Hot Science Cool Talks

UT Environmental Science Institute

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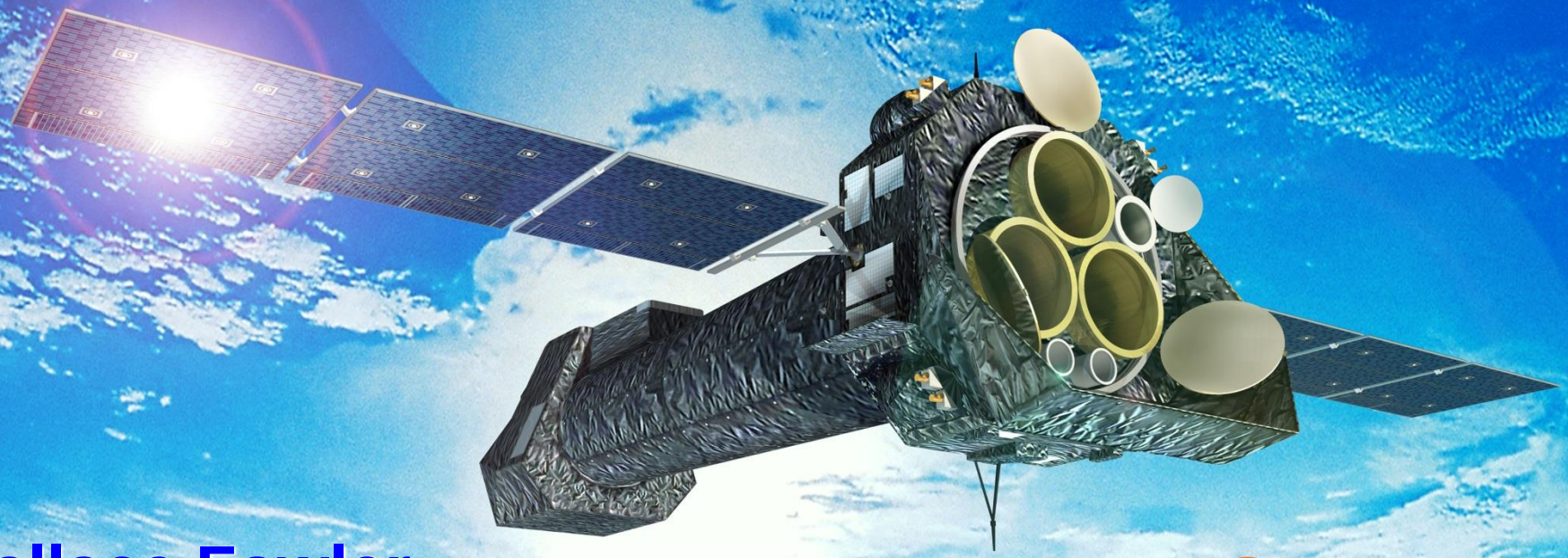
Exploring Outer Space: Fact vs. Fiction

Dr. Wallace Fowler

November 19, 2004

Exploring Outer Space:
Fact vs. Fiction



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ESI

TEXAS space grant consortium

John A. & Katherine G. JACKSON SCHOOL OF GEOSCIENCES The University of Texas at Austin

Outline

Misconceptions about Exploring Outer Space

- Gravity
- Living in space
- Rockets
- Atmospheric entry
- Space solar power

Outline (cont.)

Myths about Exploring Outer Space

- Costs/benefits of space exploration
- SpaceShipOne implications
- Star Trek
- Space myths

Gravity

- Shooting down satellites
- Falling into the sun
- Satellites hovering over cities
- Dropping bombs from satellites
- Weightlessness, zero gravity & free fall
- Escaping Earth’s gravity
- Zero-gravity rooms at NASA

Shooting Satellites Down

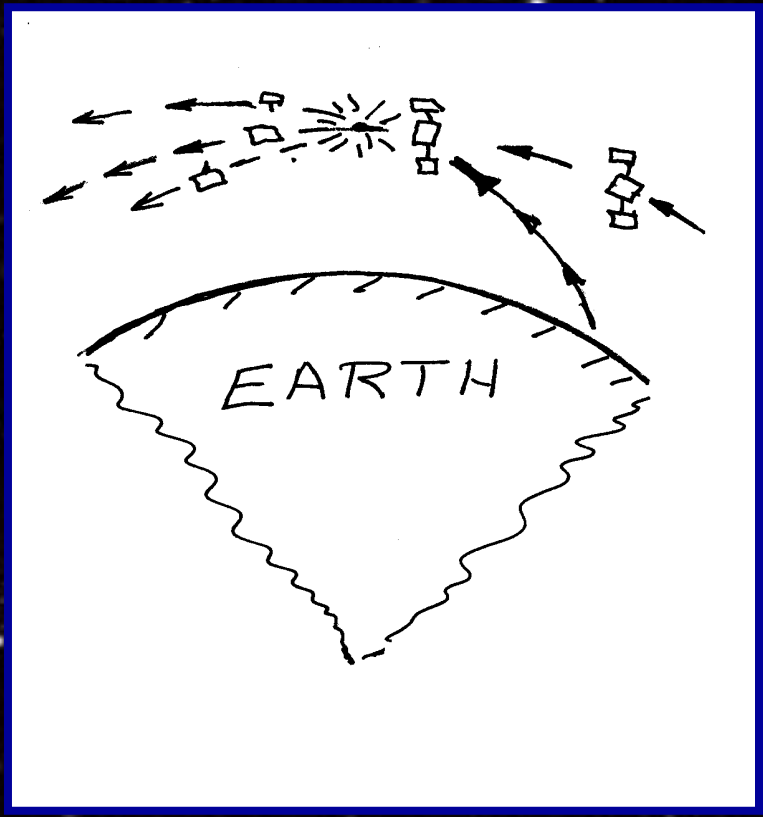
- **Fiction:**

  Satellites would fall to Earth if we were to “shoot them down”

Satellite “Shoot Down”

- **FACT:**

  Satellites shattered in a “shoot down” would just stay in orbit – making more space debris



Dropping Bombs from Satellites

- **Fiction:**

  Satellites are good bomb platforms – others could drop bombs on us from satellites

- **Fact:**

  The bombs are also in orbit. When "dropped", they would fly right along with the satellite that dropped them

Falling into the Sun

- **Fiction:**

  If not careful, a spacecraft could fall into the Sun

Falling into the Sun

- **Fact:** It is much easier to escape the solar system than to fall into the Sun
  - From Low Earth Orbit to the Sun requires a speed of 48,340 mph
  - From Low Earth Orbit to solar system escape requires a speed of 19,636 mph

  PLUS:
  - It takes about 20,800 mph to reach Low Earth Orbit from the launch pad

Satellites Hovering Over Cities

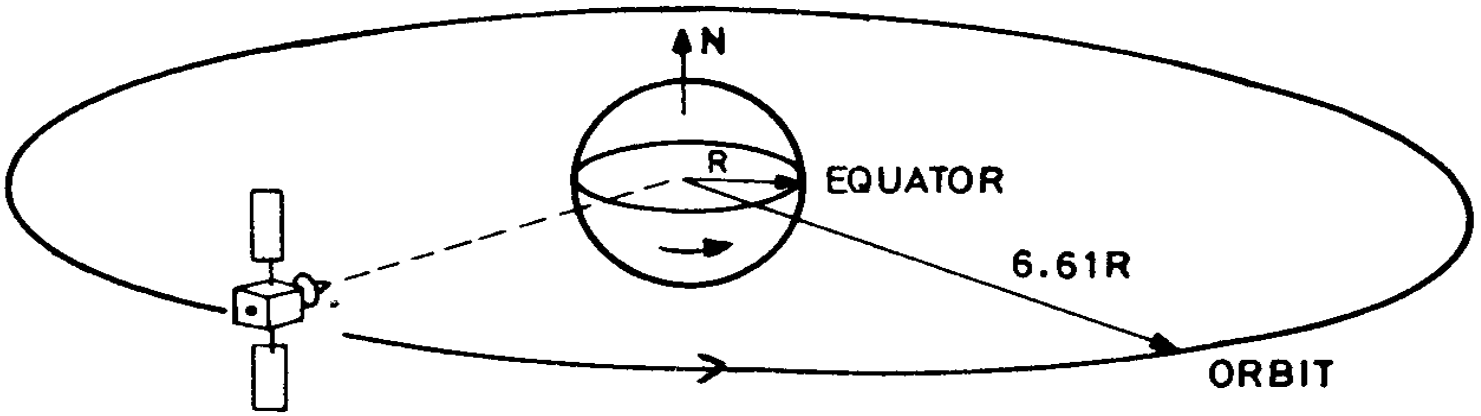
- **Fiction:**

  Satellites can hover over any city on Earth

- **Fact:**

  Satellites can hover only over cities that lie on the equator and only at a specific (geosynchronous) altitude

