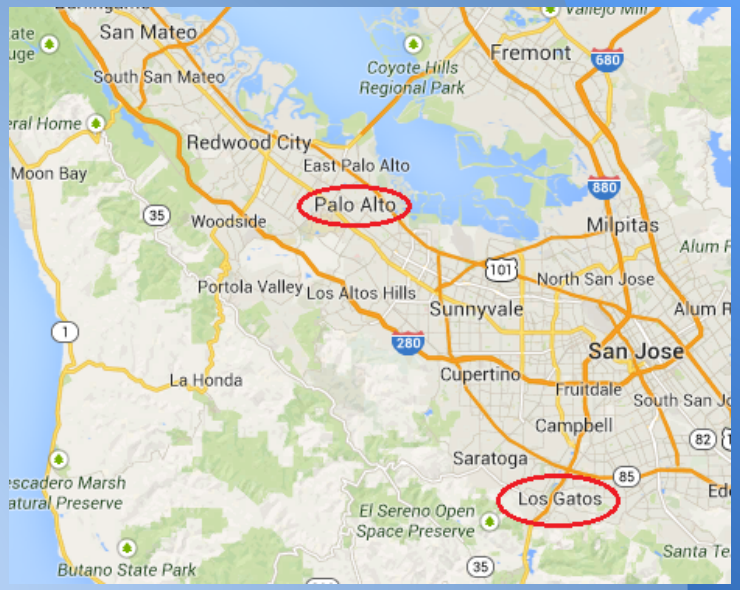
The History and Future of Manned Spaceflight

Nicholas Broad

Introduction

- Hometown: Los Gatos, CA
- Age: 19
- Sophomore
- Undeclared, engineering
- Likes: soccer, taiko, surfing, sailing



Objectives

- Learn about space technology
- Identify engineering challenges for spaceflight
- Look at the future of manned spaceflight
- Gain appreciation for space-related engineering

Rules

1. Participation is rewarded
2. Be respectful

Outline

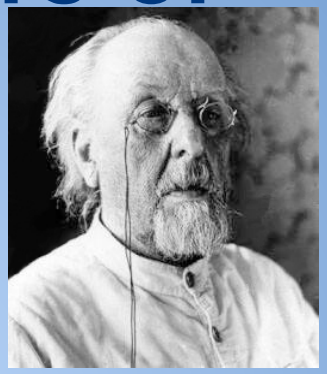
1. Why should we care about spaceflight?
2. Beginnings of spaceflight
   a. Notable scientists
   b. First rockets, satellites, people in space
3. Big spaceflight projects
   a. Space Race
   b. Space Stations
4. Engineering Difficulties
5. Propulsion Systems
6. Future manned missions
7. Becoming an astronaut

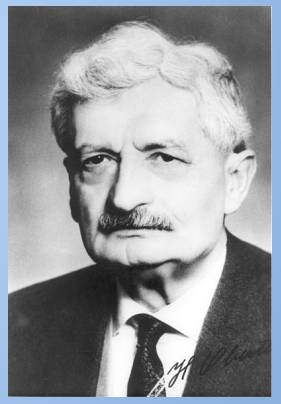
Reasons to go to space

1. It's cool
2. Fosters innovation
3. Promotes world peace and collaboration
4. It's *really* cool

Who were the pioneers of spaceflight?

- Konstantin Tsiolkovsky(1857-1935)
- Robert Goddard (1882-1945)
- Hermann Oberth (1894-1989)
- Wernher von Braun (1912-1977)
- Founding fathers of rocketry and astronautics





First rocket in space

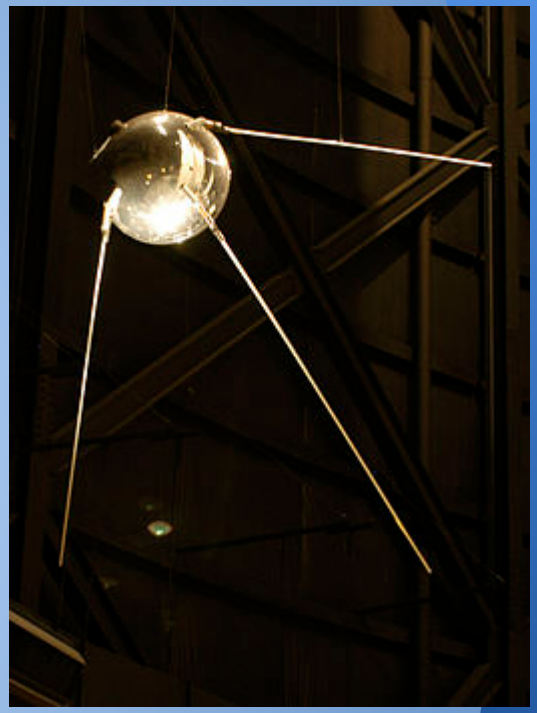
German V-2

- Vengeance Weapon 2
- 1944
- Developed by Wernher von Braun
- Used by Nazis on England

