shown, life is **possible**, but that is all we know now!
- May the future enlighten us!
- Still, let's use what we do know and see what sort of conclusions we can make.
- Is it possible that someone may see a UFO?

## Fact 1



It is possible that ETI life is abundant in our galaxy

- With 300 billion stars and plenty of opportunities for life to develop.
- Our estimate for civilizations was **2500** right now!
- So, there are clearly arguments for common life.

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## Fact 2



If ETI is abundant in our Galaxy, then we expect that, statistically, there exists or have existed ET civilizations that have achieved a technological capability greater than that which we now demonstrate— an advanced civilization!

- The time to reach Type 0 status was about 4.5 billion years on Earth, but it could easily be only 3.5 billion years somewhere else
- An intelligent civilization can do a lot in a billion years

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## Fact 3



The distances and times associated with interstellar travel are great, but as far as we know, it is conceivably possible that a civilization conducts significant interstellar exploration, especially with enough time.

- At very least, a more advanced civilization could have sent out nanoprobes across the Galaxy.

## Fact 4



It is possible therefore that an ET civilization has explored our region of the Galaxy, the Sun, and even our Earth at some point in its history

- This is not pseudo-science but real logical consequences of abundant ETI.

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## Fact 5



We have no reason to believe that this has not happened

- We also have no reason to believe that it has.
- It is an open question.

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## What are we left with?



- These are two distinct but still very significant claims from our Drake Equation
  - The Earth has been visited by ETs.
  - The Earth has not been visited by ETs.
- Neither of these statements has been validated.
- So, the only statement we can make is
  - We do not know whether or not the Earth has been visited by ETs.





# The ET Visitor Hypothesis



- So far no reliable evidence exists for ET visitation
- But, the idea that we have been visited and traces exist somewhere is a valid **THEORY**
  - Maybe improbable but still valid
- *Don't expect people to believe your theory unless it is substantiated with reliable evidence*

## Unidentified Flying Object



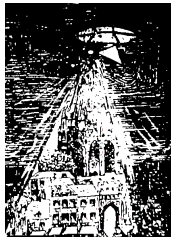
### Initial Reports around 1900

Urbanization/Industrialization

Sacramento 1896

England 1906

Blimp like object with lights



### Modern report 1947

Pilot Kenneth Arnold (Mt. Rainer)

9 objects like 'saucer skipping across the water'



He thought they were a government project

Press coverage: new sightings increased

Modern sighting phenomenon from Kenneth Arnold in 1947 who told reporters that while flying a private airplane near Mount Rainier, he saw nine objects that moved like "a saucer skipping across the water."

He actually thought they were government projects.

Picked up by the pulps, and the number of sightings jumped.

36

## Unidentified Flying Object



### Post WWII civilization changes:

Jet Airplanes

Publicity of military and space programs

Increase in media



UFO: Government term to neutralize connotation of "flying saucer"

UFO now has same connotation

50% of public believe UFOs are alien visitations



The popularity is not very surprising

Jet planes first introduced at the end of World War II

Public aware of fast-moving aircrafts

50% of the public believe in the existence of UFOs as aliens visiting Earth.

Where there's smoke...

Not all of them can be wrong...

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## Close Encounters?



Scientific approach— you gotta classify

Carl Jung

1. Nocturnal lights: bright lights
2. Daylight lights: usually cigar or disk-like shaped.
3. Radar-visual: those detected by radar
4. Close encounters of the 1<sup>st</sup> kind: visual sighting of an unidentified object.
5. Close encounters of the 2<sup>nd</sup> kind: visual sightings plus physical effects on animate or inanimate objects
6. Close encounters of the 3<sup>rd</sup> kind: sightings of occupants in or around a UFO.

## UFO Study Problems



- Why are UFO sightings hard to explain?
- Sightings must be explained “after the fact” without complete information.
- Sightings are based on eyewitness accounts, which are notoriously unreliable.
- Inconsistencies are often ignored.
- Humans seem to have a psychological need to believe in superior beings (→religion?).
- Failure to find a “normal” explanation is not evidence for alien visits.

