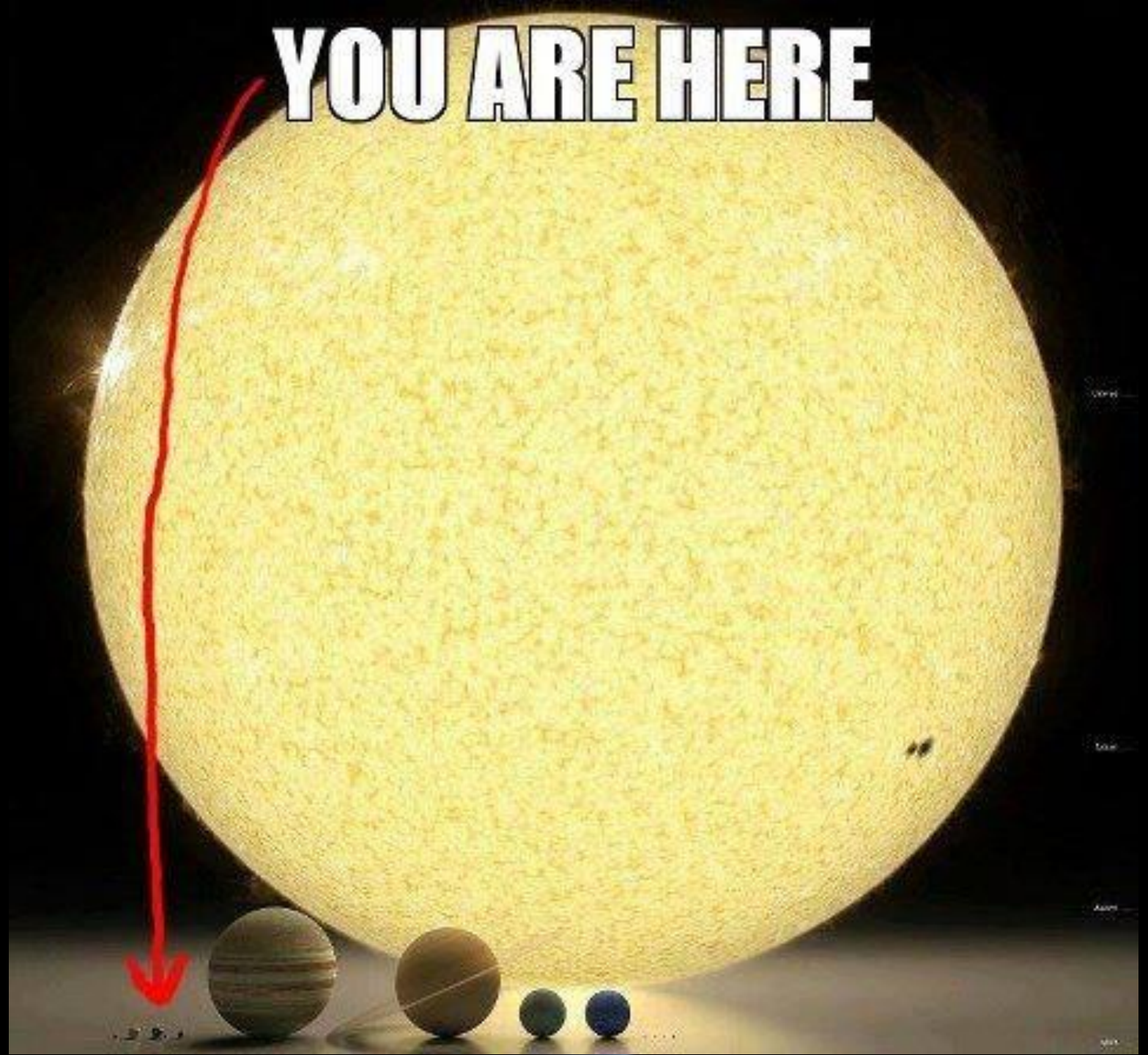
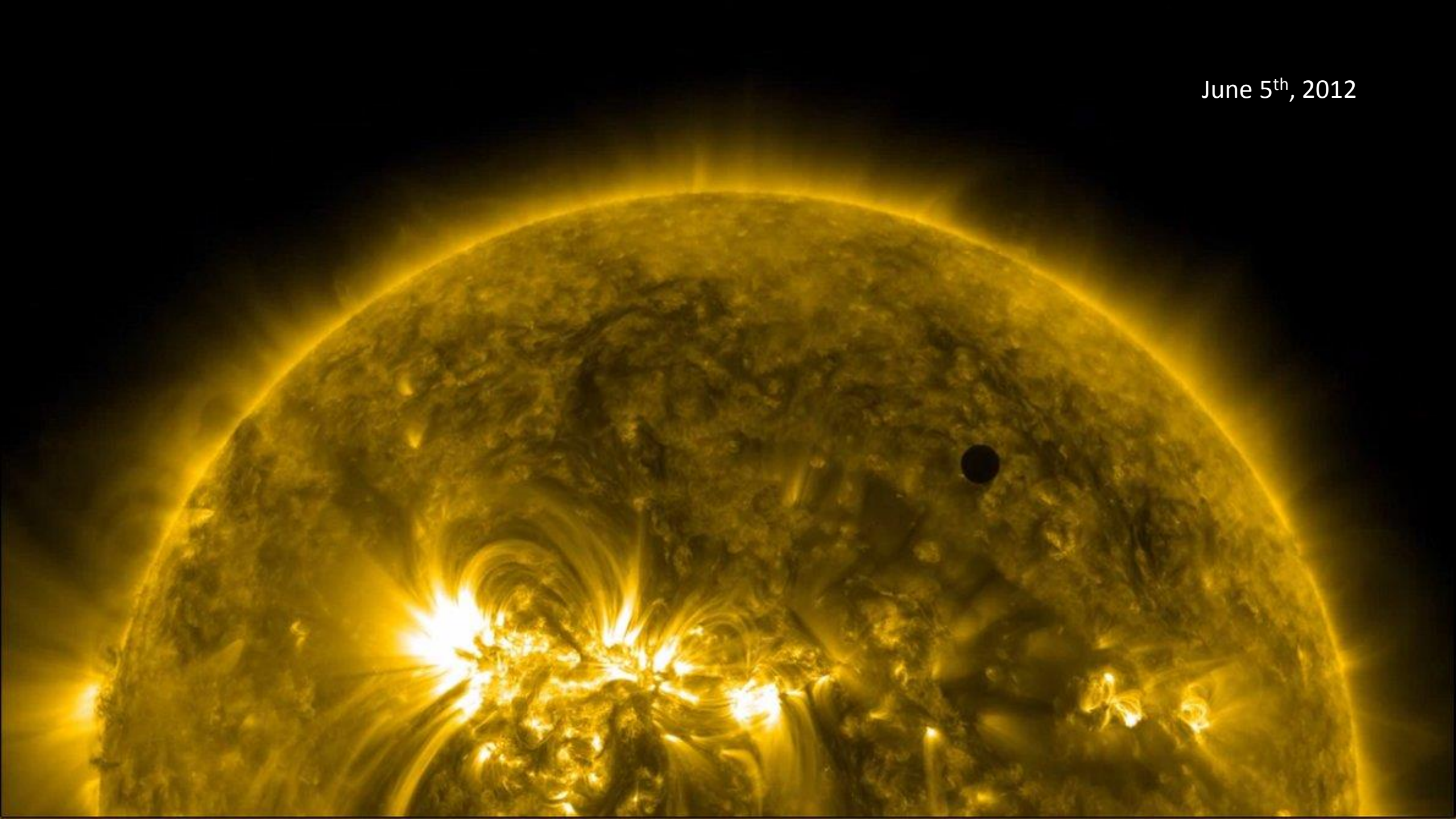
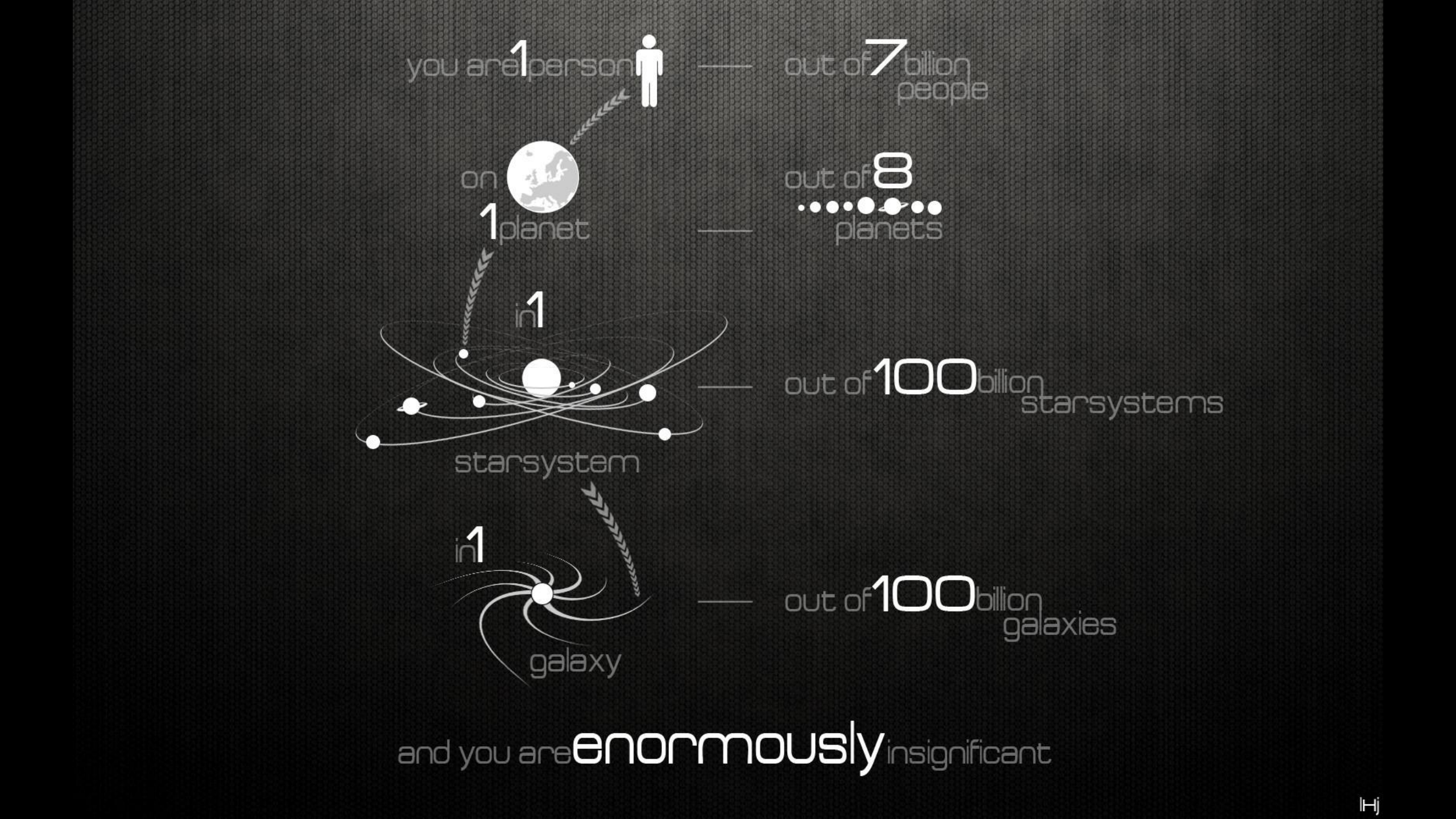
Space Exploration

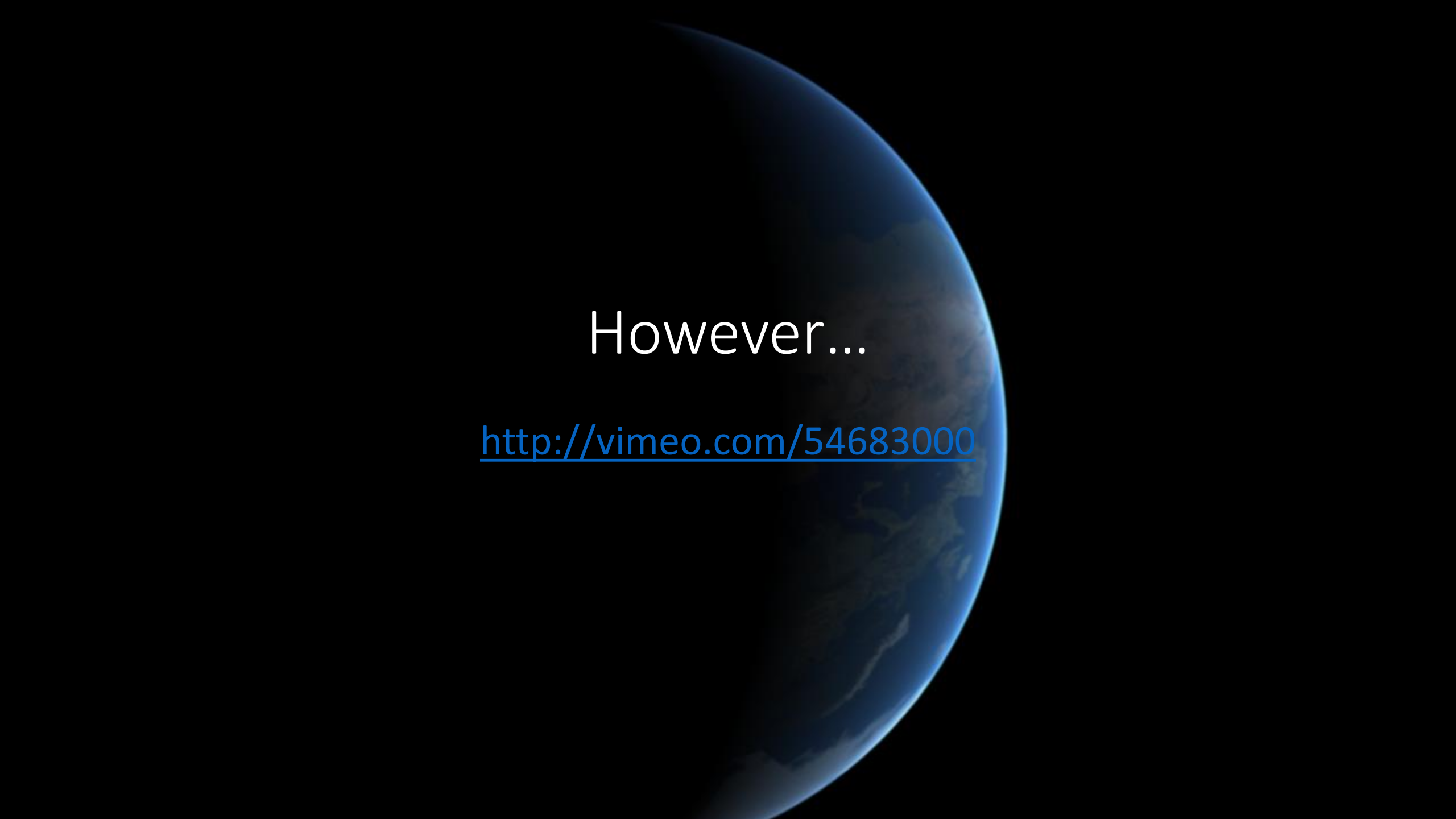
AKA: How to feel really, really small in the universe


YOU ARE HERE


June 5th, 2012


July 11th, 2010
www.iayc.org


you are 1 person
out of 7 billion people
on 1 planet
out of 8 planets
in 1 starsystem
out of 100 billion starsystems
in 1 galaxy
out of 100 billion galaxies
and you are enormously insignificant


However…
http://vimeo.com/54683000

Intro to NASA

‘Cause they study everything!