Geostationary Satellites
(in geosynchronous orbit)



- EARTH'S ROTATION PERIOD = ORBIT PERIOD
- SPACECRAFT STATIONARY WITH RESPECT TO EVERY POINT ON THE EARTH.
- ORBIT LIES IN THE EQUATORIAL PLANE

Weightlessness, Zero-Gravity, and Free Fall

Zero-Gravity or Weightlessness

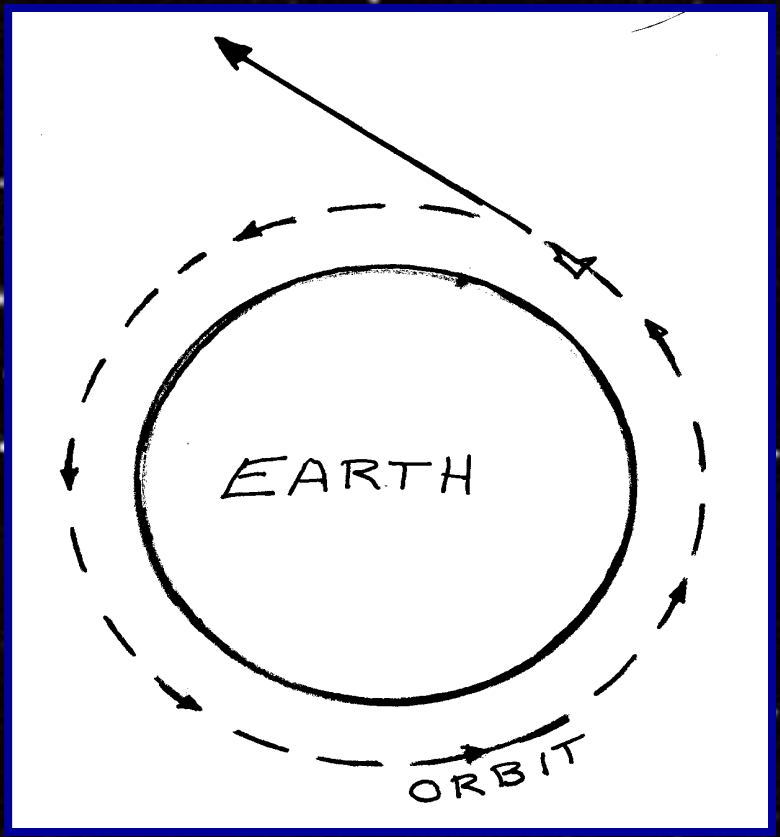
- **Fiction:**

  In orbit, there is zero gravity.
  Things and people are weightless.

Consequence of Zero-Gravity

- **Fact:**

  In true zero-gravity, orbits are impossible. Things in orbit would move away from the Earth in a straight line. All astronauts would be “Lost in Space”.



Escaping Earth's Gravity

- **Fiction:**

  In orbit, we have escaped Earth's gravity

- **Fact:**

  There is gravity in orbit

- **Fact:**

  If we get far enough away from Earth, the gravity of the Sun makes Earth's gravity negligible

Zero-Gravity Rooms at NASA

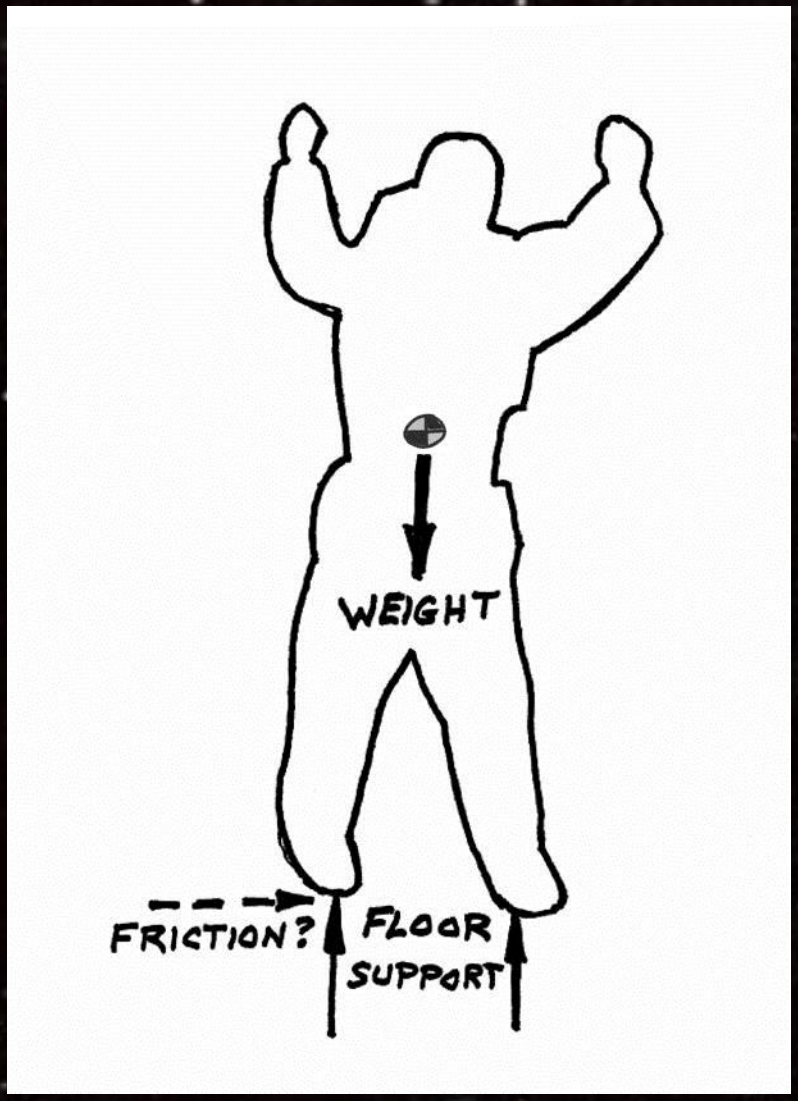
- **Fiction:**

  There is a “room” at NASA where the astronauts can go to experience “zero gravity”.