## Occam's Razor



- *Pluralitas non est ponenda sine necessitate* [Latin]
- Given two equally predictive theories, choose the simpler.

Or

- *The simplest explanation is usually the best.*

## We Need Hard Evidence?



- A probe or remains of a probe somewhere on our planet or in our solar system
- The remains of ET biological activity somewhere on our planet or in the solar system.
- ET clearly announce themselves.
- If you expect to have your scientific investigation received seriously, you have to follow simple logic and common sense
  - The rules for the scientific method are just logic and common sense



[http://www.biochem.wisc.edu/wickens/jpgs/2001\\_spac\\_odd.jpg](http://www.biochem.wisc.edu/wickens/jpgs/2001_spac_odd.jpg)

## UFO Phenomenon



- Some argue that we have proof:
  - UFO sightings.
  - Strange historical accounts or grand technological accomplishments of humans in the past.
  - Alien abductions.
- This all falls into the realm of pseudoscience.
- There has never been any concrete evidence of extraterrestrials having anything to do with UFOs.
- UFOs could be so very many things. Why assume automatically that there is an otherworldly explanation? But those who want to believe will do so even despite evidence to the contrary.
- In this class, we think that "**Extraordinary Claims Require Extraordinary Evidence**" - Carl Sagan.

## Witness This



- In a court of law, testimony is used and it has to be judged for legitimacy
  - Bad testimony often gets judged as good and vice versa
- Science is not a court of law
  - We know that testimony can be flawed, so we can not rely on it as a reliable source of information
  - The mind can deceive or be deceived or it can relate observations accurately
    - We don't ever know which for sure



<http://www.buttonhouse.com/catalog/aliens-ufo.html>

## Pictures



- Pictures are getting close to evidence...
  - What is in the picture?
    - It could be forged (photoshop-ed)
    - It could be a misprint
    - It could be real
  - We don't know.
- Even if we have a picture or a reliable sighting of, say, a space craft the most logical explanation is still that a human-made object was seen.
  - Occam's razor.
  - We know that governments work on advanced projects in secret.
  - Without evidence of ET life, this explanation is simplest.



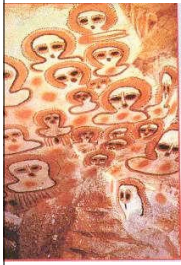
<http://home.tiscali.be/mathias.appelmans/alien.jpg>

## Ancient ET Visits?



- There are a number of ancient images and artifacts that have been associated with UFOs by modern “UFO researchers”.
- Let's look at some of those. They're easy to find on the web– too easy.
- If we can't really trust modern isolated photographs...maybe ancient or renaissance paintings?

# Cave Paintings



Australia (5000BP)

Ancient Evidence

Are we misinterpreting?



Utah (7500BP)



Italy (12,000BP)



Tanzania (29,000BP)

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The other painting is from Kolo shows four entities surrounding a women. Notice also the entity looking down from inside some sort of box or object.

This cave painting on the left is c.10,000 BC and is from Val Camonica, Italy. It appears to depict two beings in protective suits holding strange implements.

On the left, more strange looking figures (aliens) this time from Sego Canyon , Utah. Estimated up to 5,500 BC.

These are images from Kimberley, Australia (approximately 5,000 years ago). They are Australian Aborigine cave paintings. Aboriginal myths incorporate the idea of "sky-beings", with the Wandjina being among the most interesting to consider. The Wandjina have been preserved in a fascinating oral tradition and in a large collection of rock paintings scattered throughout the Kimberley region of northern Australia. The paintings have received all manner of interpretations from stylized representations of a pervasive myth system to naive "ancient astronaut" theories. It is however fascinating to see that the indigenous tribes viewed the Wandjina as "the spirit in the cloud." Indeed, the unique painting style shows a logical sequence from human figures to stylised representations of clouds. This duality of anthropomorphic form and "clouds" is widespread in primitive cultures and finds an interesting parallel in the biblical accounts in "Exodus."