NASA

National Aeronautics and Space Agency

- *"An Act to provide for research into the problems of flight within and outside the Earth's atmosphere, and for other purposes."*
- Created by an act of Congress on October 1, 1958
- Basically to make the Russians mad and scared of us

What does NASA do?

- Pretty much anything to do with airplanes, space or technology
  - Satellites
  - Weather
  - Probes
  - The solar system
  - Sending humans into space
  - Air travel
  - Research into new technologies
  - Etc.
  - And yes, they literally search for aliens

And then NASA does stuff like this…

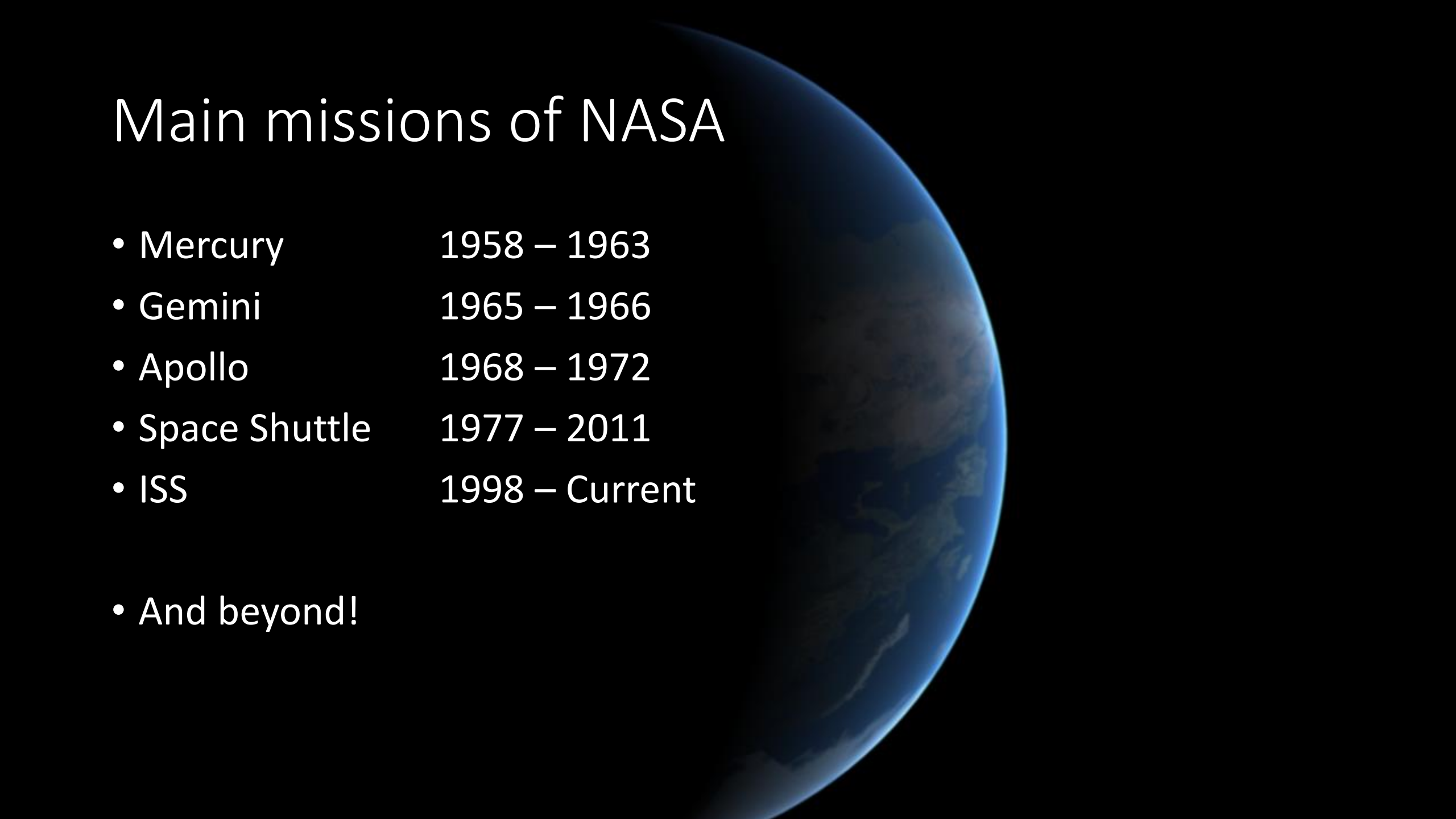
I don’t care about space. What has NASA done for me?

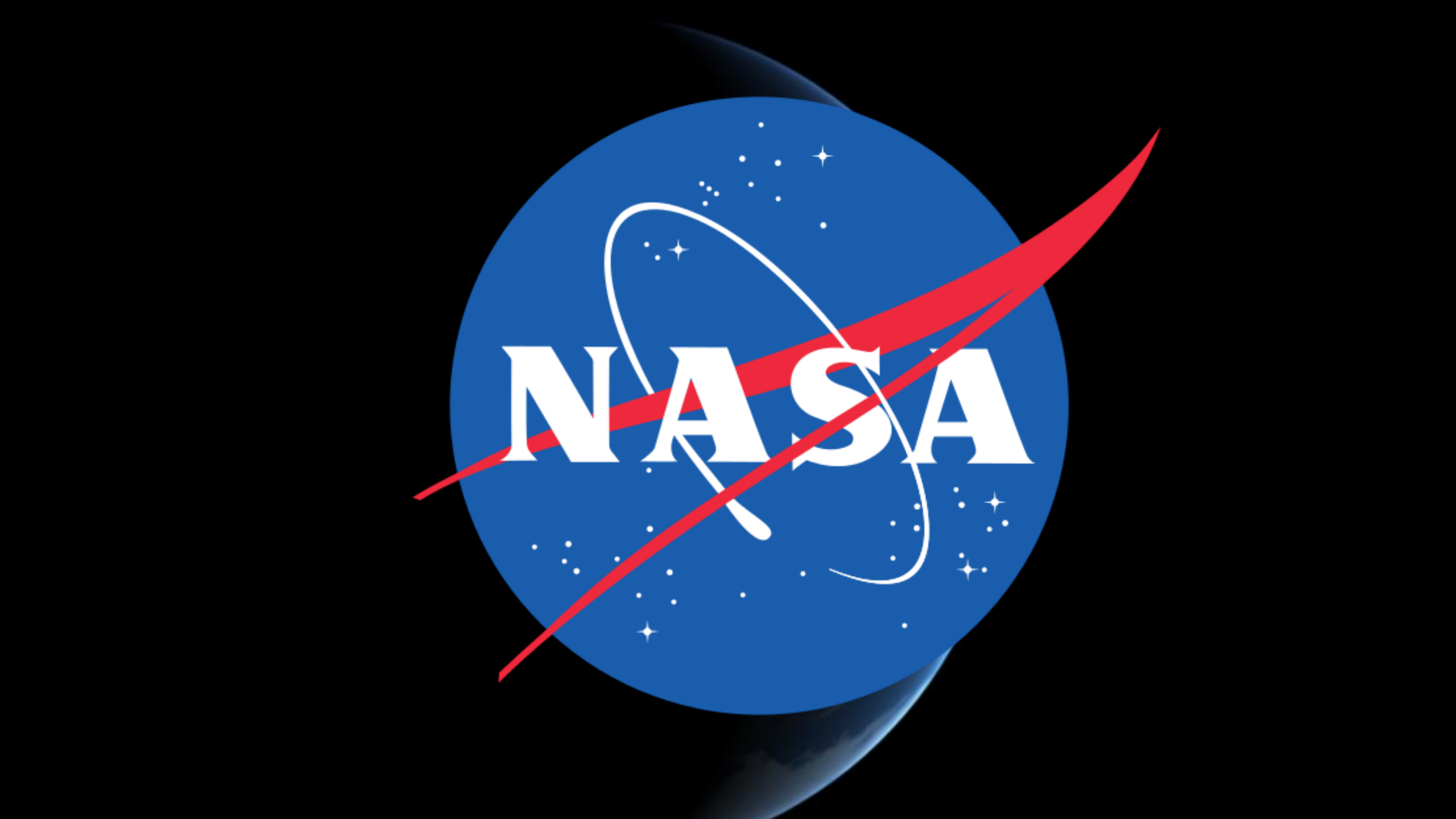
- CAT scanners
- Computer microchips
- Cordless tools
- Ear thermometers
- Freeze-dried food
- Insulation
- Invisible braces
- Enriched baby food
- The joystick
- LED lights
- Memory foam
- Scratch resistant lenses
- Shoe insoles
- Smoke detectors
- Solar energy
- The swimsuit
- The water filter
- Land mine removal
- The super soaker
- Flame-resistant textiles
- Work-out machines
- Long distance communication
- Highway safety grooving

Main missions of NASA

- Mercury 1958 – 1963
- Gemini 1965 – 1966
- Apollo 1968 – 1972
- Space Shuttle 1977 – 2011
- ISS 1998 – Current

- And beyond!




NASA

NASA has mission patches – You should too!

Shoot for the moon.

Even if you miss,
you'll be amongst the stars...

...suffocating.

The Space Race

Darn Russians

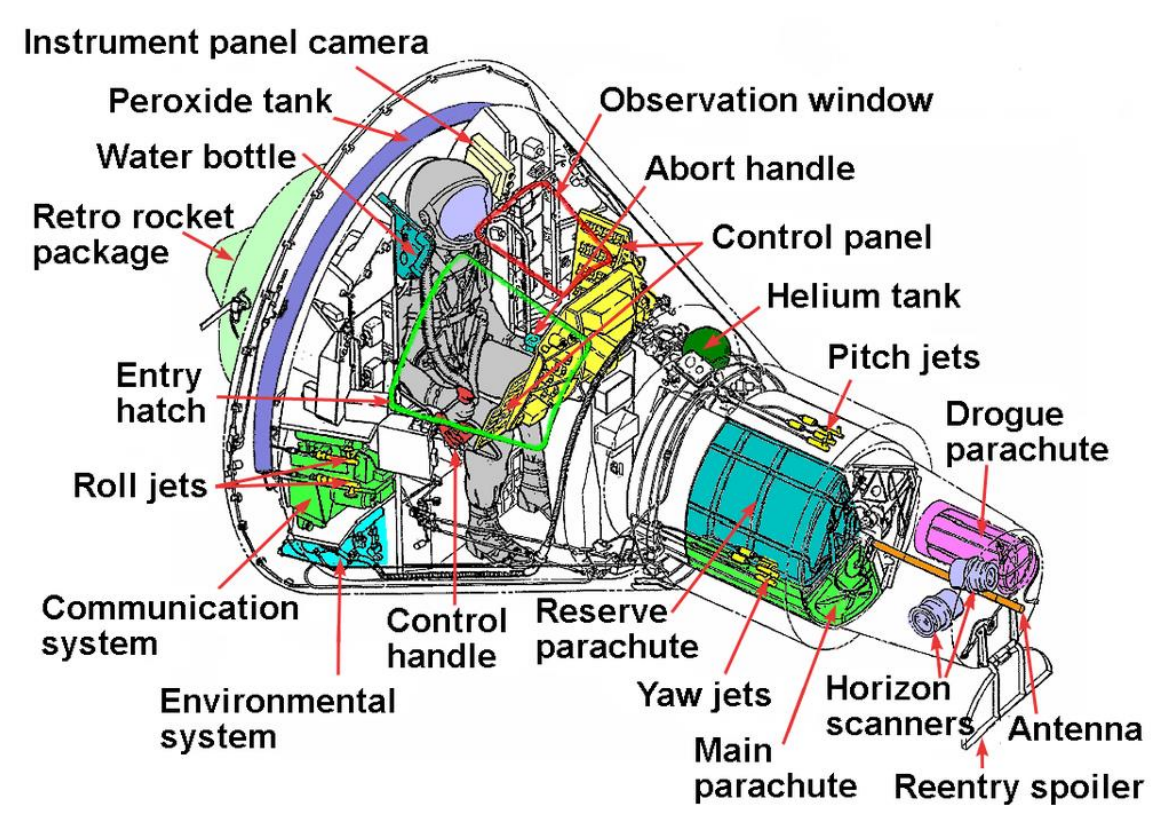
http://www.history.com/topics/space-race