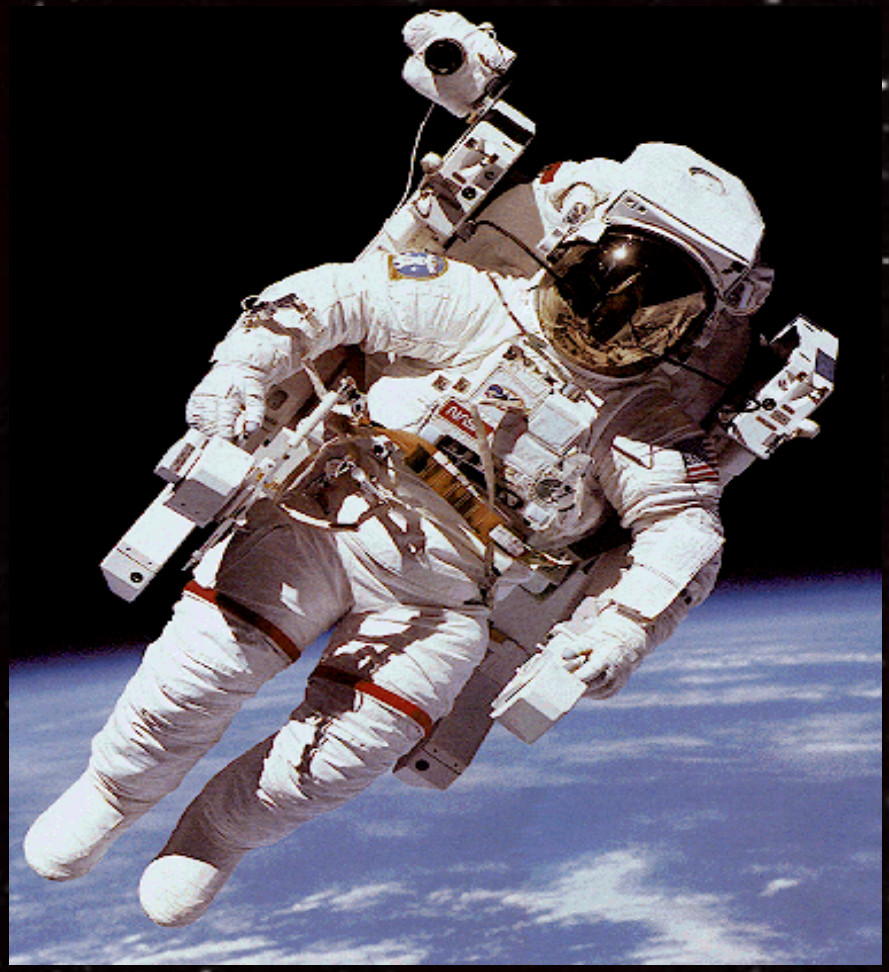
- **Fact:**

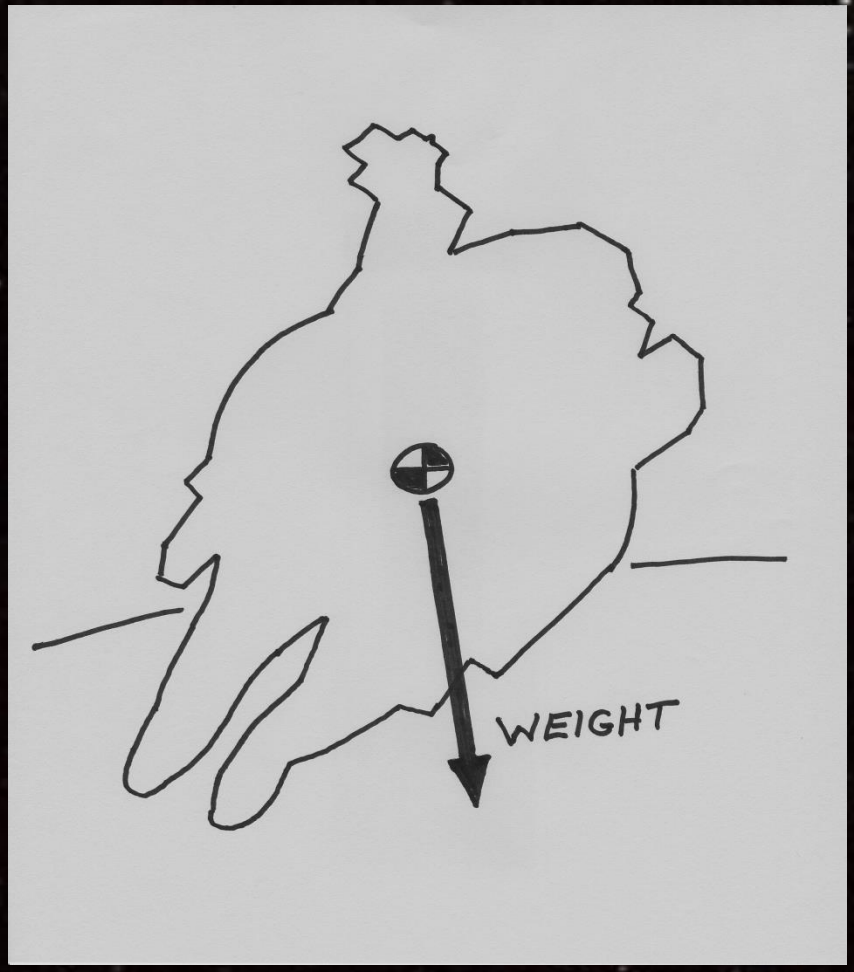
  “Zero Gravity” is free fall, we can free fall for seconds off of a diving board, minutes in SpaceShipOne, etc., but never standing in a room on Earth.