## The Madonna with Saint Giovannino



Foto: Diego Cugghi, 2003

Domenico Ghirlandaio- 15<sup>th</sup> century.

Foto: © Diego Cugghi, 2003

## The Annunciation with Saint Emidius



Carlo Crivelli- 15<sup>th</sup> century.



## The Crucifixion



A fresco above the altar at the Visoki Decani Monastery in Kosovo, Yugoslavia– 14<sup>th</sup> century.



## Glorification of the Eucharist



Bonaventura Salimbeni – in the Church of San Pietro in 1600 AD.

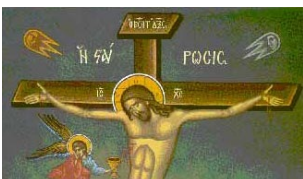


<http://homepage.ntworld.com/jackaram/>

## Symbolic Symbolism



- Biblical references have become completely incomprehensible to modern man.
- The symbols were a way to express meaning to illiterate populace.
- Early humans needed a way to express symbols of god, weather, or whatever and the sky is magical.

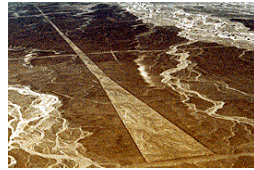
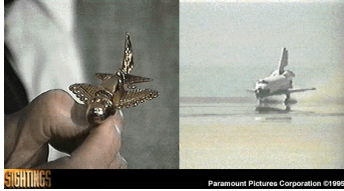


[http://www.sprezzatura.it/Arte/Arte\\_UFO\\_6.htm](http://www.sprezzatura.it/Arte/Arte_UFO_6.htm)



## Amazing or Ordinary?

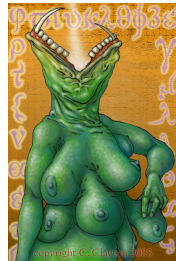
- We have no reliable evidence that ET's helped to build the pyramids or any other amazing artifacts.
- We do have plenty of evidence of humans doing extraordinary things when working in concert
  - What is the most logical explanation?



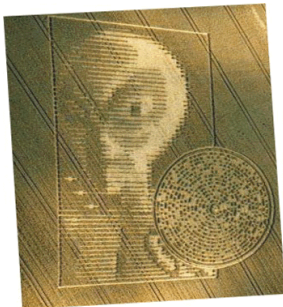
<http://homepage.nttworld.com/jackaram/>  
<http://www.aegypten-online.de/images/giza/pyramid.jpg>

## Pseudoscience

- Although there are numerous examples of interesting paintings, drawings from the middle ages or ancient times can not sensibly be used as evidence of UFO visitation!
- The most logical explanation is that people saw something in the sky (a comet or meteorite or clouds) and let their imaginations run wild.
- Strange sights do not mean aliens.



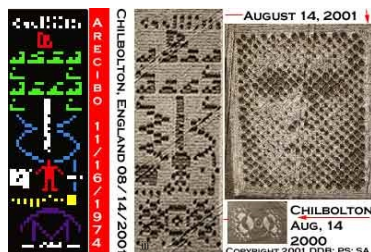
## Crop Circles



- Clearly shown to be man-made structures.
- No one has seriously studied them.



<http://www.enterprisemission.com/glyph.htm>



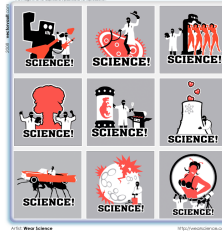
# Define Proof: Give Me Evidence



## Scientific Evidence

- Multiple unaltered videos of same scene
- Reliable, logical calculation
- Piece of an ET probe or spaceship
- A trace that can be uniquely linked to ETI
- Biological material

Chelyabinsk Meteor



In other words, a scientific investigation



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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