http://www.nbcnews.com/feature/flashback/flashback-race-space-n220531

Mercury Missions

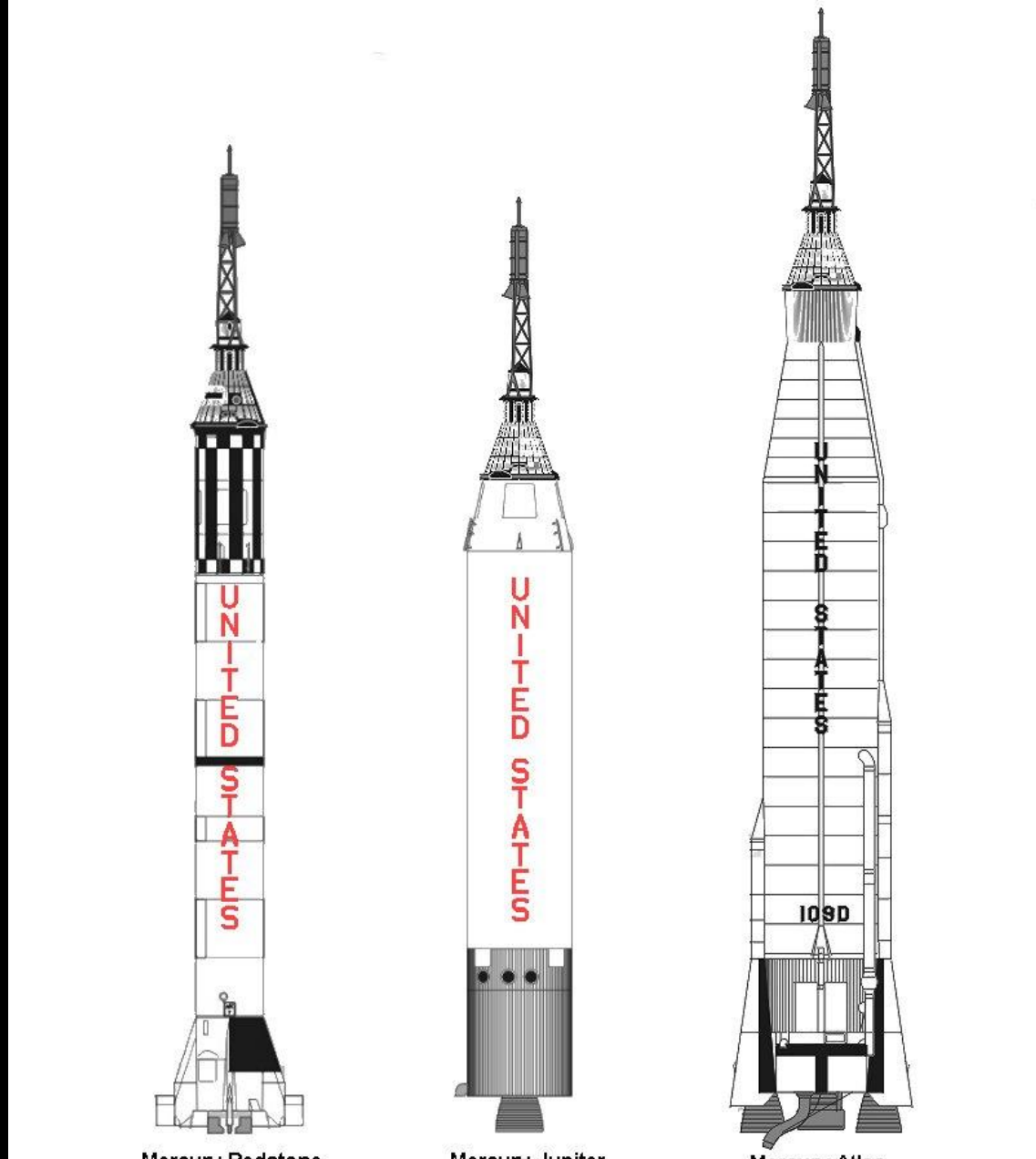
First shot at space

The Mercury Capsule



The Mercury Capsule

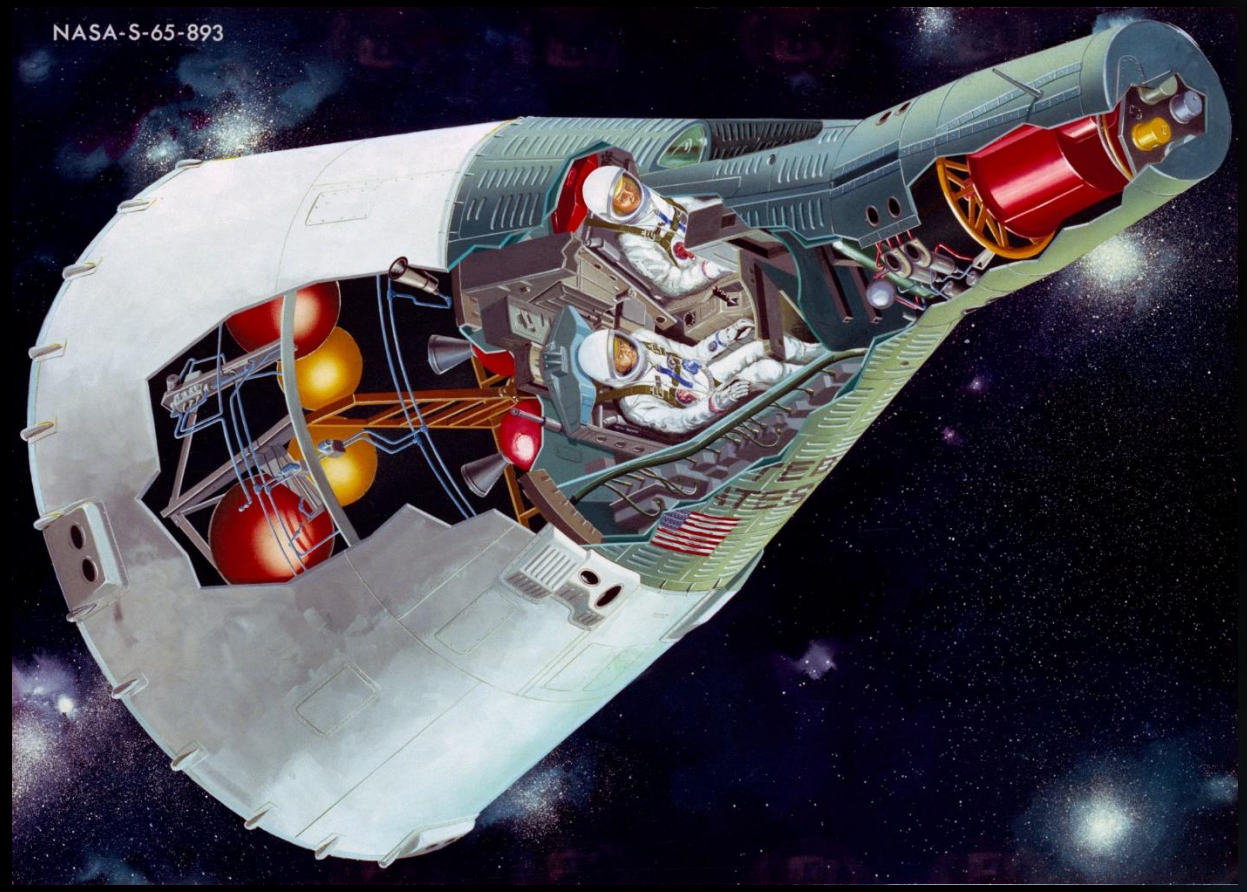
The Mercury Rockets



Gemini Missions

Two people are better?