First satellite

Russia's Sputnik 1

- 1957
- 58 cm (23 in) in diameter
- Transmitted radio while orbiting
- Launched using an ICBM
- Started the Space Race

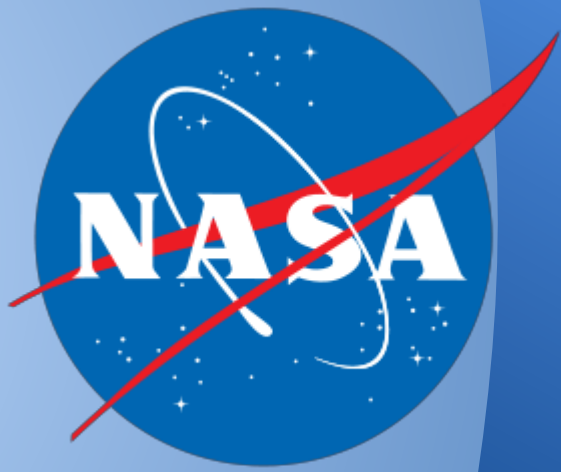


First United States agency focused on aeronautics?

NACA - National Advisory Committee for Aeronautics
1915-1958

Founding of National Aeronautics and Space Administration(NASA)

- Established by President Eisenhower in 1958
- Focus on peaceful rather than military space science



What nation put the first man in to space?

A. United States
B. Germany
C. France
D. Russia (Soviet Union)
E. India
F. China

What nation put the first man into space?

A. United States

B. Germany

C. France

D. Russia (Soviet Union)

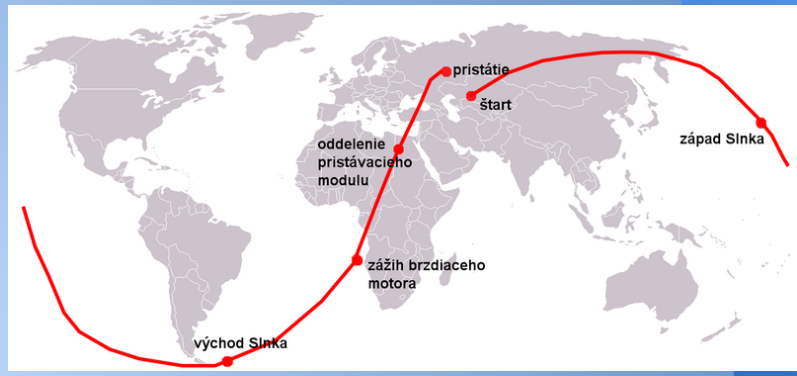
E. India

F. China

First human spaceflight

Yuri Gagarin

- April 12, 1961
- Vostok 1 “East 1”
- Total flight time of 108 minutes
- Single orbit around Earth
- Seen as triumph for mankind, embarrassment and shock for US



When did the US put someone in space?

Soviets did it on April 12, 1961

A. April 13, 1961
B. May 5, 1961
C. July 4, 1961
D. December 25, 1961
E. January 1, 1962

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First American in space

Alan Shepard

- *Project Mercury*
- *Freedom 7* Mission
- Mercury-Redstone Rocket
- 15 minute suborbital flight

Space Race - Soviet Union vs United States

- Cold War tensions
- Establishing
  - National security
  - Technological superiority
  - Ideological superiority
- Involved satellites, sub-orbital and orbital human spaceflight, and the voyage to the Moon

Joint US and Soviet Moon Program

- Proposed by Kennedy
- Cost benefits and technological gains
- Initially rejected
- Almost accepted, but Kennedy assassinated
- No more joint moon program

Which nation put the first woman in space?

A. United States
B. Australia
C. Germany
D. Russia (Soviet Union)
E. Japan

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C. Germany

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E. Japan

First woman in space

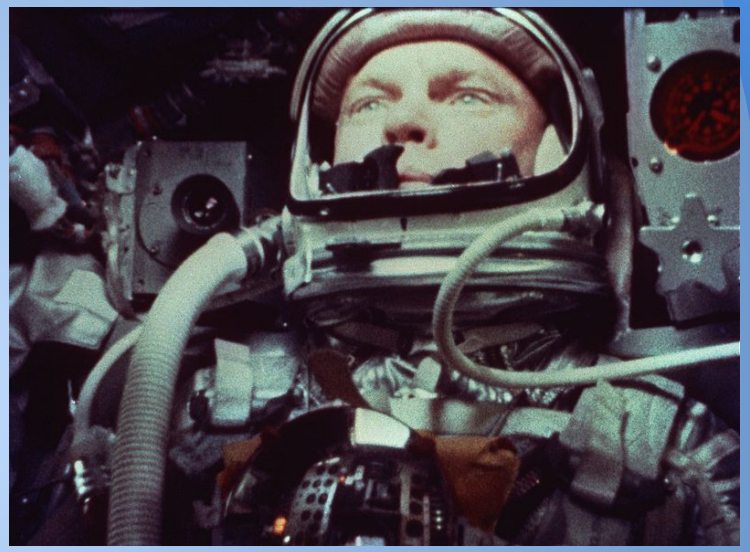
Valentina Tereshkova

- Aboard Vostok 6
- June 16, 1963
- First civilian in space
- Conducted tests on herself to gather information about the female body's reaction to spaceflight

First American orbital flight

Mercury-Atlas 7

- John Glenn
- *Friendship 7*
- 5 hours



John Glenn Research Center in Cleveland, Ohio

Year of Moon Landing?