Forces On Earth



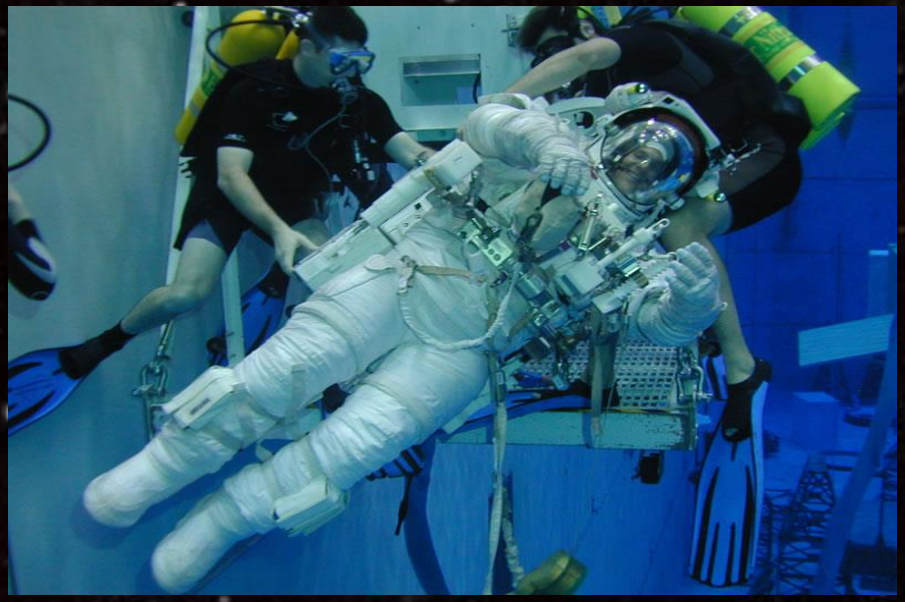
Forces In Space





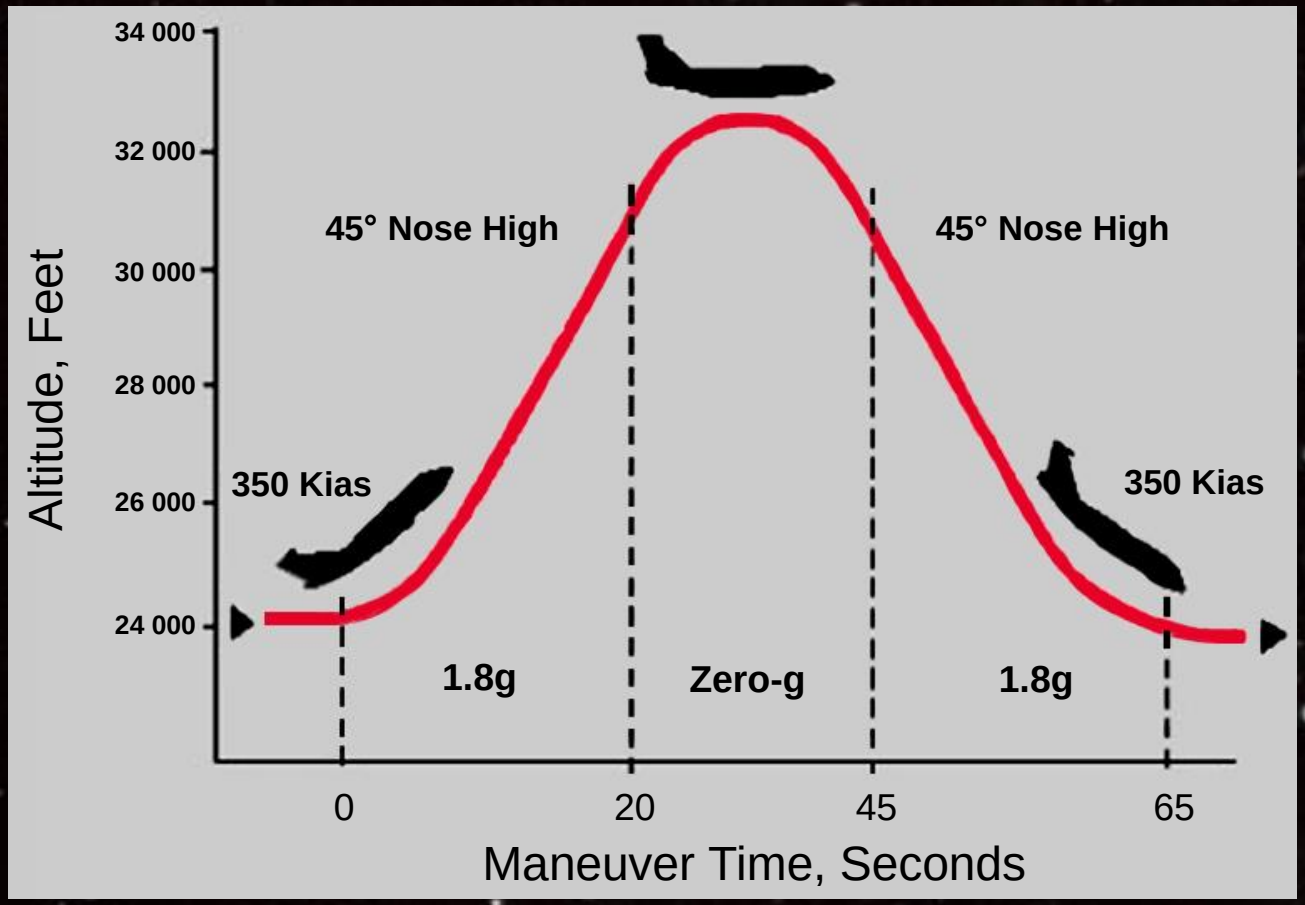
NASA's "Zero-g" Simulators

KC -135A



Neutral Buoyancy Laboratory

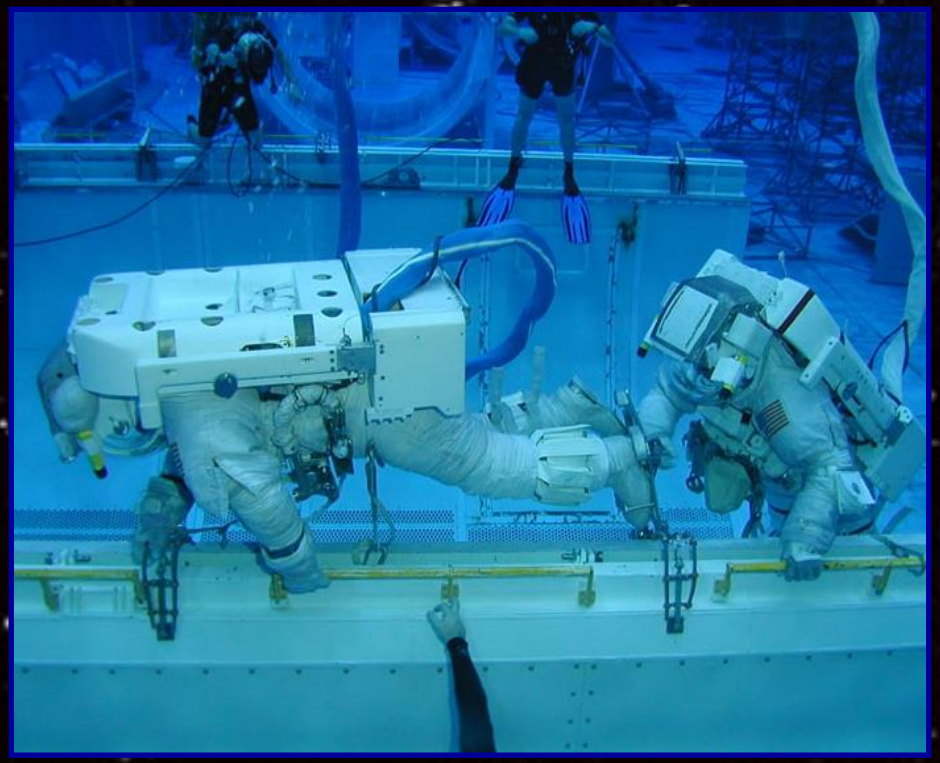
KC-135 Flight Profile

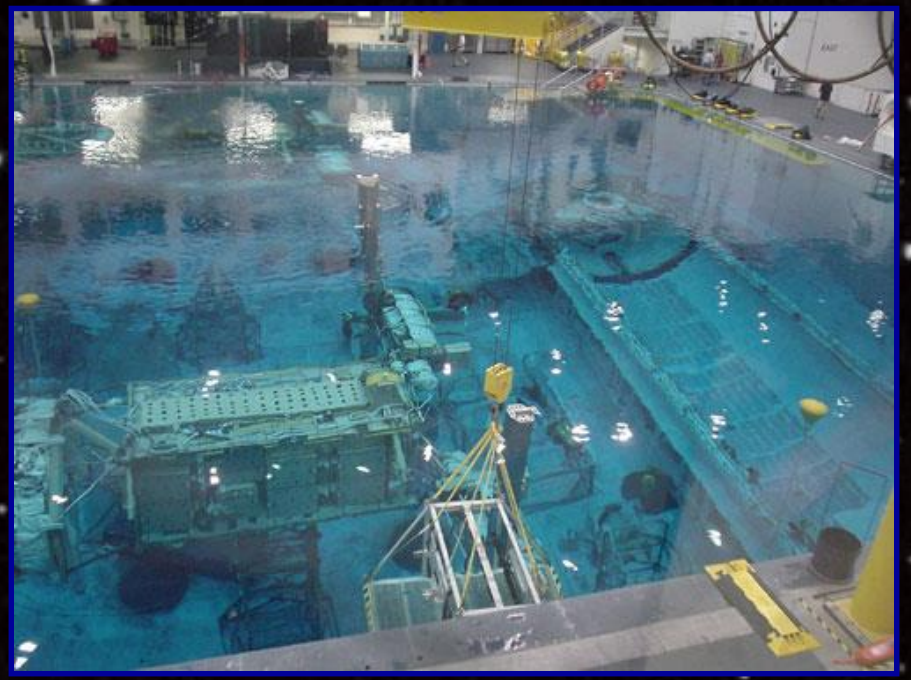


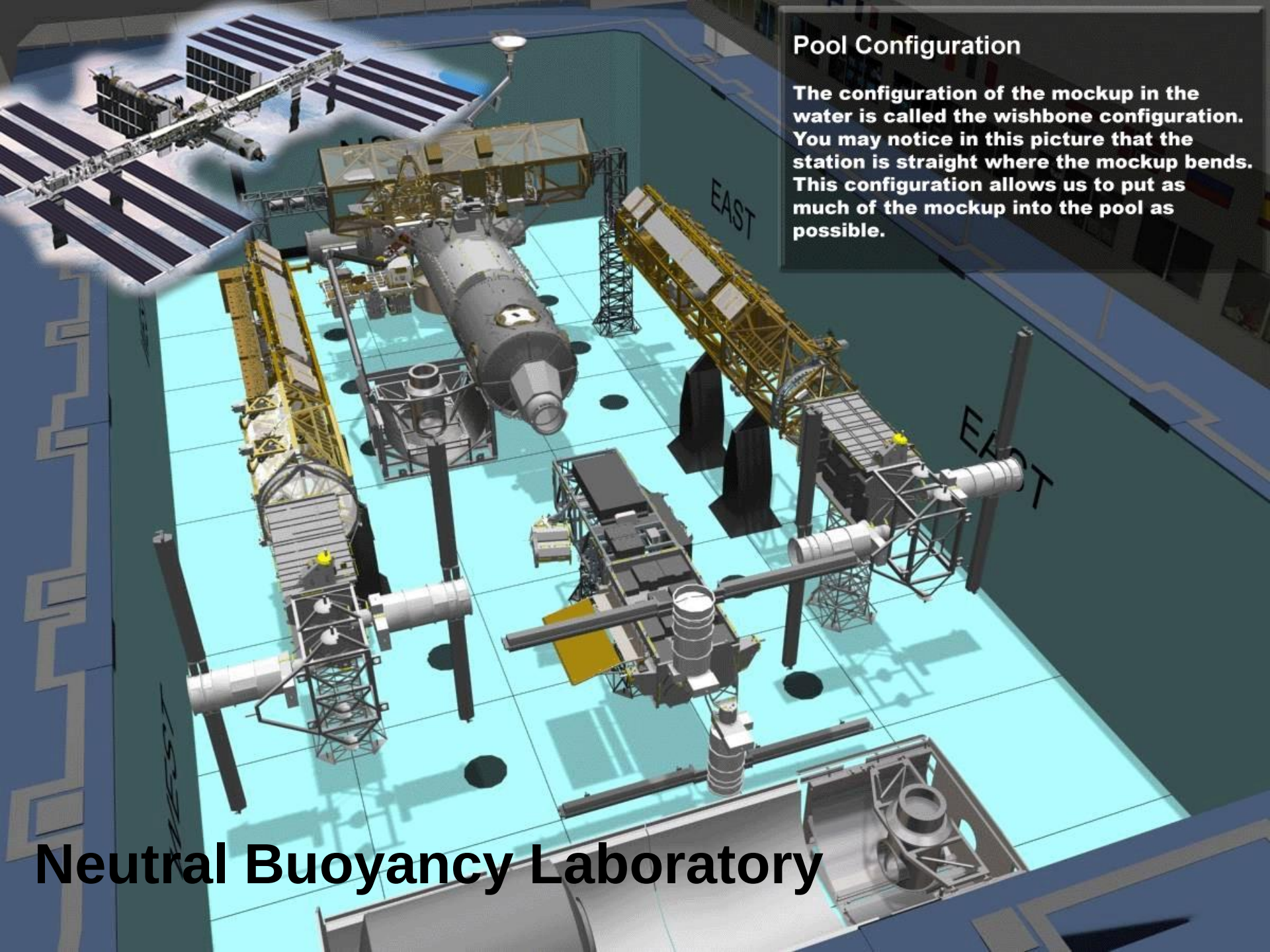
NASA's KC-135A - "Vomit Comet"

Neutral Buoyancy Laboratory

Johnson Space Center, Houston Texas







Neutral Buoyancy Laboratory

Neutral Buoyancy Laboratory is a big deep pool!