Gemini Capsule

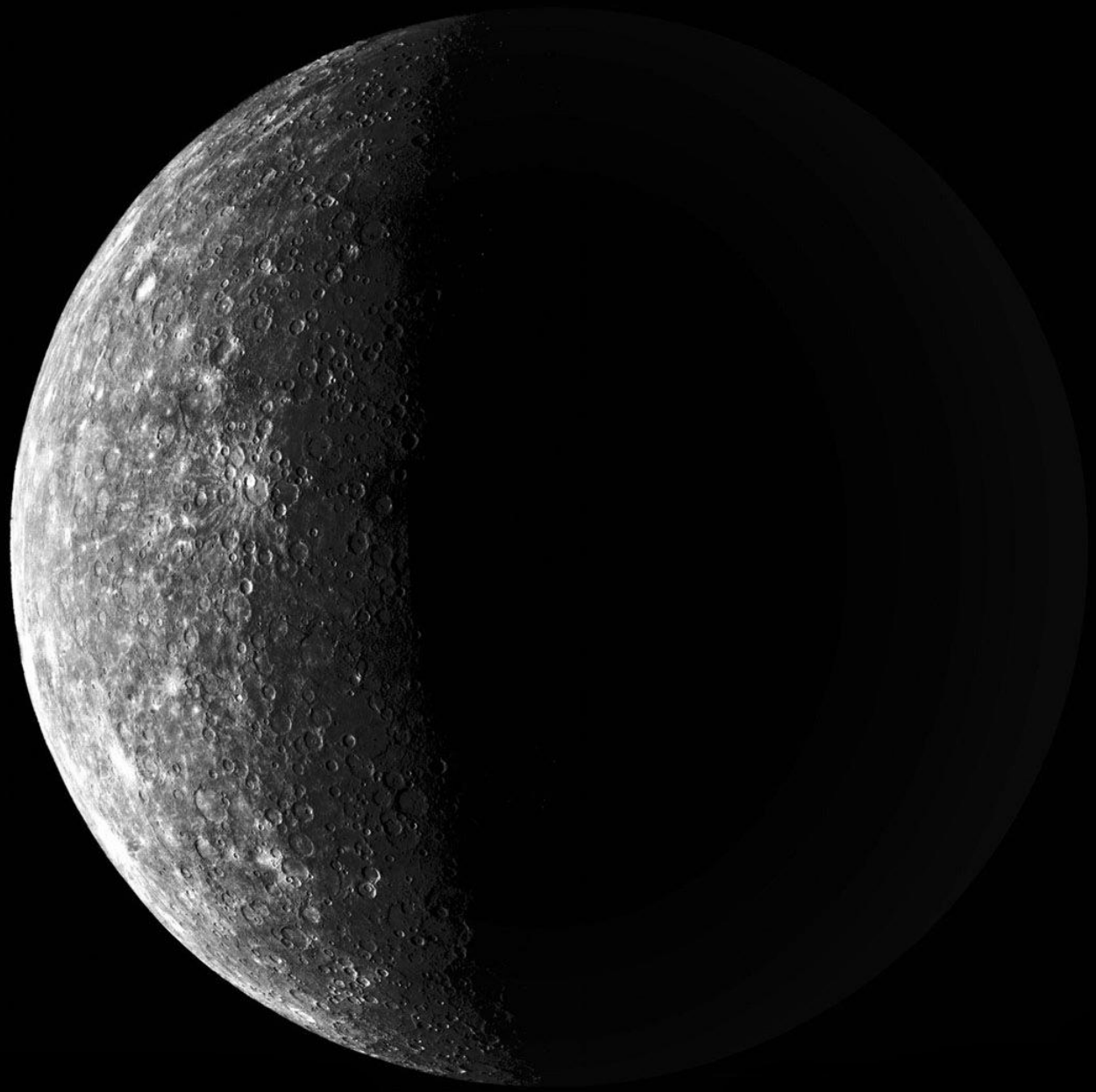


Gemini Capsule

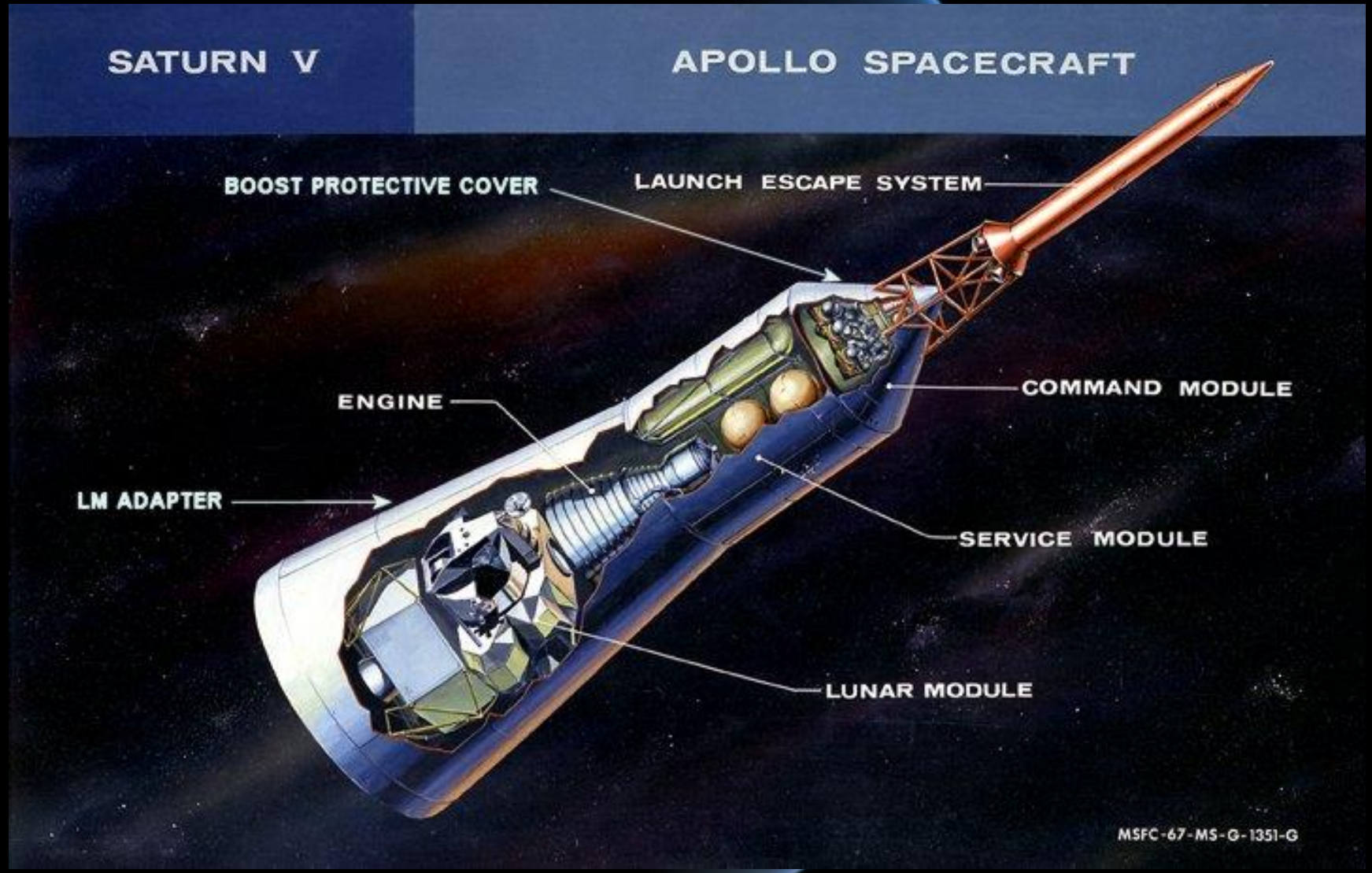
Gemini Missions: Titan II Rocket

Apollo Missions

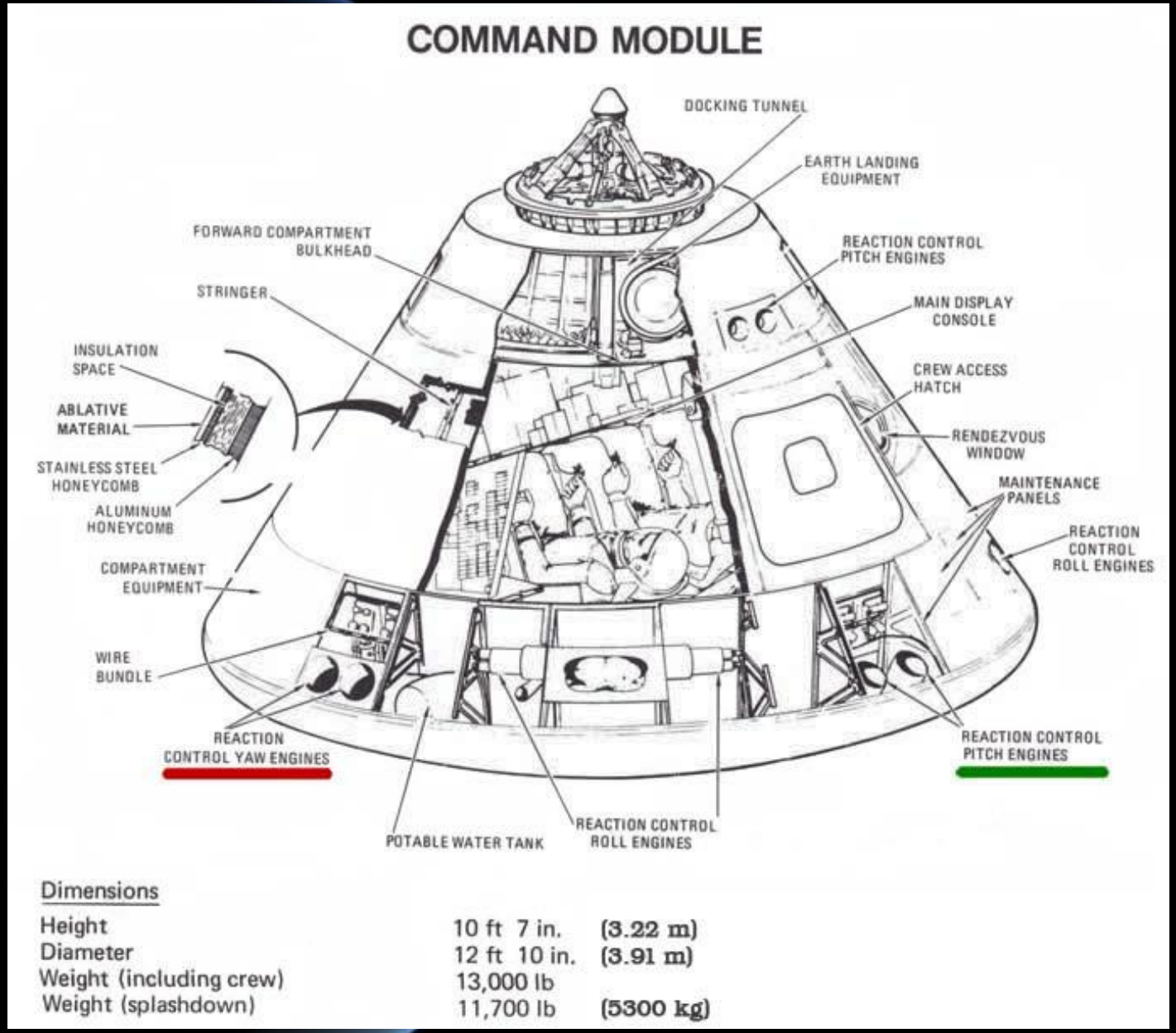
To the moon!!!!



Apollo Capsule

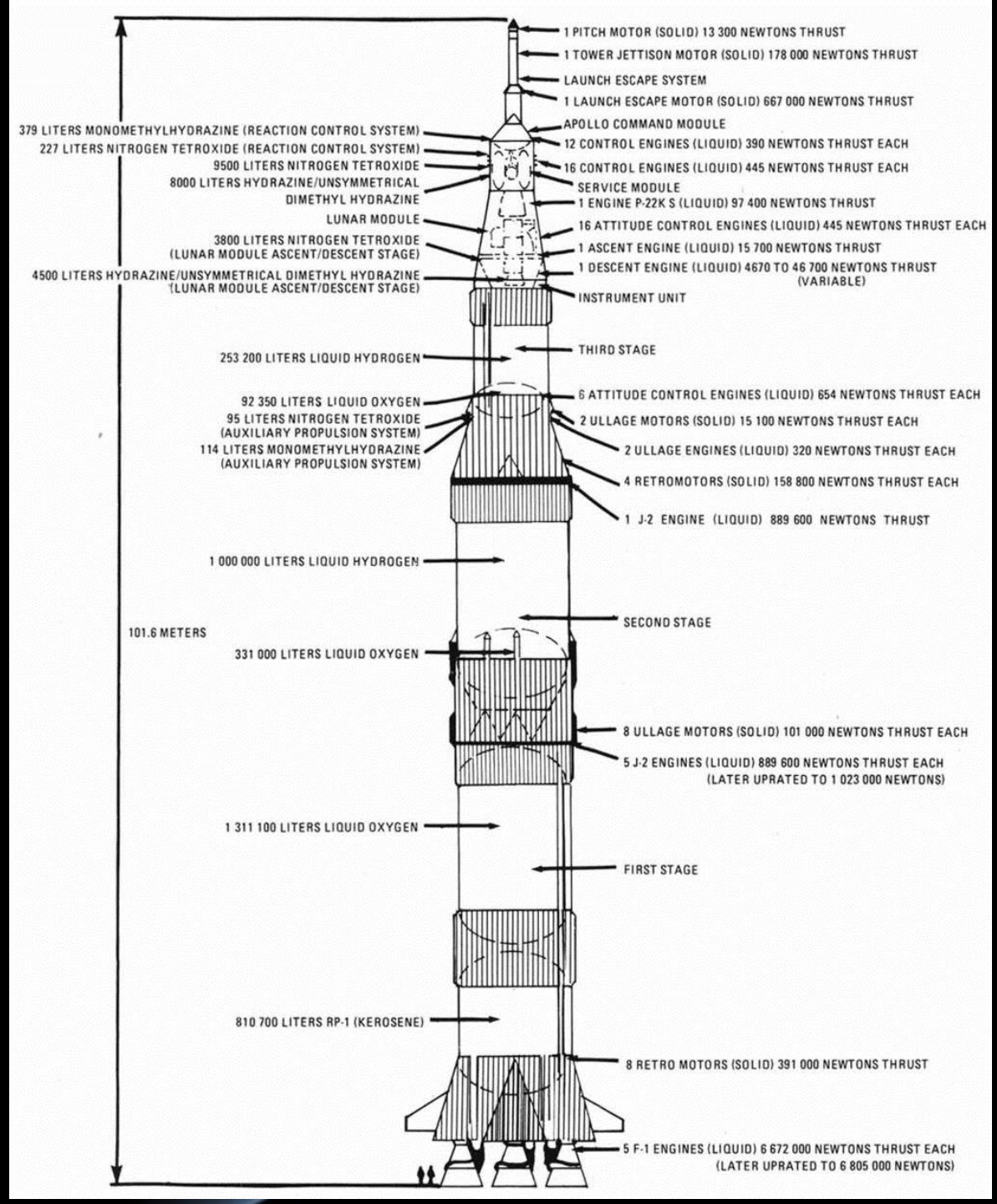


Apollo Capsule



Apollo Capsule

Apollo Missions: Saturn V Rocket

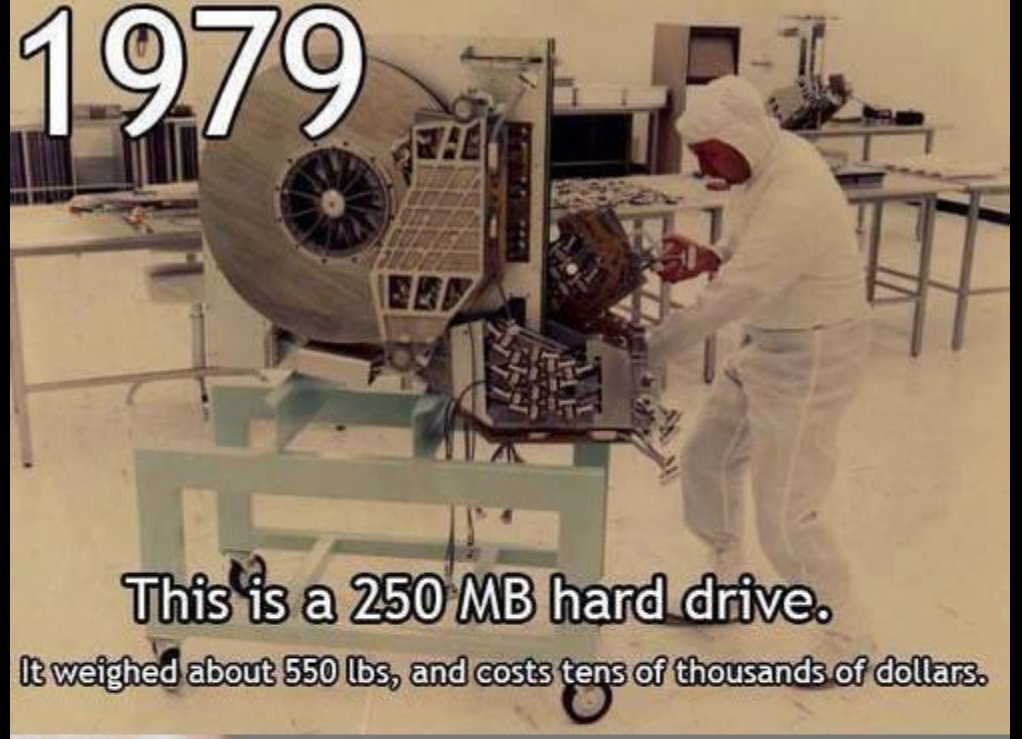


Apollo Missions: Saturn V Rocket

http://videos.howstuffworks.com/discovery/32385-massive-engines-saturn-v-moon-rocket-video.htm

The Ones You Hear About

- Apollo 11
  - http://www.youtube.com/watch?v=iSPQTfp5vJE
- Apollo 13
  - http://www.youtube.com/watch?v=C2YZnTL596Q
  - http://sploid.gizmodo.com/this-is-the-actual-hack-that-saved-the-astronauts-of-th-1598385593


1979
This is a 250 MB hard drive.
It weighed about 550 lbs, and costs tens of thousands of dollars.


2014
This is a 128 GB microSD card.
It holds about 525x the data as the DH above.
It weighs about 4/10 of 1 gram and costs about $25.

Review of Missions

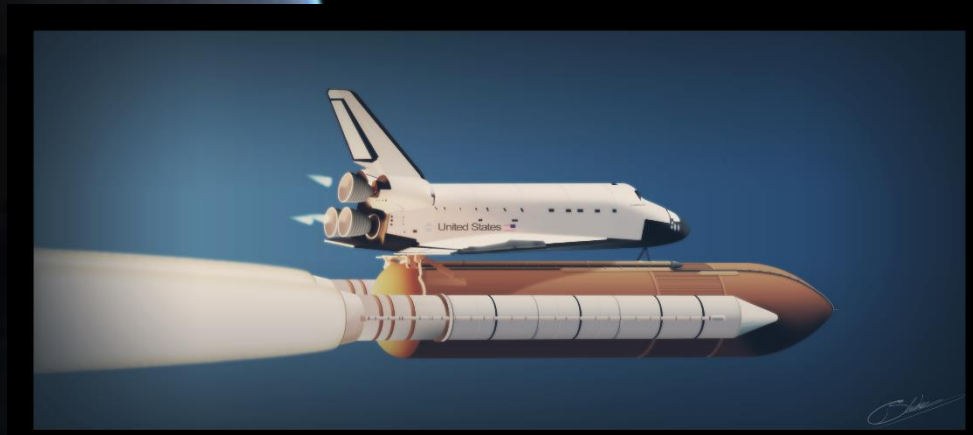
http://www.youtube.com/watch?v=QiJ_KFVHzA0

http://ed.ted.com/lessons/what-was-the-point-of-the-space-race-jeff-steers

After Apollo

Yes, stuff was still happening…

After Apollo



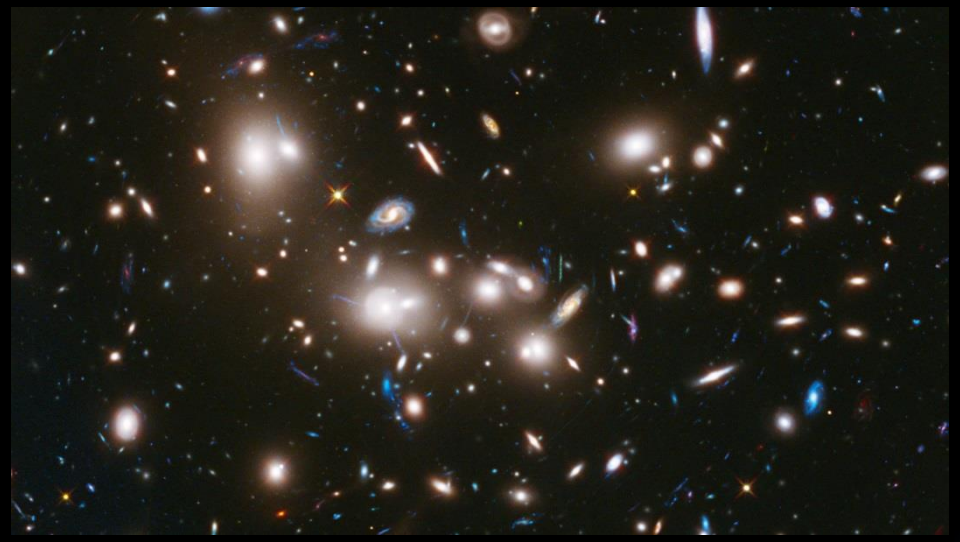
- Space Shuttle Missions
  - From 1981 to 2011
  - 135 missions
  - Using 5 reusable shuttles
    - Columbia
    - Challenger
    - Discover
    - Atlantis
    - Endeavour
  - Challenger and Columbia were lost to explosions