A. 1963

B. 1966

C. 1969

D. 1972

E. 1975

Year of Moon Landing?

A. 1963

B. 1966

C. 1969

D. 1972

E. 1975


Which country won the space race??

Name of the mission to moon?

A. Apollo
B. Mercury
C. Saturn
D. Gemini

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A. Apollo

B. Mercury

C. Saturn

D. Gemini

Which Apollo mission was it?

A. Apollo 1
B. Apollo 3
C. Apollo 9
D. Apollo 11
E. Apollo 13

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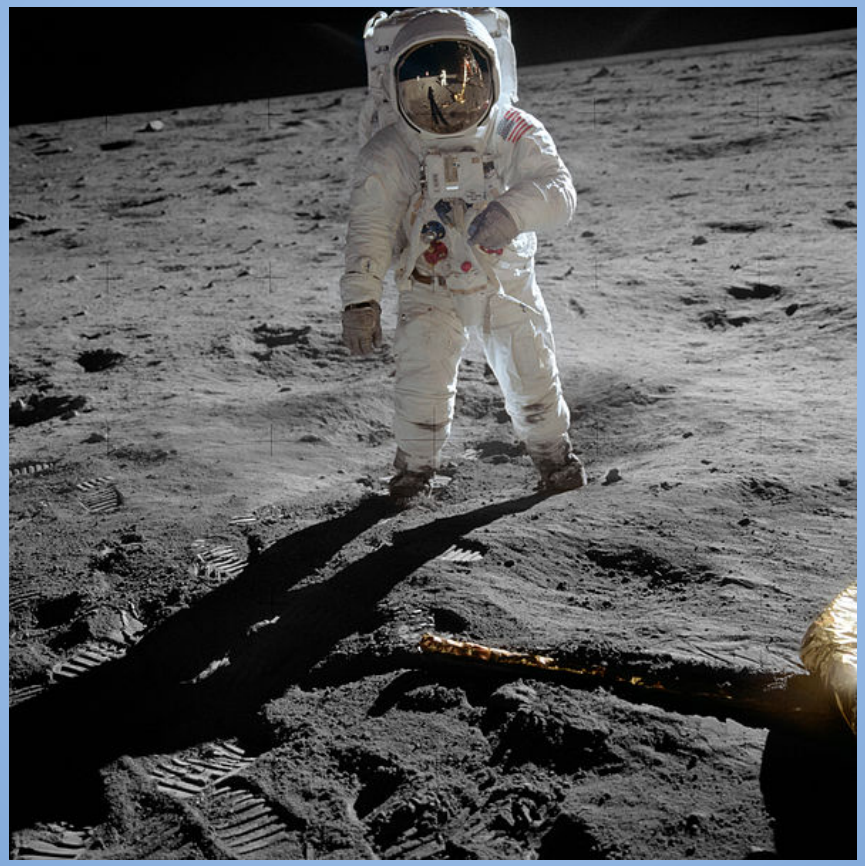
Apollo 11

Neil Armstrong, Buzz Aldrin, Michael Collins

- July 20, 1969
- Saturn V rocket
- *Eagle* Lunar Module

“That’s one small step for man, one giant leap for mankind”



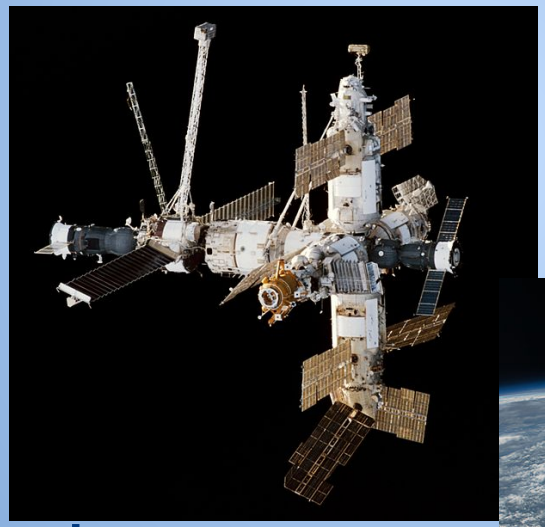
Moon Landings since Apollo 11

- Apollo 12, 14, 15, 16, 17
- Total of 12 people have been on moon
- All Americans
- Last been on moon in 1972