- 102 ft. wide by 202 ft. long
- 40 ft. deep
- Capacity
  - Volume = 824,160 cubic feet
  - 6.2 million gallons of water
  - 49.6 million pounds of water

Living in Space:
Space is a hostile environment

- Unexpected Motions
- Pressure
- Sounds

Unexpected Motions

- **Fiction:**

  Earthbound intuition about how you move applies when you are in orbit

- **Fact:**

  Orbit removes most normal and frictional forces → unexpected motion (or lack of motion)

Loose Items in Spacecraft

- **Fiction:**

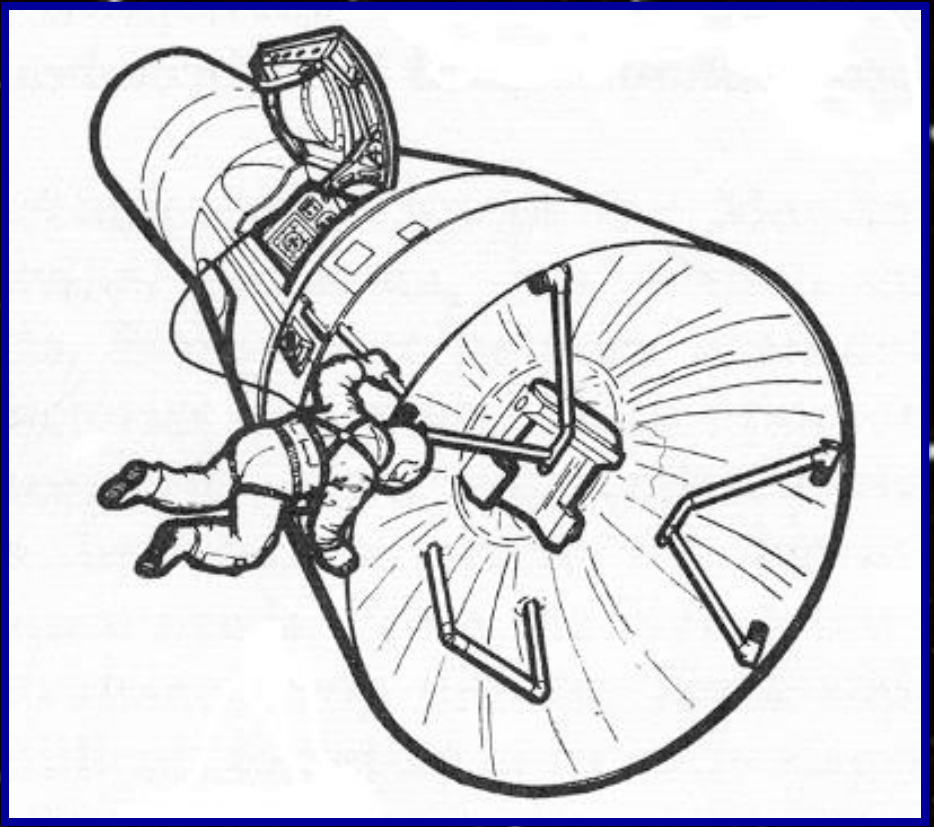
  If you lose something in a spacecraft, you have little hope of finding it, because it could drift anywhere

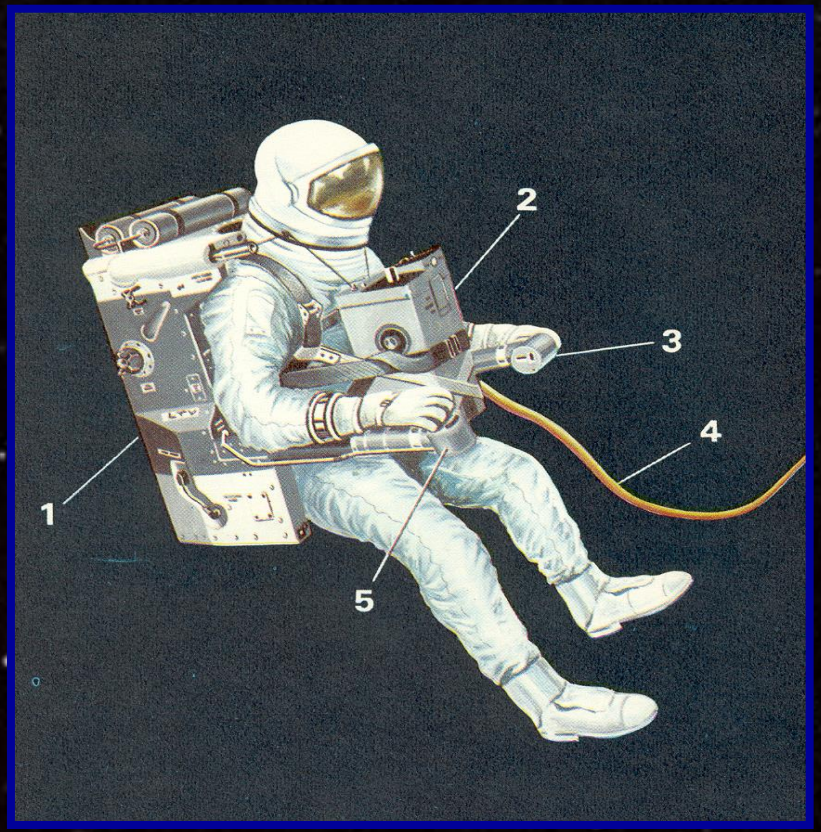
- **Fact:**

  Always look in the same place

Problems with moving in orbit

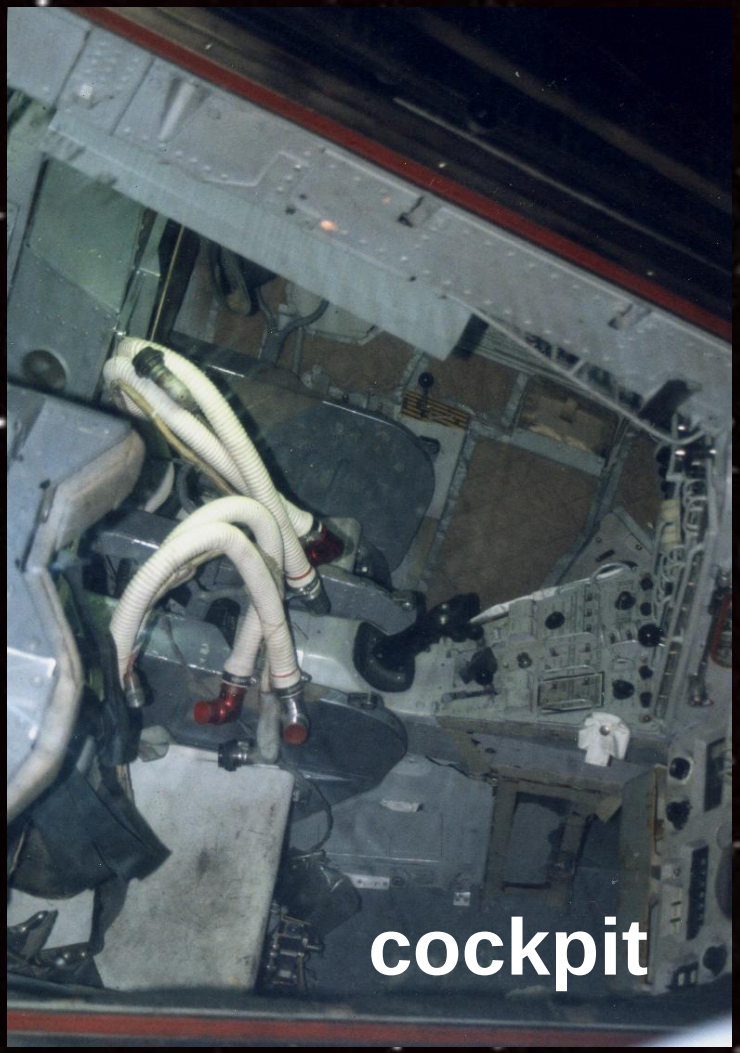
Gemini 9A astronaut maneuvering unit (AMU)





Problems with moving in orbit

Gemini 9A photo “float”



There is no air convection in orbit
(Hot air does not rise)

- **Fiction:**
  - Fires burn well in orbit
- **Fact:**
  - Combustion gasses extinguish fire
- **Caution:**
  - Do not sleep in an unventilated area!

Pressure

Fiction:

If suit pressure fails, the astronaut explodes.