Space Shuttle Missions Gone Wrong

- Challenger accident of 1986
  - http://www.youtube.com/watch?v=lYX35Z_L-dw
  - http://www.history.com/topics/challenger-disaster
- Columbia accident of 2003
  - http://www.youtube.com/watch?v=2eTRaJGDe-8&list=PL9F3EF0875CD58DF3&index=6

Hubble Telescope

- So many pretty pictures!
- http://www.youtube.com/watch?v=--X9zfgZtS0
- Why put telescopes in space? https://www.youtube.com/watch?v=lj-u2bHo_fw&feature=em-subs_digest



Hubble Telescope

- Hubble is still doing awesome things, even though it is now broken and slightly less cool
- http://www.engadget.com/2015/09/25/hubble-veil-nebula/?ncid=txtlnkusaolp00000618

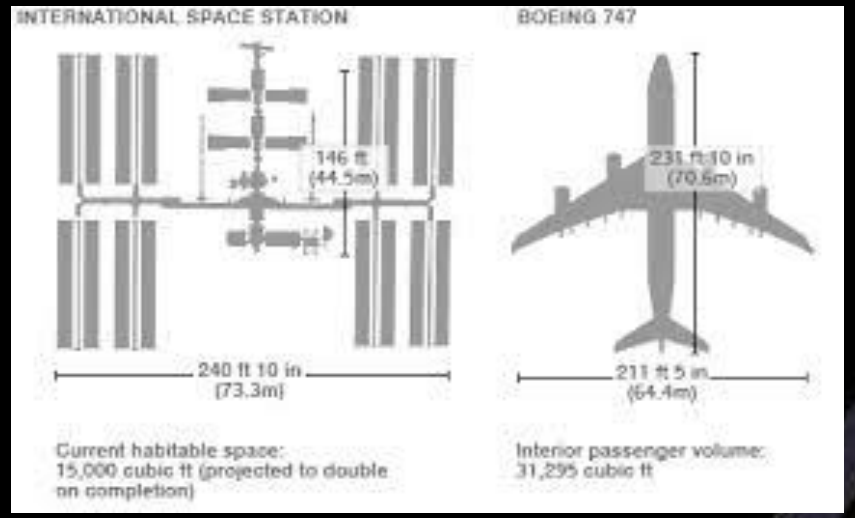
- Hubble is in a LEO (low earth orbit)
- http://www.wired.com/2015/09/whats-special-low-earth-orbit/

The ISS

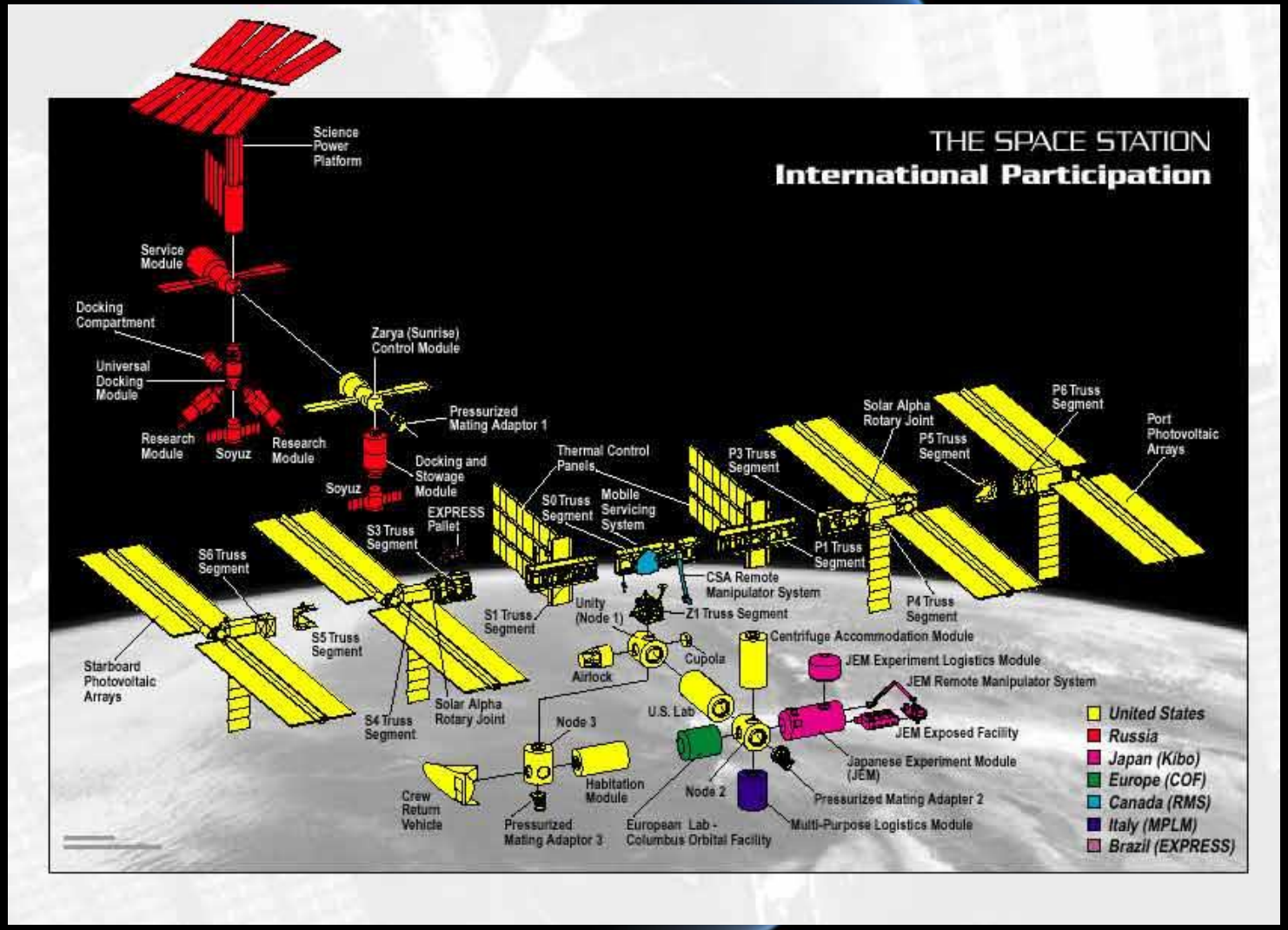
- The ISS
  - International Space Station
  - In-orbit assembly of the station began on Nov 20, 1998
  - Construction was officially completed in 2011 (although stuff is still added all the time)
  - Continuously occupied since Nov 2, 2000
  - Main contributors:
    - NASA / Russia / Canada / Japan / Brazil / and 11 members of the ESA

The ISS

The Size of the ISS

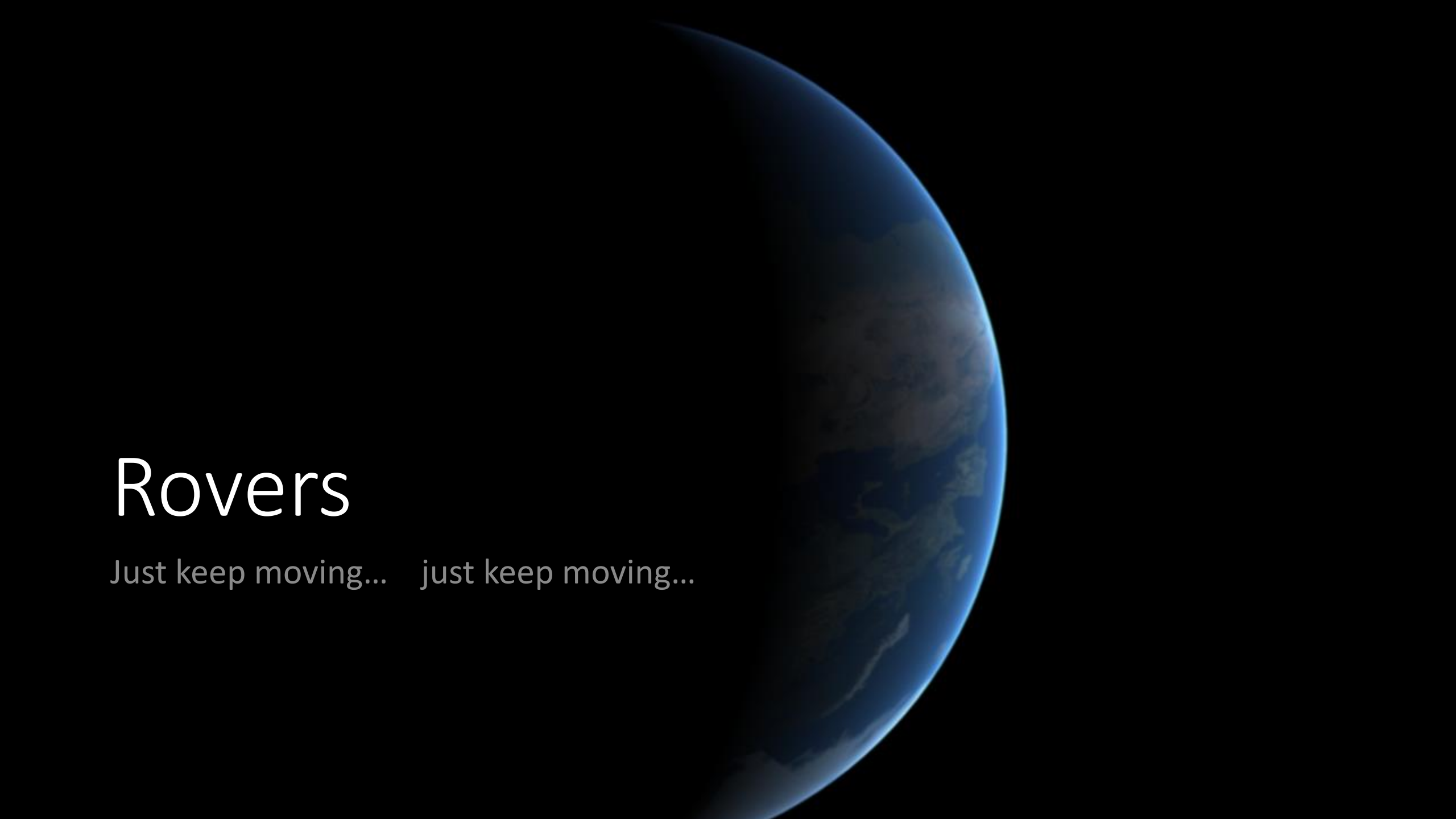


The Components of the ISS



Videos of the ISS

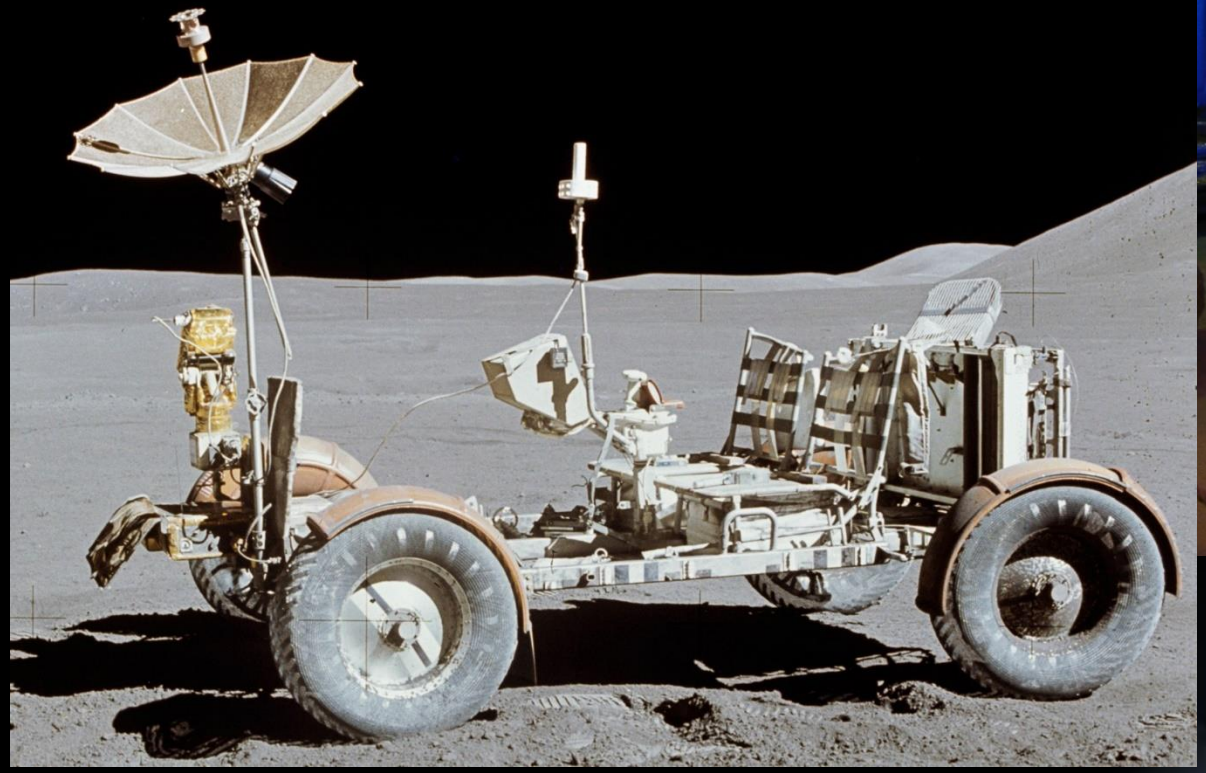
- Tour: http://www.wimp.com/orbitaltour/
- Funness! http://www.youtube.com/watch?v=o8TssbmY-GM