## An Example: Meteor 1972

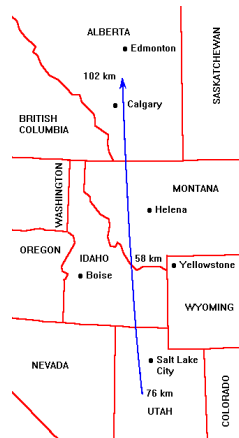


<http://www.ungh.edu/dutch/>

## 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?



The 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>

## The Official Story

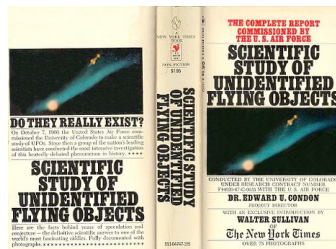


### Multiple Government Reports

Some were biased

### Condon Report

"The report concludes that there is no evidence to justify a belief that extraterrestrial visitors have penetrated our skies and not enough evidence to warrant any further scientific investigation."



### Government Coverup?

US Government bad at keeping secrets.

*Snowden?*

### Scientific Disinterest?

No Real Evidence not disinterest!

Serious Scientists would **JUMP** at opportunity!

There were numerous government studies on the topic of UFOs– some very biased.  
The main one of importance was the only scientific study of UFOs called the Condon report (1969).  
"The report concludes that there is no evidence to justify a belief that extraterrestrial visitors have penetrated our skies and not enough evidence to warrant any further scientific investigation."

## Some Real Facts



- The fact that the majority of humans live in cities with very little familiarity with the sky goes a long way to explaining most UFO sightings.
- How many of you have ever seen ball lightning?
- The planet Venus is mistaken for a UFO all the time because it is very bright, is often viewed low to the horizon and therefore experiences atmospheric scintillation which makes its color change rapidly.



<http://www.meteoros.de/ufo/venus.htm>





## Some Real Facts



- Have you ever seen a stealth fighter or bomber in flight?
- What about swamp gas?
  - decaying organic matter turns gaseous and on extremely rare occasions takes on certain properties of luminescence
- Insect swarms flying through electric fields?
- All of these things are in the sky and most people have no idea what they are looking at when they see them.



## Alien Abductions



- Alien abduction stories bare a resemblance to post traumatic stress disorder.
- People experience something horrible in their lives and their brains suppress the memories.
- The memories remanifest in dream-like states where the mind is highly susceptible to confabulation and fantasy.
- The stories often involve elements that sound like a condition called *sleep paralysis*.



## Alien Abductions



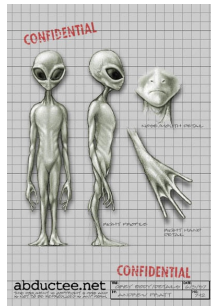
- When you are in REM sleep and are dreaming your body paralyzes the major voluntary muscles so that you cannot injure yourself while you dream.
- Sometimes we can fall into dream states before we have become completely unconscious. Our bodies become paralyzed and we can even dream in the state, but yet we are also partially awake. It's called *waking dreams* it's a real and studied phenomenon.



## Expect to See



- Descriptions of aliens do not reflect the expected diversity of life elsewhere, but do reflect psychological biases of observers. Descriptions are almost always humanoid and usually male



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## Your Call



- We have no reliable evidence to support actual ET contact.
- We have evidence that people historically make up stories about things they imagine to be linked to a light in the sky
  - So, what is the most logical explanation?

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## Open Your Mind?




- Yes, as we have justified, it is possible that an ETI civilization has visited the Earth at some point in its history
- It is a legitimate scientific question to investigate this
- **We need legitimate scientific evidence in order to believe this theory**

## Bottom-line



- We have probably not been visited by aliens; there is **no** evidence.
- To me, alien reports are images of human psyche.
- But, our Drake equation estimate suggest that extraterrestrial life is common.
- So the Fermi Paradox: “Where are they?”
- I would argue that we keep trying to figure out the Universe, look at the concept of extraterrestrial life with a critical eye, fill in our gaps of knowledge, and the search is on.

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Thank You &  
Good Luck! 😊

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