Loss of Pressure

- **Fact:**
  - **Bends**
  - **Air leaves lungs**
  - **Suffocation**
  - **No bulging eyes or exploding people**

Sounds in Space

- Sound comes from molecular collisions
- Collisions form pressure waves
- Waves of molecules strike eardrums
- We detect the impacts with our ears

Sounds in Space

- **Fiction:**

  There are no sounds in space

- **Fact:**

  Space is not empty

  Extremely thin “atmosphere”

  Molecular collisions occur

  There is sound, but we cannot hear it

Sounds on Mars

- **Fiction:**

  We could hear, unaided on Mars, because it has an atmosphere

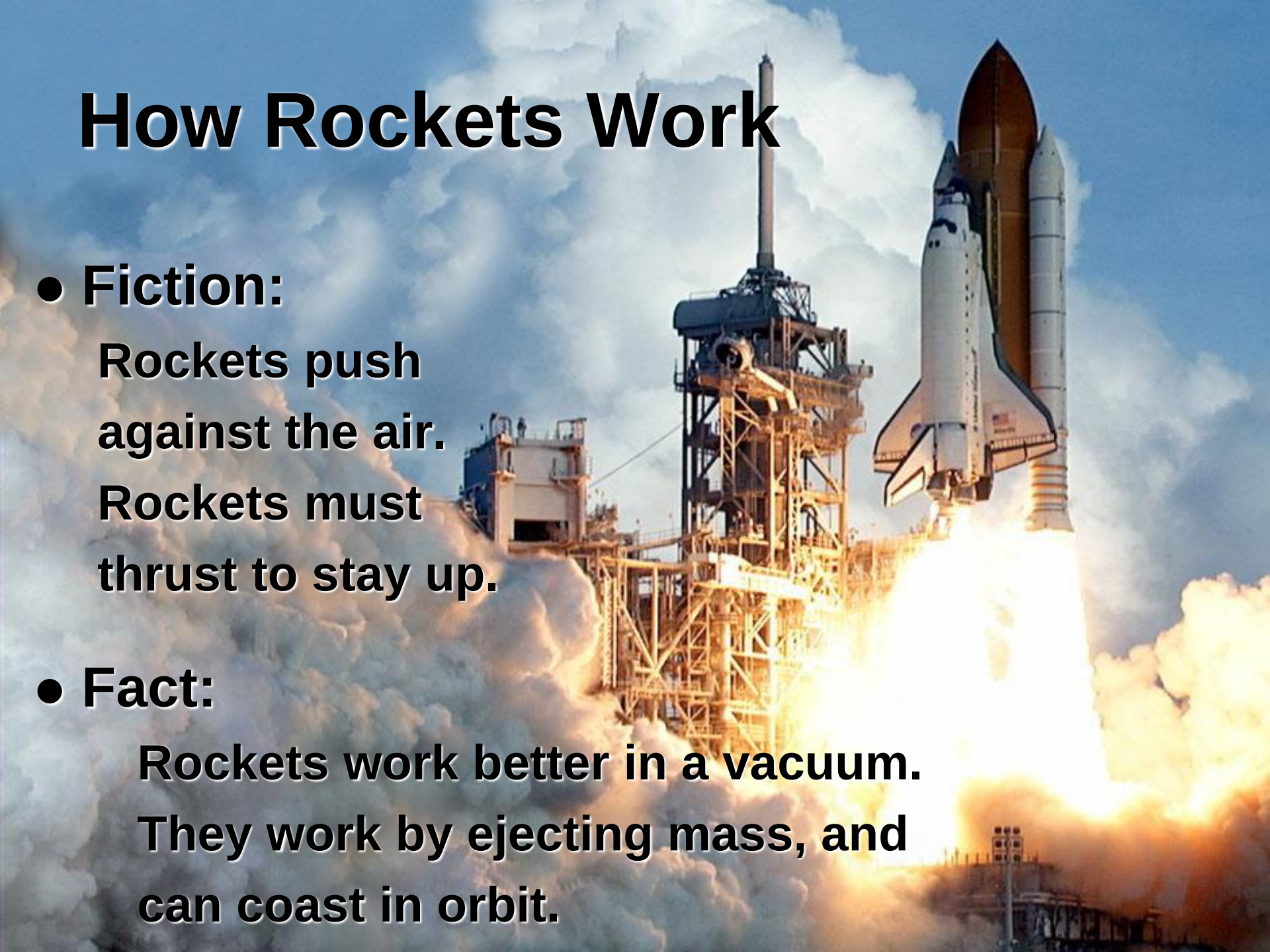
- **Fact:**

  Must wear Mars suits

  Ears alone won't work

  Microphones and amplifiers needed

How Rockets Work



- **Fiction:**

  Rockets push against the air. Rockets must thrust to stay up.

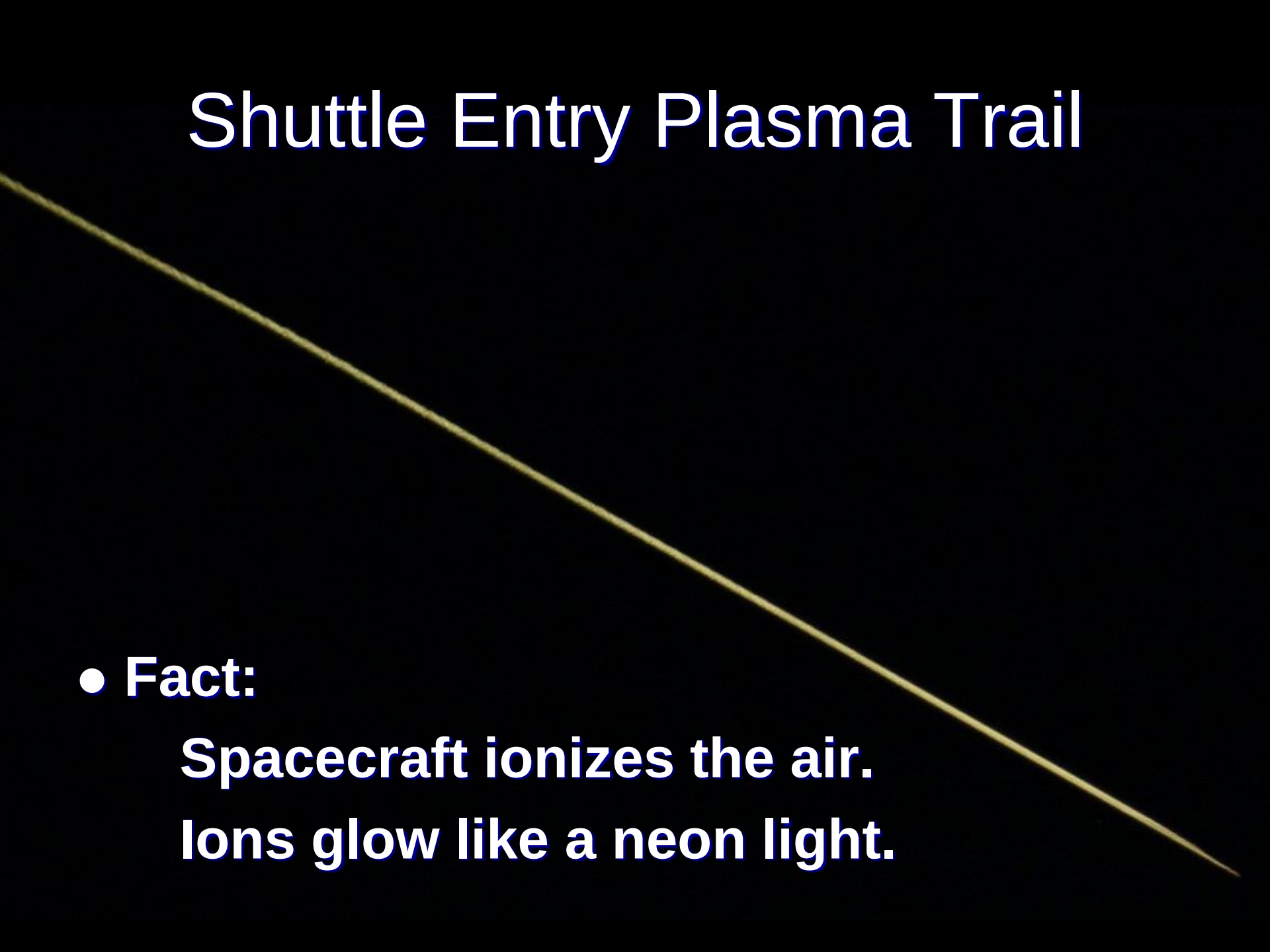
- **Fact:**

  Rockets work better in a vacuum. They work by ejecting mass, and can coast in orbit.

Atmospheric Entry

- **Fiction:**
  - **Air friction heats shuttle and causes the entry fireball**

Shuttle Entry Plasma Trail



- **Fact:**

  Spacecraft ionizes the air.

  Ions glow like a neon light.