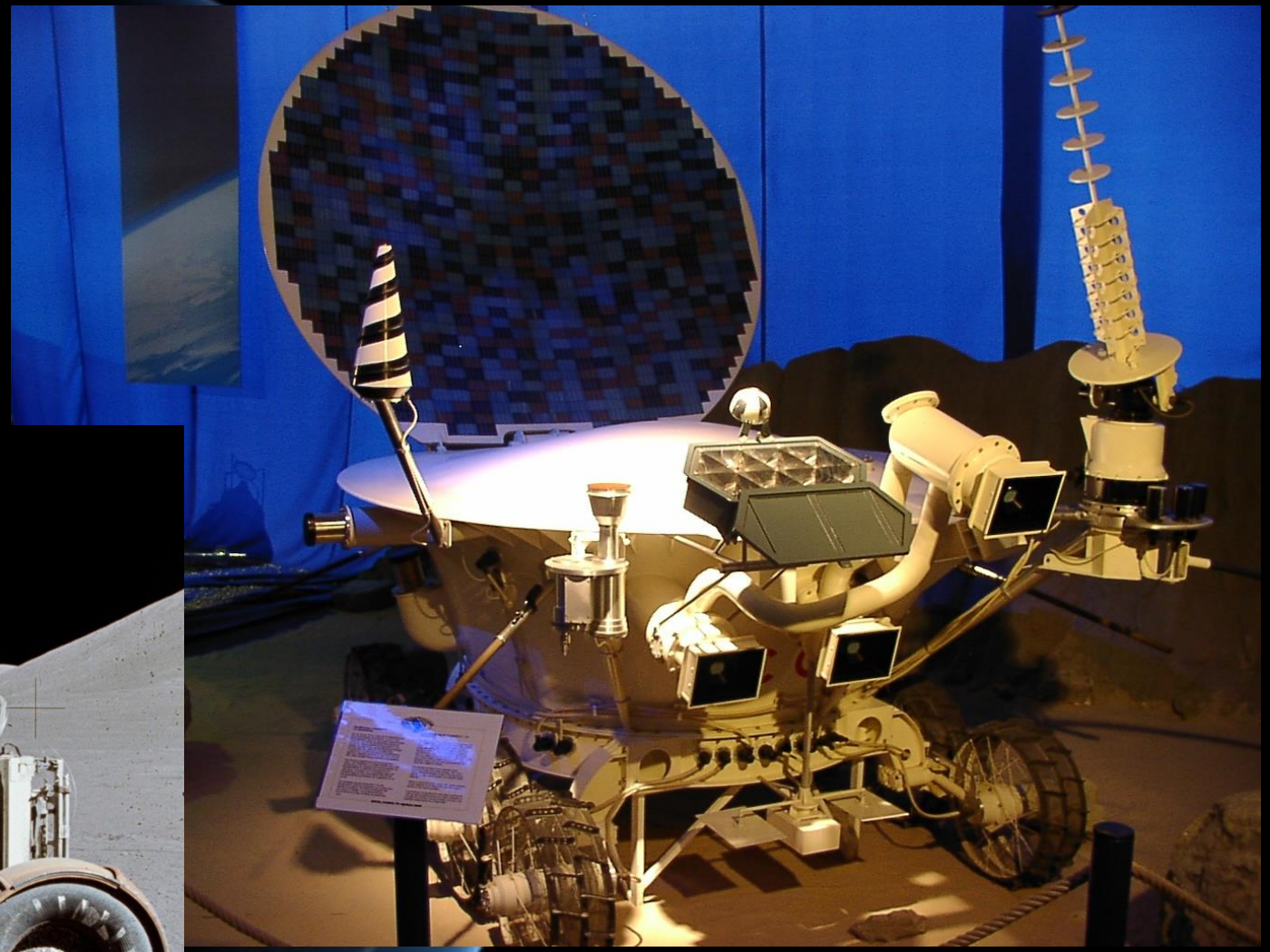


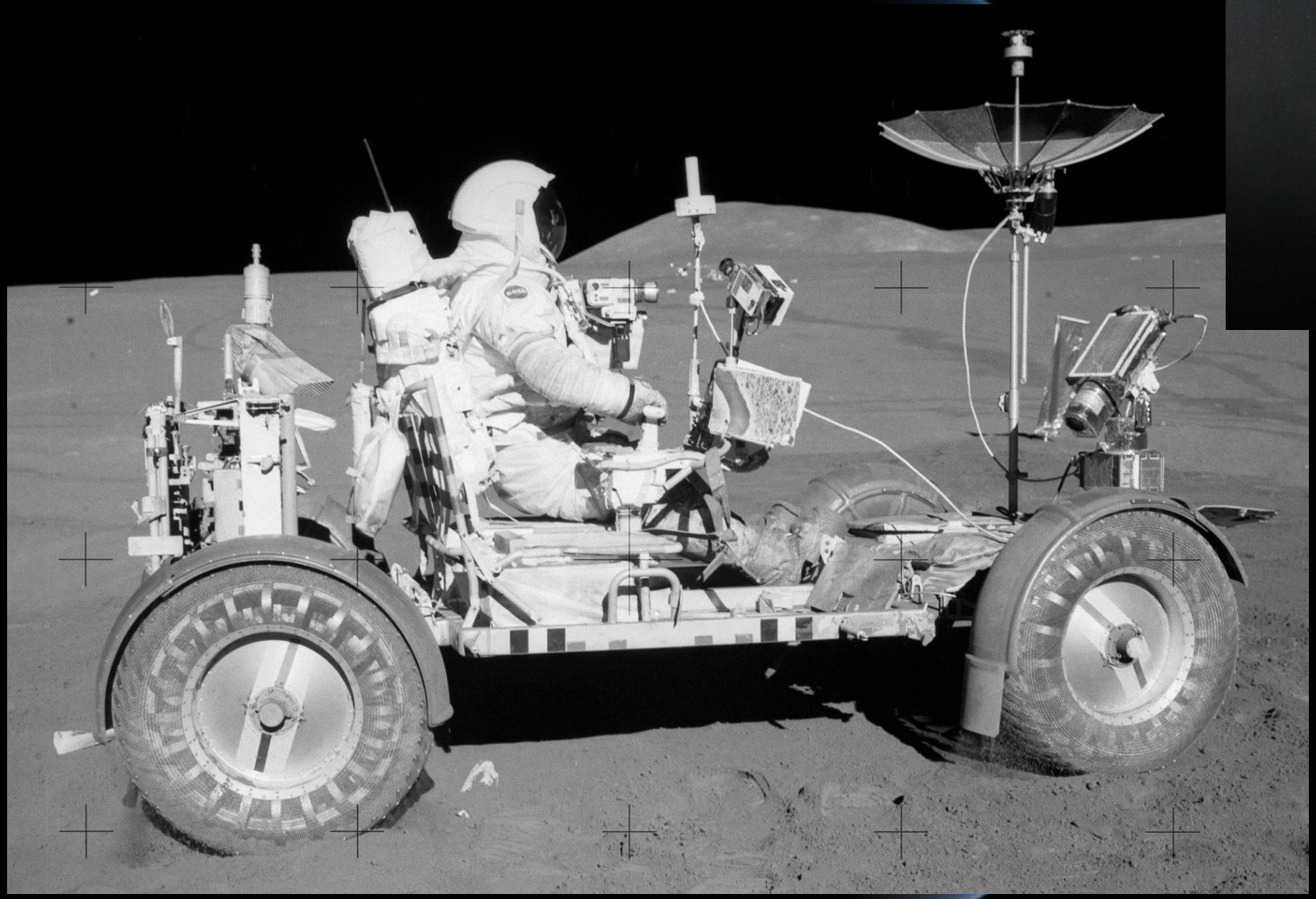
Rovers

Just keep moving… just keep moving…

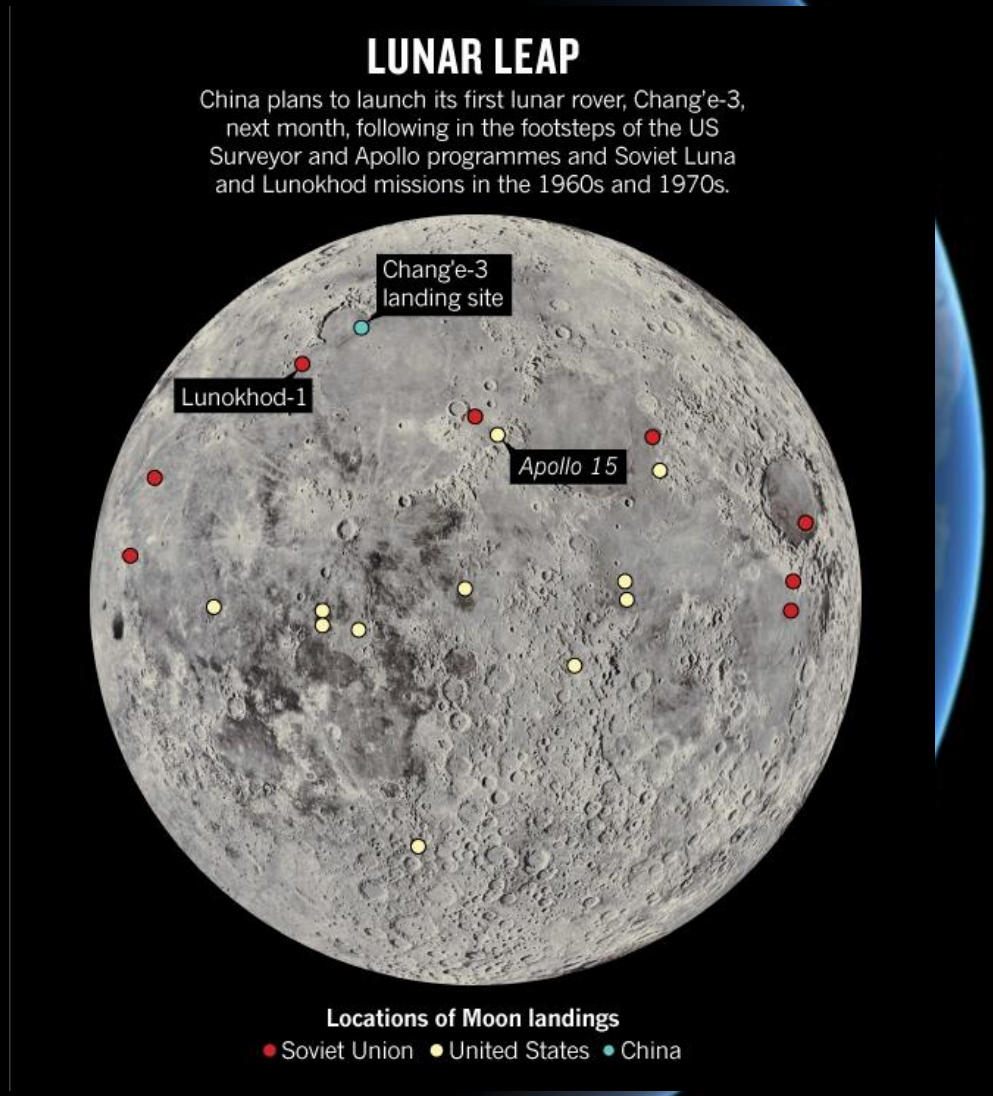
Moon Rover!