Space Stations

Salyut
1971-1986

Skylab
1973-1979



Mir
1986-1996

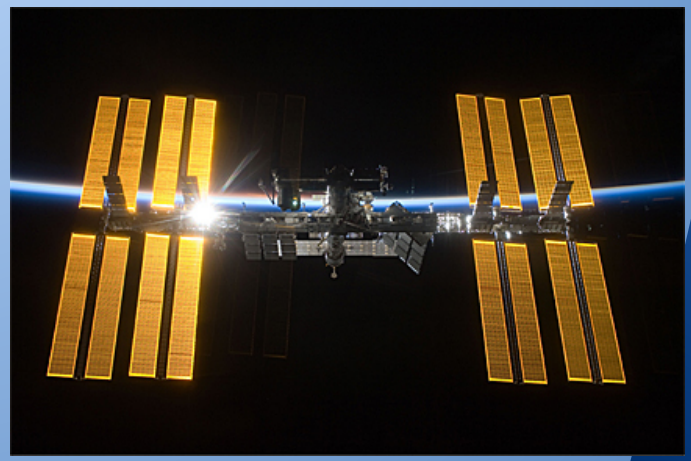
International Space Station (ISS) 1998-2020

Estimated total cost of ISS?

A. $1 billion
B. $10 billion
C. $50 billion
D. $100 billion
E. $150 billion

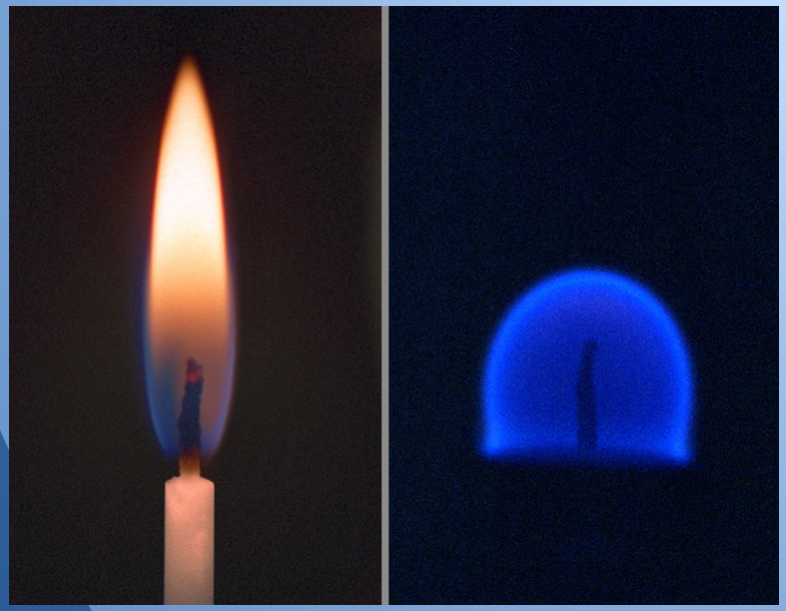
International Space Station

- Cost: $150 billion
  - Most expensive single item ever created
- Size: 72 x 109 x 20 meters
- Speed: 17,100mph
- Orbital Period: 92 minutes
- Altitude: 260 miles



Scientific Research on ISS

Microgravity experiments to understand physics, chemistry, space medicine, practically EVERYTHING!



Short break!

Grab some water, go to the bathroom, stretch your legs!

Try to be back in 2 minutes

Engineering difficulties?

Things to think about:

1. Overcoming gravity
2. Biological necessities (food, water, air)
3. Dangerous things (asteroids, radiation)
4. Returning back to Earth
5. Maneuvering/navigation
6. Power for lights, heating

Important things to have

1. Propulsion system (escape velocity of 11.2km/s)
2. Food, water and air recycling
3. Protection from radiation, thermal insulation to stay warm and protection to stay cool(121ºC in sun, -150ºC in the shade)
4. Thermal protection, landing equipment
5. Gyroscopes, control centers
6. Solar arrays, batteries

Propulsion Systems

1. Chemical(liquid, solid)
2. Nuclear
3. Electromagnetical
    a. Ions
    b. Solar
4. Ramjet Fusion

Closest star system?

Alpha Centauri

4.4 light years from Sun

What is a light year?

Distance covered when light travels for a year.

Speed of light: 3×10^8 m/s
Seconds in a year: 3.15569×10^7 s
Speed x seconds (1 light year) =

9.4605284×10^{15} meters

Combustion Engines (Chemical)

Using solid and liquid chemicals

- Oxygen
- Hydrogen
- Hydrocarbons
- Time to Alpha Centauri: ~70,000 years

Pros and Cons of Chemical

Pros:

- Cheapest
- Works in Earth's atmosphere

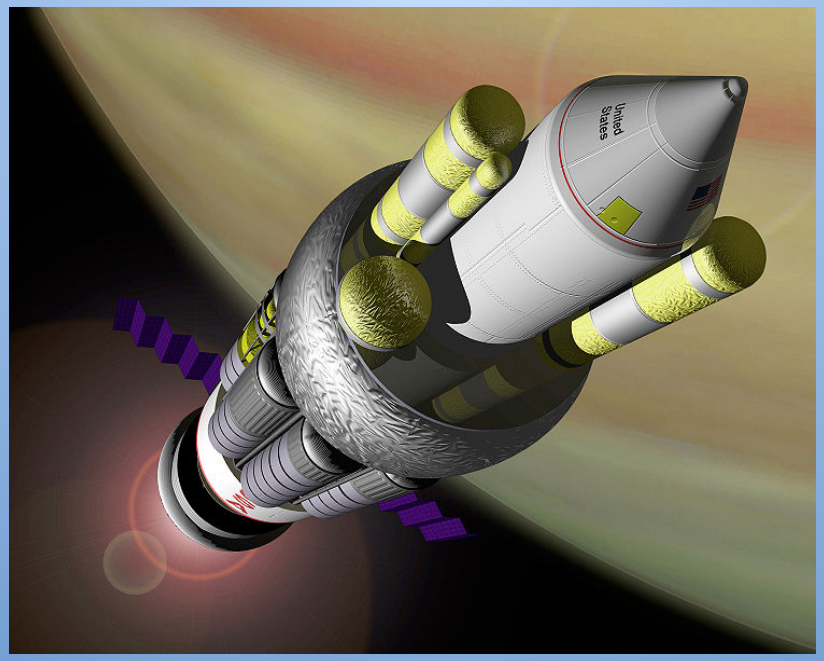
Cons:

- Poor mass/thrust ratio
- Slow in space
- Volatile

Nuclear Engines

Exploding nuclear bombs behind your vehicle

- Project Orion
- Time to Alpha Centauri: ~45-1000 years



Pros and Cons of Nuclear

Pros:

- Faster than chemical
- Get rid of thousands of bombs

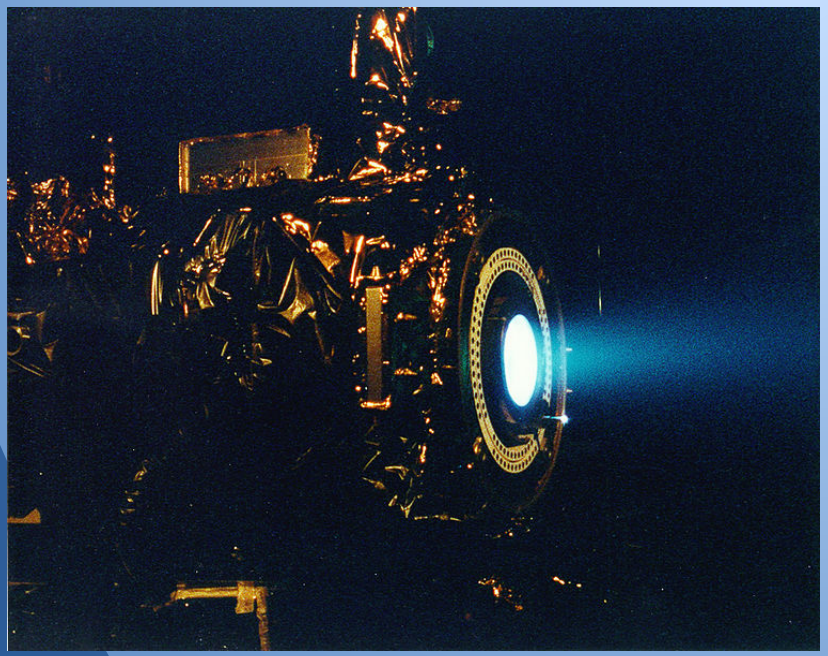
Cons:

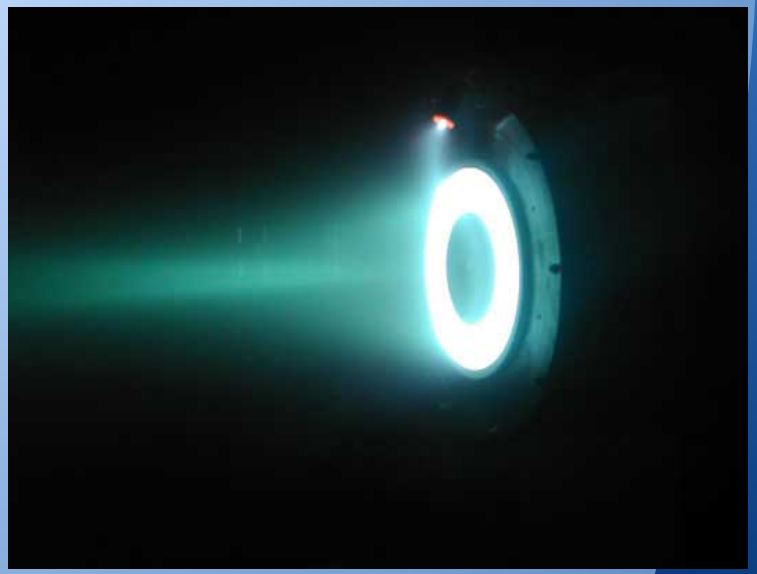
- Dangerous (obviously)
- Expensive to produce bombs
- Laws preventing testing of nuclear bombs above ground

Ion Thrusters

Using ions (charged particles) to accelerate the ship

- Time to Alpha Centauri: ~14,000 years





Pros and Cons of Ion Thrusters

Pros:

- Very good propulsion efficiency
- Runs off of electricity

Cons:

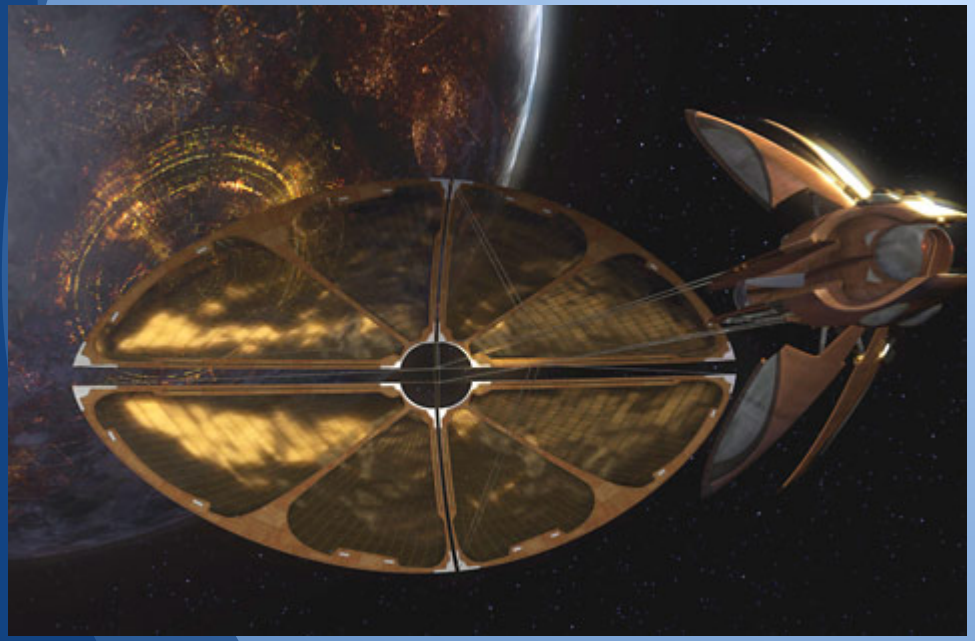
- Terribly slow acceleration
- Requires xenon gas ($$$)
- Can't be used to escape Earth

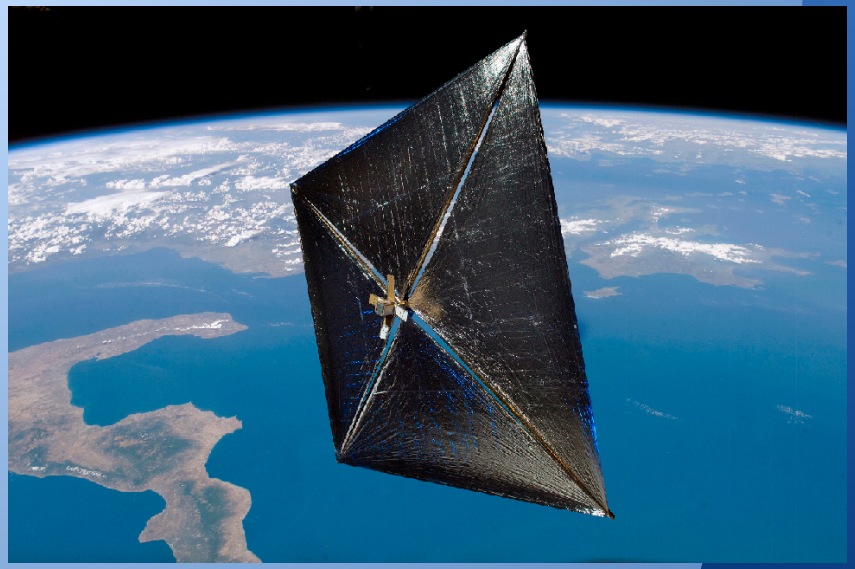
More practical for interplanetary trips in our solar system

Solar Sail

Uses the solar pressure from the Sun

- Not just in Star Wars
- Time to Alpha Centauri: ~400 years





Pros and Cons of Solar Sail

Pros:

- Doesn't require fuel (uses the sun)
- Have been built and tested
- Moderate speeds

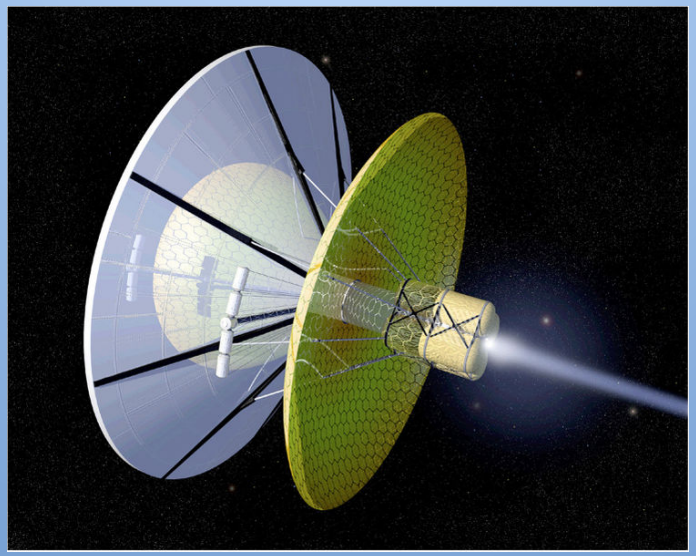
Cons:

- Requires a laser to give it added momentum
- Would have to orbit the sun for several years before going to destination
- Difficult to stop and reverse

Ramjet Fusion

Scoops in hydrogen gas and fuses it into helium to generate enormous amounts of energy

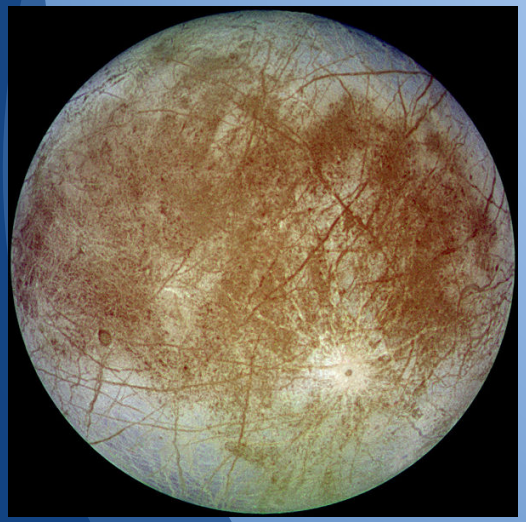
- Hypothetical
- Time to Alpha Centauri: <5 years

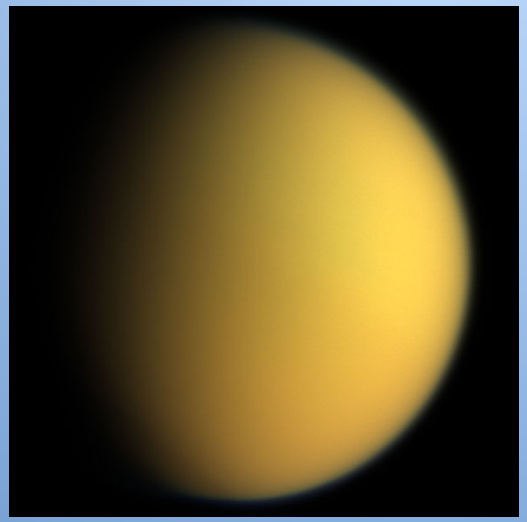


We need better propulsion systems!

Future manned missions

1. Asteroids
2. Mars
3. Moons of Saturn, Jupiter





Terraforming Mars!

SPACEX

Facts about Mars

- 1/10 the mass of Earth
- ½ of the radius of the Earth
- Average temperature of -63ºC
- Atmosphere of CO_2
- Red color from iron oxide (rust)
- No magnetic field

Why we can't live on Mars now

1. It's hard to get there
2. It is too cold
3. No magnetic field means much more radiation
4. Nothing to breathe, eat, drink

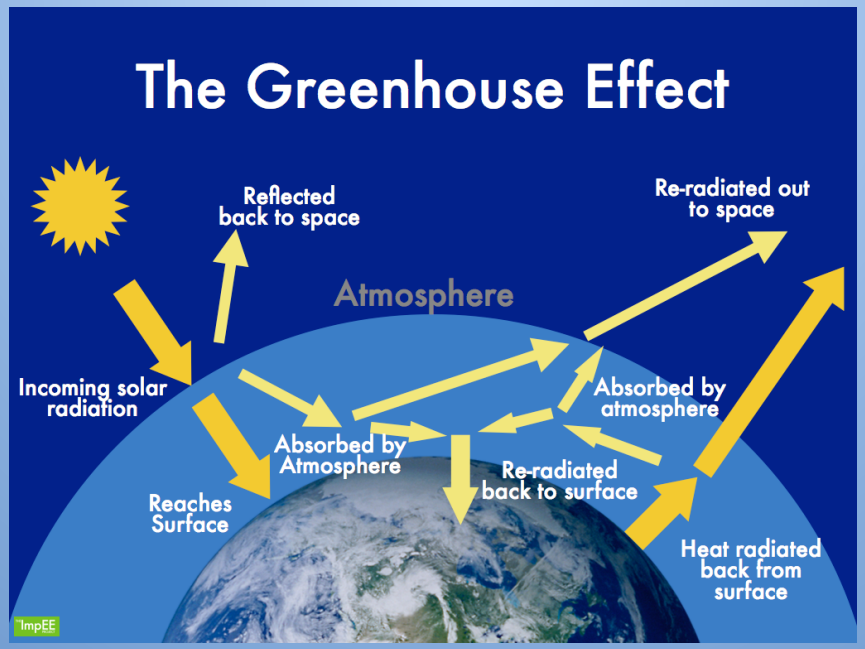
Why should we go to Mars?

1. It's cool
2. In the event that Earth becomes uninhabitable, we have another place to live
3. Pushes the rate our technology improves

Assuming we get there...