Space Solar Power

- **Fiction:**

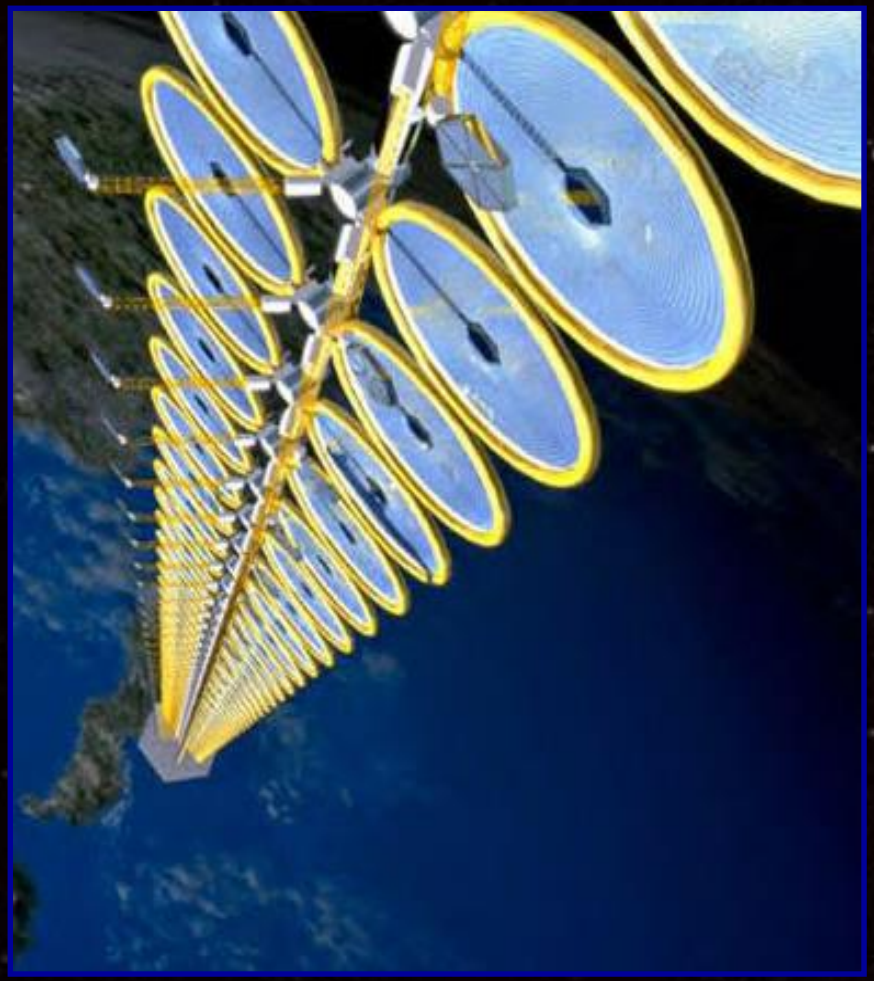
  An array of solar power satellites could supply Earth's electrical power

- **Fact:**

  The technology exists but…

  the size and mass required are prohibitive

Solar Power Satellite Concepts



Earth's Power Needs

- US Power: ~ 6 kilowatts/person
- Europe: ~ 3 kilowatts/person
- Projected Earth Population in 2050: 8 to 10 billion
- Assume: ~ 3 kilowatts/person

Size of Required Solar Array

A satellite solar panel produces 1.3 kilowatts of energy per square meter

Solar Array Deployment

- Requirement:
  - One Titan 4B launch PER DAY (EVERY DAY) for over 4000 years
- NOT THE SOLUTION

Costs of Space Program

- **Fiction:**

  NASA's expenditures are our primary national expenditure on space

- **Fact:**

  Other U.S. space programs spend about twice what NASA spends

  - *The military*
  - *The National Reconnaisance Office (part of the Department of Defense)*

How expensive is the space program?

- **Fiction:**

  NASA's expenditures are large compared to other federal programs

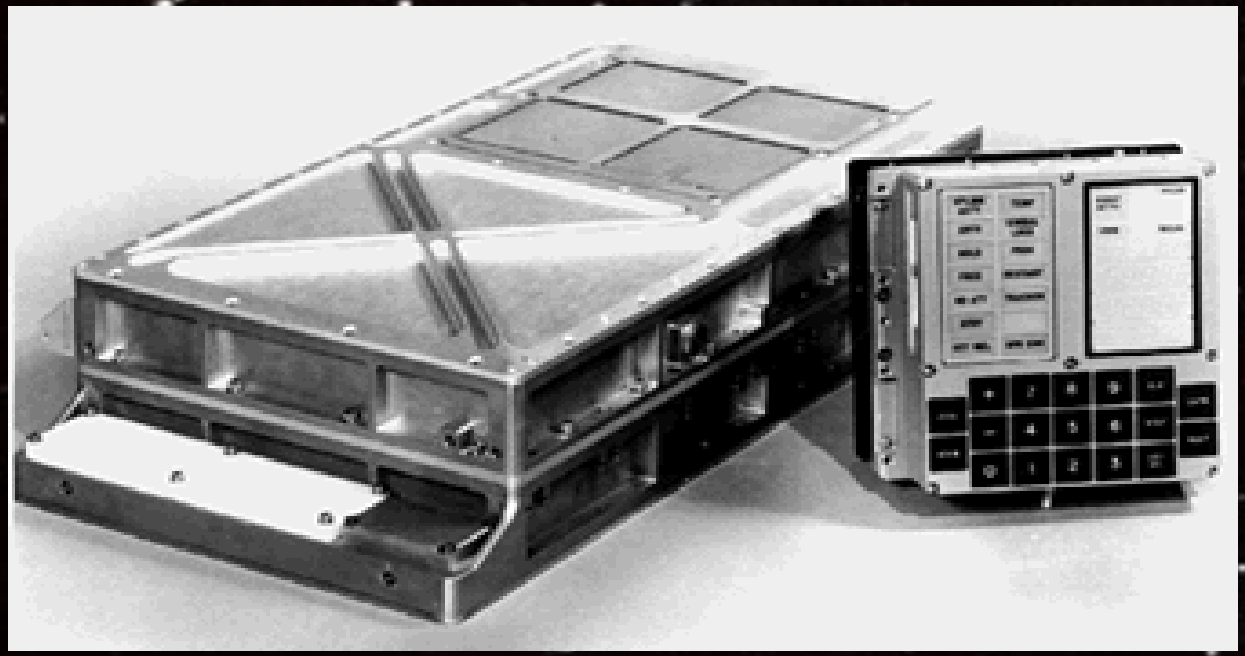
- **Fact:**

  NASA's expenditures are only a very small percentage of the federal budget. In 2001, NASA's budget was 0.69% of the Federal Budget.

Benefits of the Space Program

- **Fiction:**
  - Tang and Velcro are typical civil benefits of the space program
- **Fact:**
  - Substantial civil benefits include:
    - Satellite communications (phone, TV, etc.)
    - Enhanced medical diagnostics and monitoring
    - And …….

Apollo Guidance Computer



Microcomputers – The primary legacy of Apollo

Commercial Space Travel?

SpaceShipOne won the Ansari X-Prize on October 4, 2004

Photo courtesy of Scaled Composites, LLC

Shuttle vs SpaceShipOne

Weight:	**200,000 lb dry**	**6,800 lb dry**
Speed:	**17,500 mph / 385 miles**	**2,300 mph / 69.5 miles**

Commercial Space Travel?

- **Fiction:**

  Now that civilians have “gone into space”, civilian flights around the Moon and back to Earth are only a few years away.