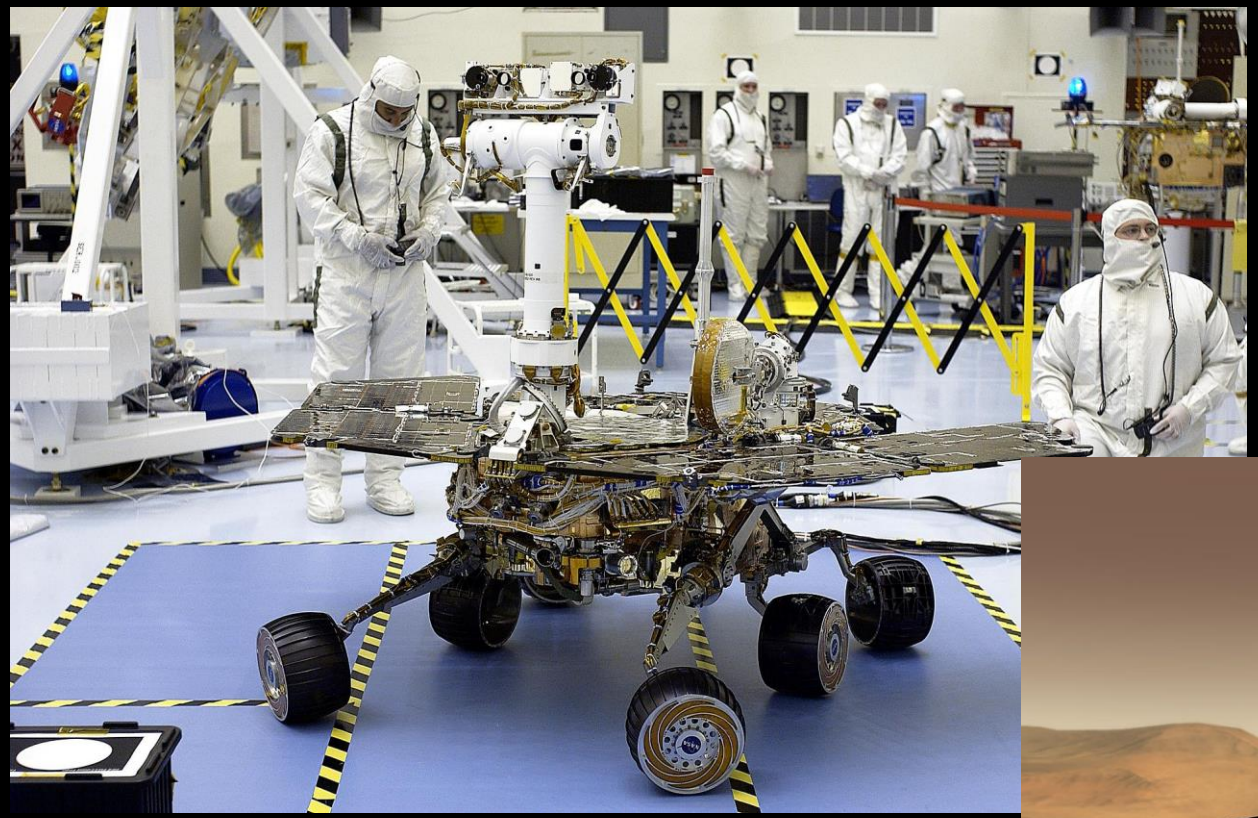




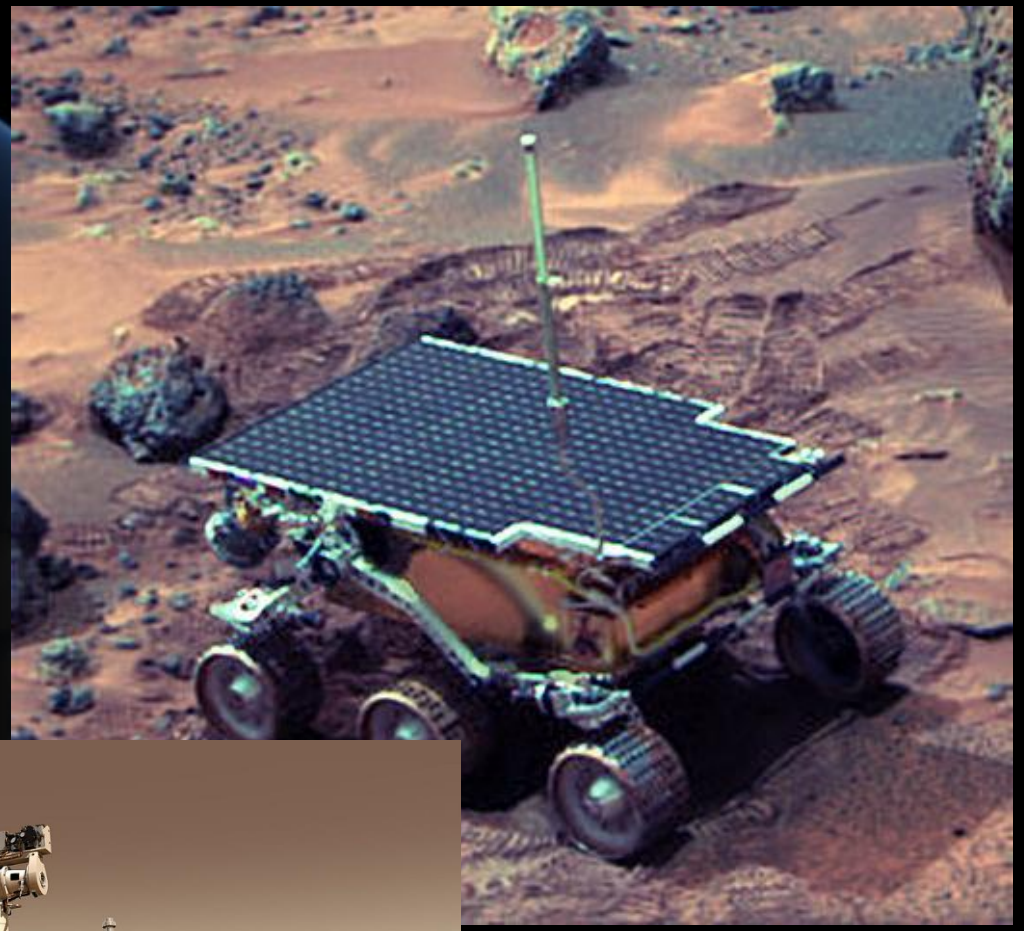
Map of Where the Moon Rovers Are



Mars Rovers!



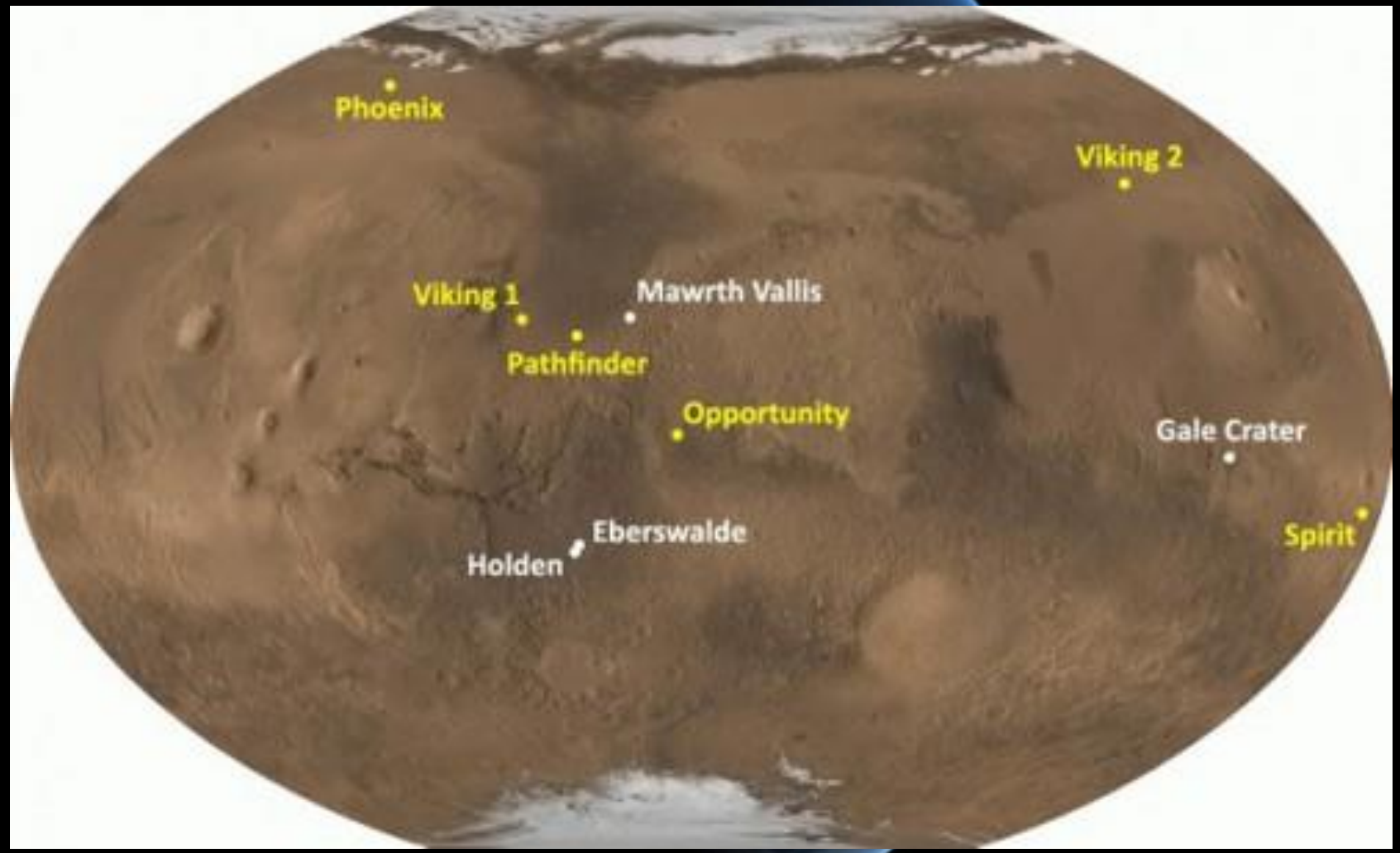
Opportunity



Sojourner

Spirit

Map of Where the Mars Rovers Are



Mars Rovers

- **Not** the first things on Mars but the first ones that move by themselves
- Sojourner
  - Landed on Mars in 1996 and stopped communicating in 1997
  - Was supposed to work for 7 Mars days but lasted 83 Mars days
- Spirit
  - Landed on Mars in 2004 and stop communicating in 2010
  - Got stuck in sand in 2009 but kept doing experiments
  - Lasted 20 times longer than expected
- Opportunity
  - Landed 3 weeks after Spirit but on other side of Mars
  - Has been active ever since it landed in 2004
  - Lasted 10 years longer than expected (so far!)
  - New record for longest drive of a rover on another planetary body (24 miles)

OUT-OF-THIS-WORLD RECORDS!

DRIVING DISTANCES ON MARS AND THE MOON

(AS OF JULY 28, 2014)
MARS — MOON —

0 10 20 KILOMETERS 30 40 50

Opportunity
[2004-present]

Lunokhod 2
(USSR)
[1973]

Apollo 17
Lunar Rover
[1972]

Apollo 15
Lunar Rover
[1971]

Apollo 16
Lunar Rover
[1972]

Lunokhod 1
(USSR)
[1970-1971]

Curiosity
[2012-present]

Spirit
[2004-2010]

Marathon race distance
(42.195 km / 26.22 miles)

Sojourner
[1997]

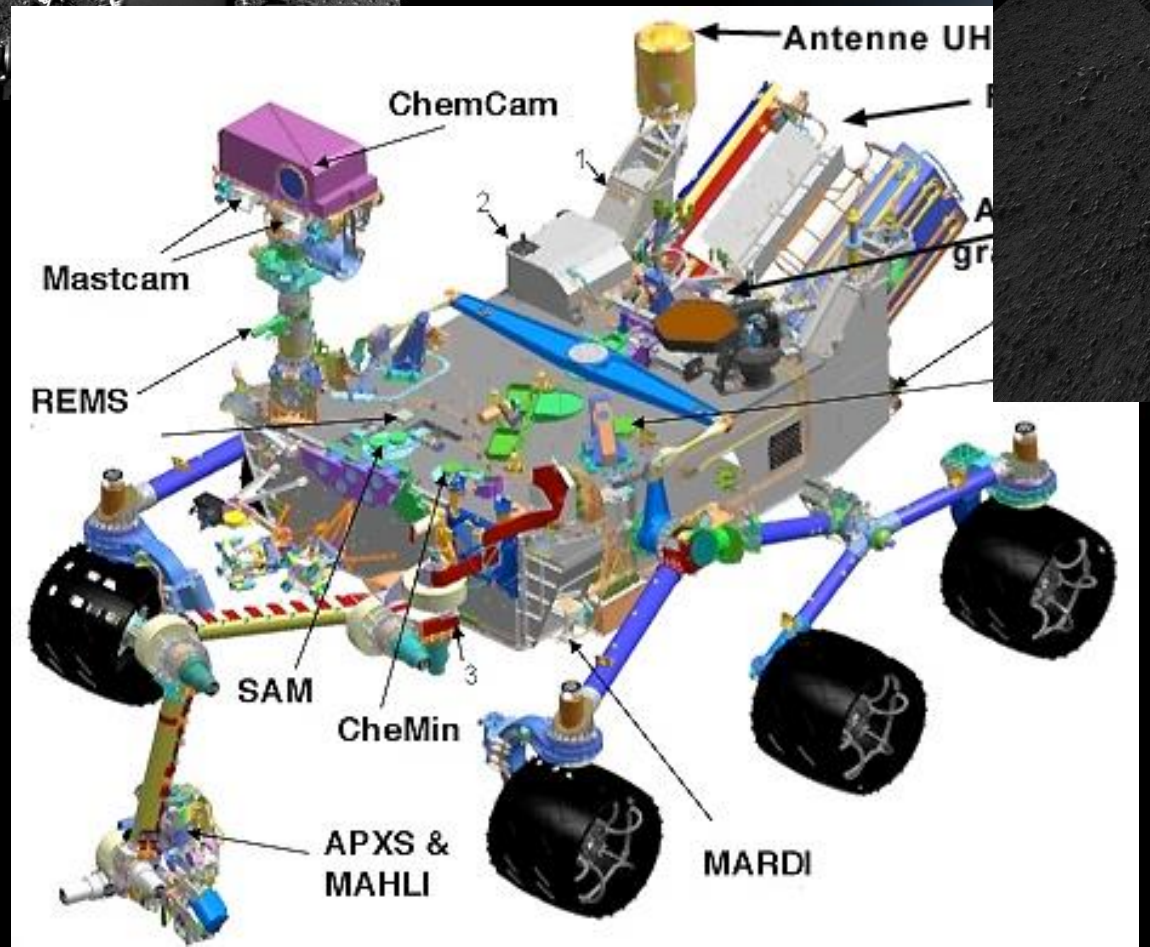
Yutu
(China)
[2013]