Problem: cold temperature

Solution: Release more greenhouse gases to heat up the planet.



Which of the following are greenhouse gases?

A. CO_2 Carbon Dioxide
B. H_20 Water Vapor
C. CH_4 Methane
D. NO_2 Nitrous Oxide
E. O_3 Ozone
F. All of the above

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F. All of the above

Method for releasing gases

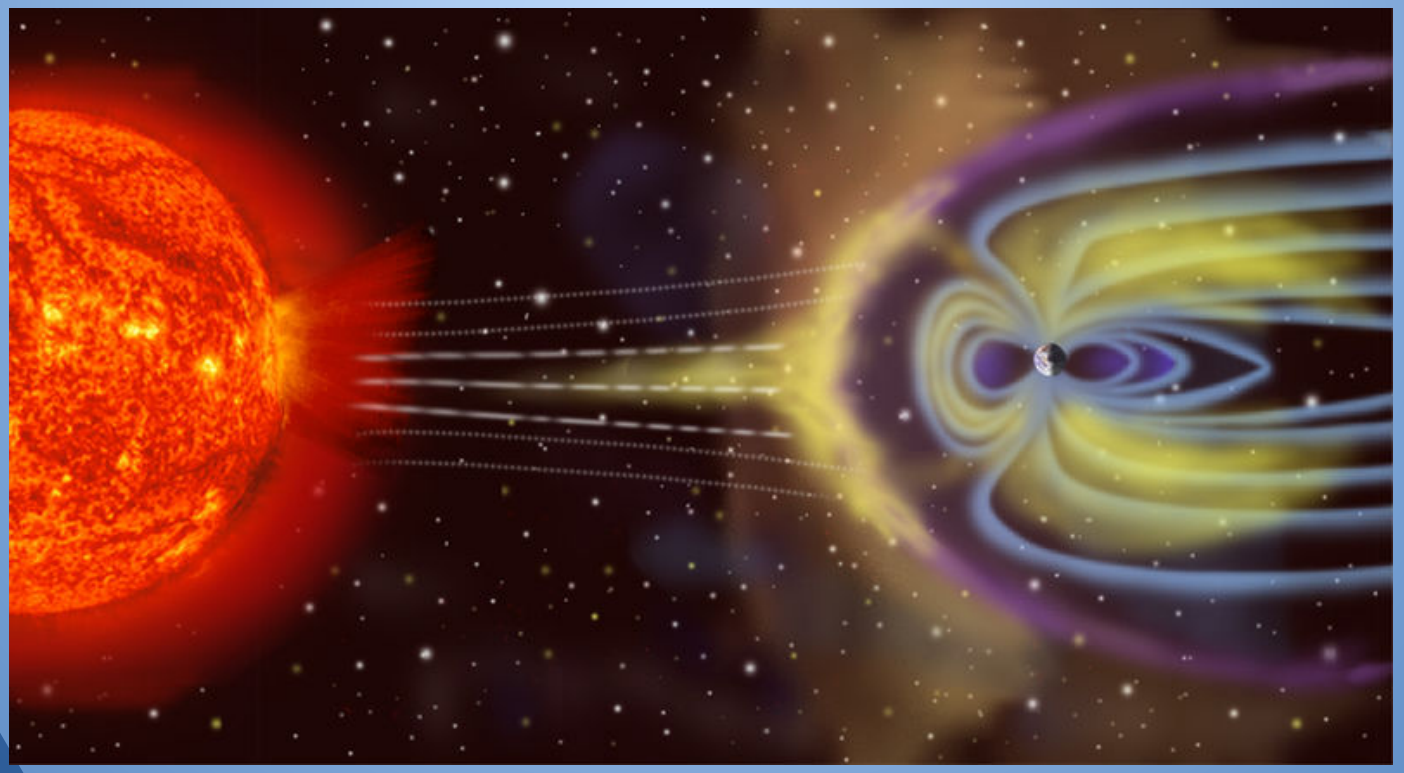
1. Inject Methane from Earth
2. Deflect a comet into atmosphere
    a. The ice would melt and release water into the atmosphere in the form of steam
3. Detonate nuclear bombs on the poles
    a. Liquid water will be released

Assuming temperature is improved…

1. Pools of water will form, and algae can then start growing
2. Further increase the temperature by absorbing heat
3. Provide food source, oxygen
4. Permafrost starts melting, warming up

How to deal with radiation

1. Block it with thick metal or water
2. Generate a magnetic field



MARS ONE

- 4 colonists on Mars by 2023
- 20 colonists by 2033
- One way trip

Becoming an astronaut

1. Be a US citizen
2. Pass physical examination, have 20/20 vision, blood pressure below 140 over 90
3. Height between 4’10.5” and 6’4”
4. Bachelor’s degree in engineering, physical science, biological science, or mathematics
5. Advanced degree (Master’s, doctoral)

Recommendations

- Find something you are passionate about and pursue it as far as you can (do what you love, love what you do)
- Keep applying
- If you end up not becoming an astronaut, you will have formed an excellent career


Keep Looking Up!