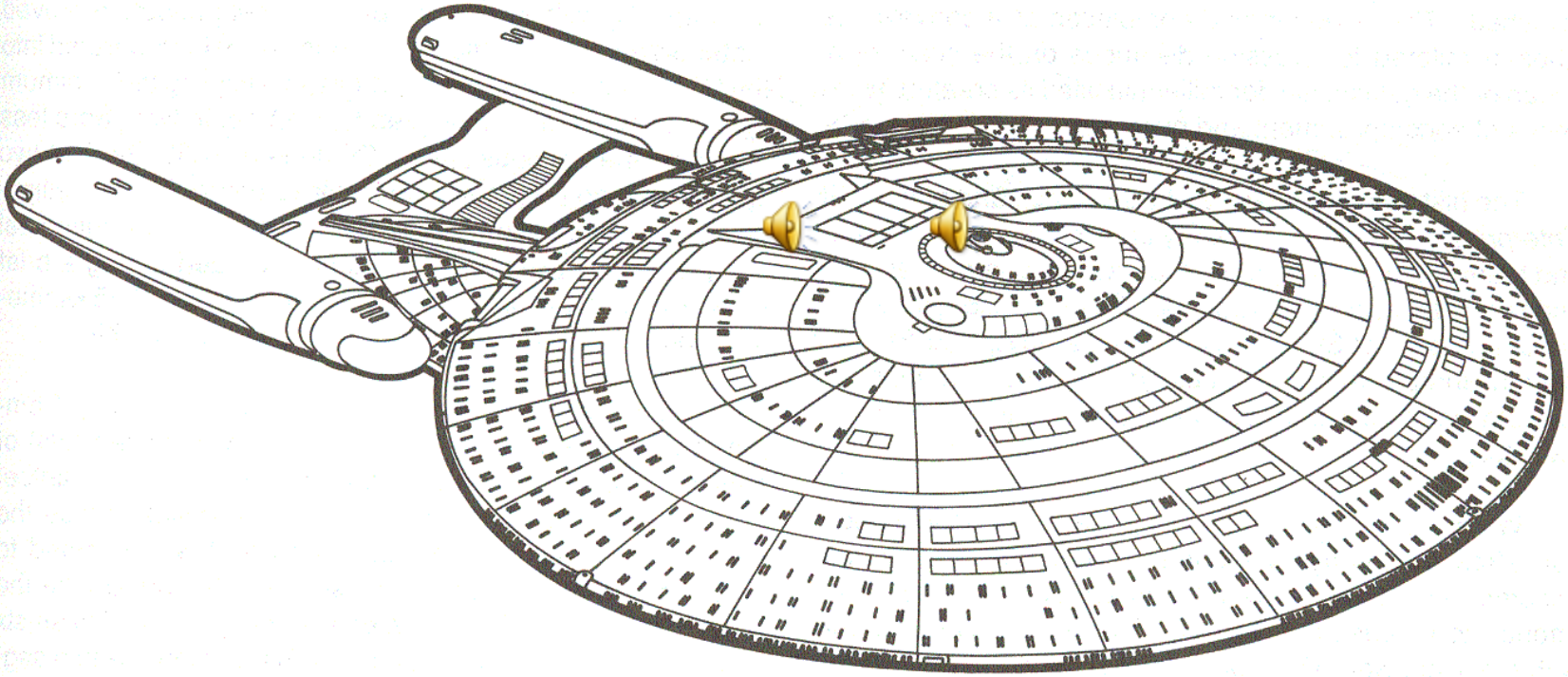
- **Fact:**

  The energy required to do an “up and down” flight like that of SpaceShipOne is much smaller than that required to go to orbit or to the Moon.

Energy Required

- SpaceShipOne flew to about 100 km altitude
- To put SpaceShipOne in orbit requires 85 times as much energy
- To take SpaceShipOne to the Moon requires 150 times as much energy

Star Trek



USS Enterprise

Warp Drive

- **Fiction:**

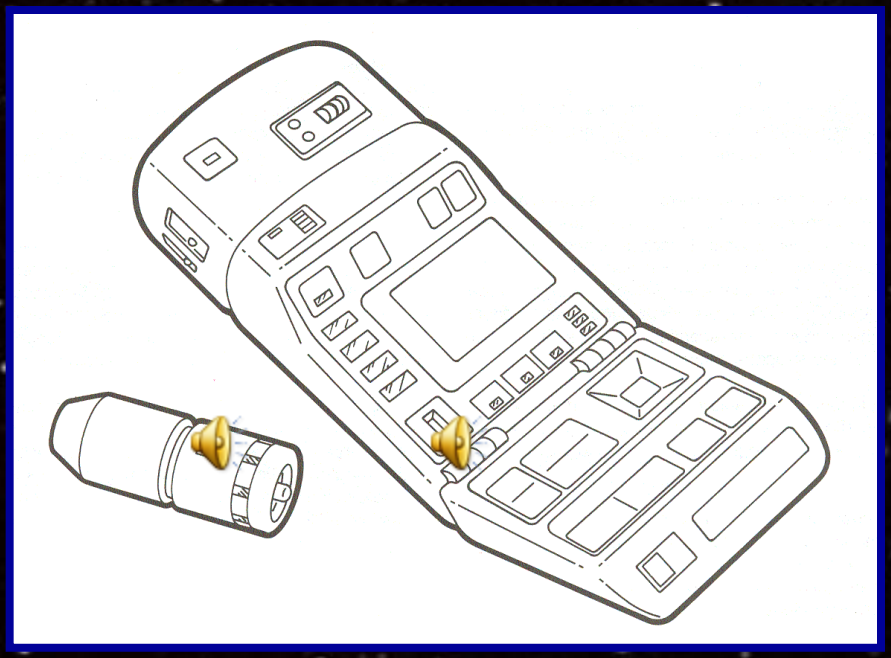
  By 2500, we will regularly travel faster than light – at “Warp” speeds

- **Fact:**

  No known source for energy

  Flight times to stars still too long

Medical Tricorder



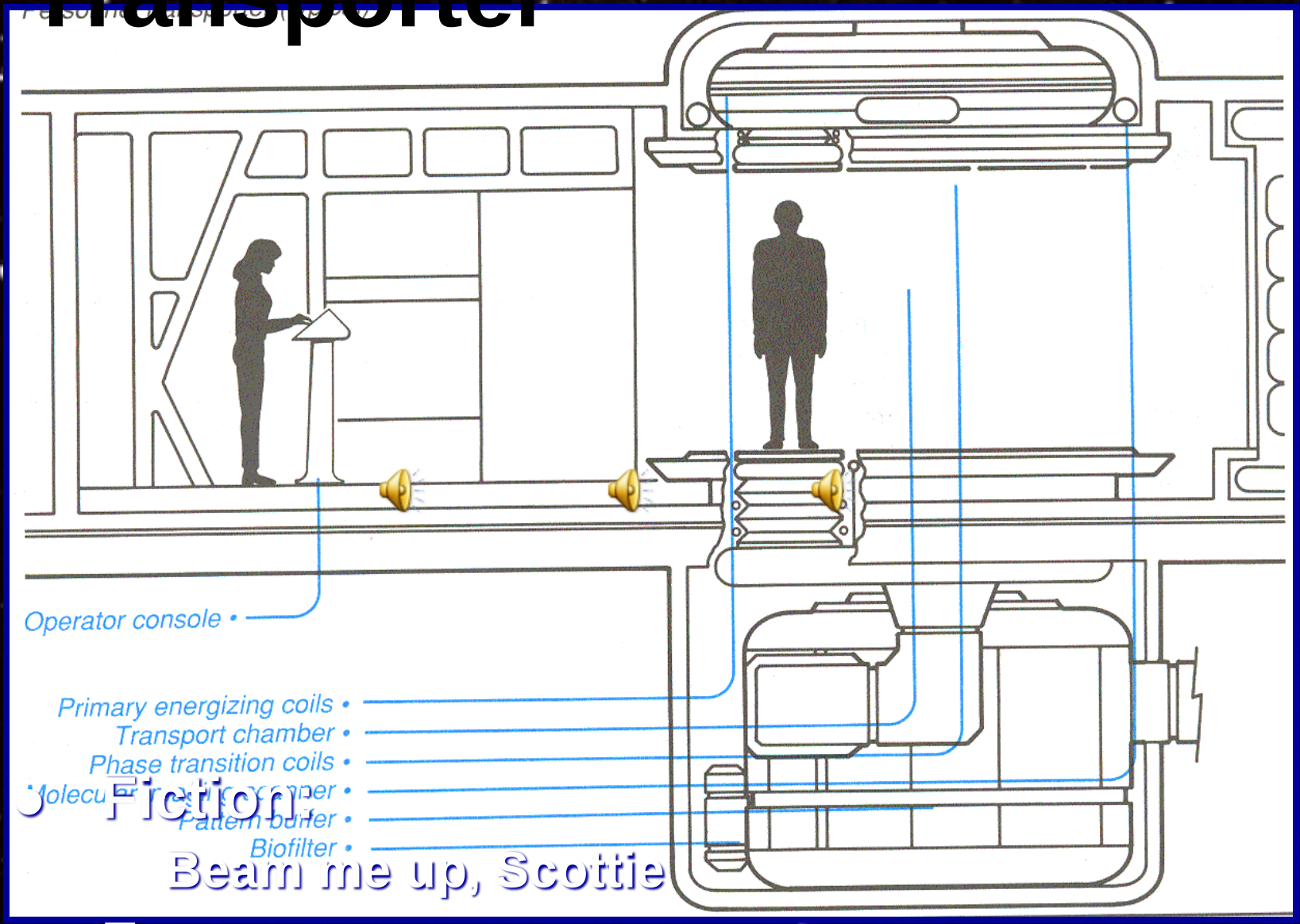
- **Fiction:**

  Detects all anomalies without intruding into the body

- **Fact:**

  We can only hope for devices like this

Transporter



- **Fact:**

  Major technical problems – revolution if solved

Common Space Myths

- We never went to the Moon
- UFOs
- Roswell, New Mexico is the site of an alien spaceship crash
- Aliens abduct Earthlings and then turn them loose

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Dr. Fowler's research focuses on the area of design and design methodology, the modeling and design of spacecraft, aircraft, and planetary exploration systems. He has served on the College of Engineering faculty since 1965. He has three years of industrial experience, has published more than 50 technical articles and reports and has co-authored two books. He is the recipient of 1997 Academy of Distinguished Teachers Ex-Students Association Award and has recently been elected as the new President-Elect of the American Society of Engineering Education. In 1999 he was awarded the Engineering Foundation Advisory Council Award. Dr. Fowler is Director of the Texas Space Grant Consortium (TSGC) and is currently serving as the ASE Undergraduate Advisor.