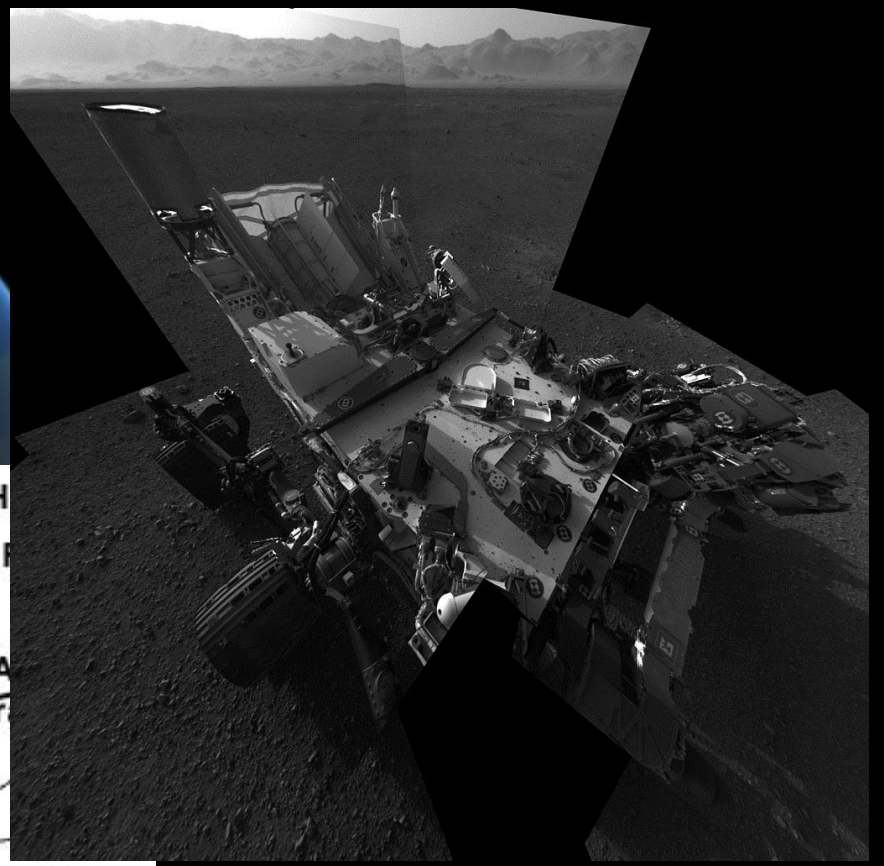
0 10 MILES 20 30

FOR MORE INFO, VISIT
MARS.NASA.GOV

Mars Rovers

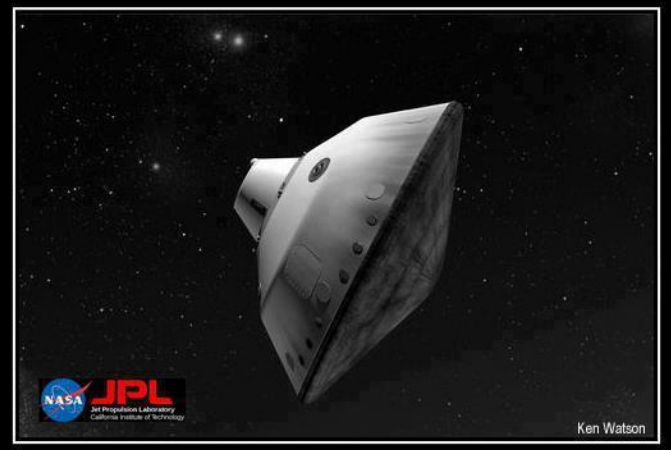
- Curiosity
  - Landed on Mars in 2012
  - Expected to last 2 years but still going strong
  - First rover with the expressed mission to find evidence of life on Mars
    - Investigate climate and geology
    - Water
    - Planetary habitability
    - Possible human exploration?
  - Also the biggest rover ever


Antenne UH
ChemCam
Mastcam
REMS
SAM
CheMin
APXS &
MAHLI
MARDI
1
2
3



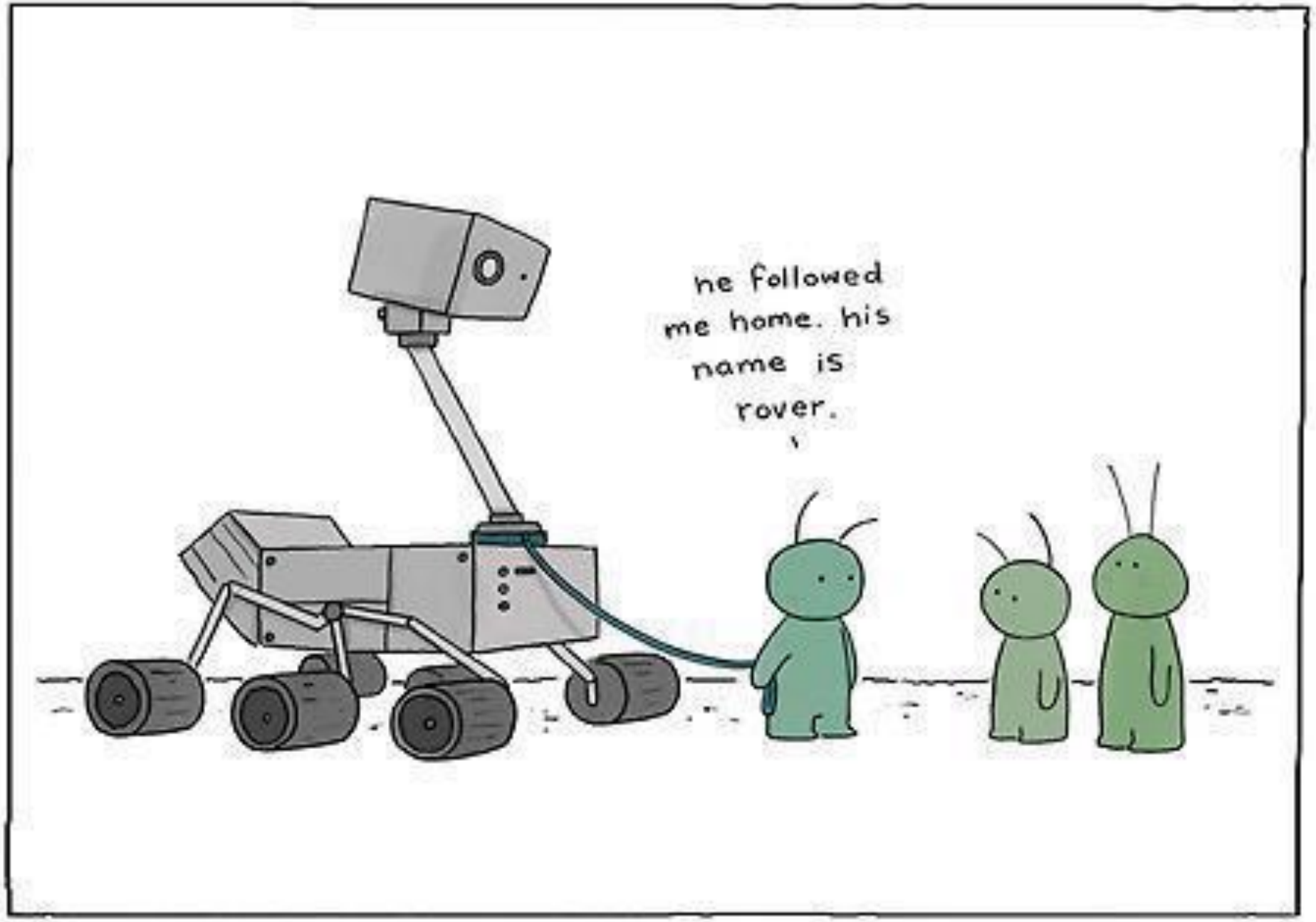
Curiosity

- Seven minutes of terror
  - http://www.jpl.nasa.gov/video/details.php?id=1090
- Mission Overview
  - https://www.youtube.com/watch?v=d1coV7XqE1M
- Time-lapse of first year
  - https://www.youtube.com/watch?v=p83pSCm5ZMU
  - https://www.youtube.com/watch?v=S5P7XgE02SM



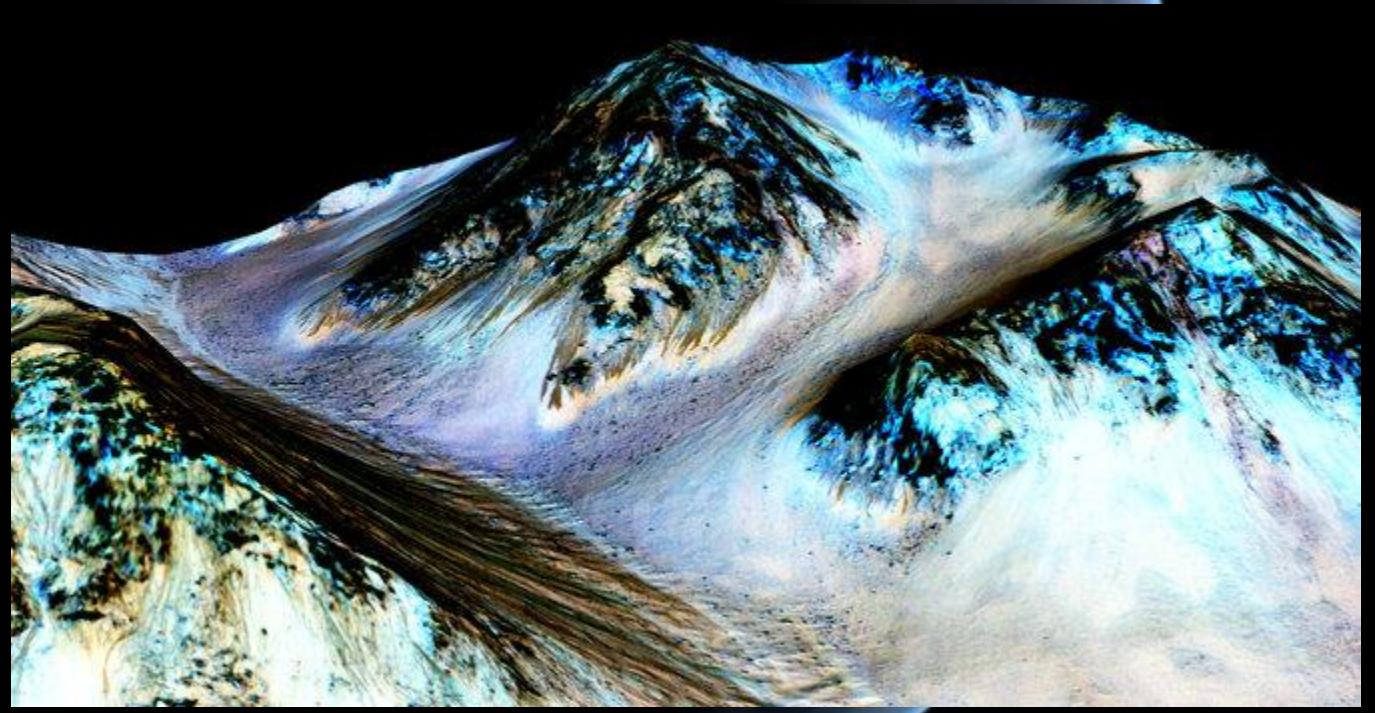
IRONY

The first real flying saucer is from Earth
And it landed on Mars.


he followed me home. his name is rover.
lizclimo.tumblr.com

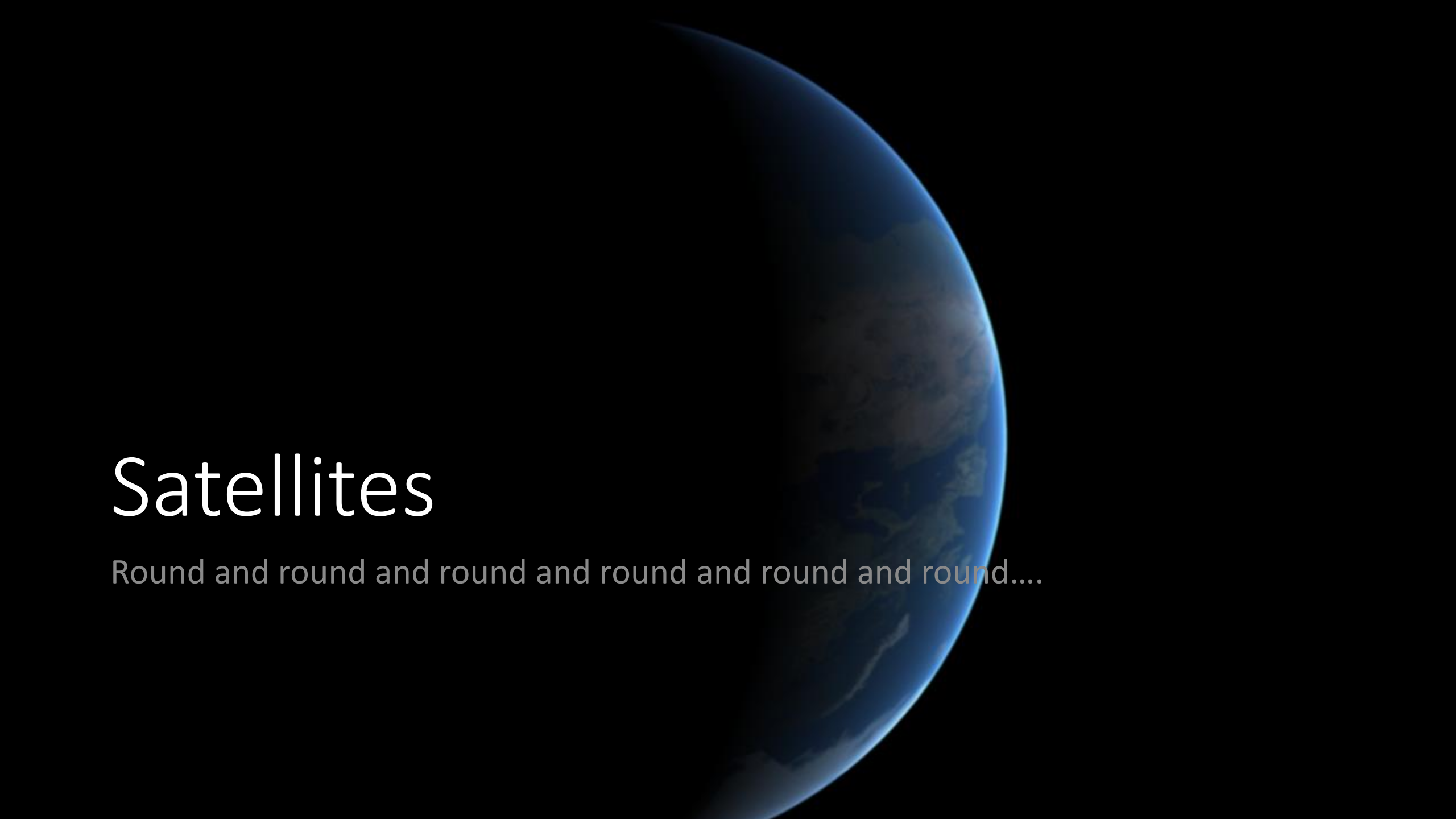
Liquid Water?!?

- http://www.nytimes.com/2015/09/29/science/space/mars-life-liquid-water.html?_r=1



Life on Mars Experiment

http://www.nydailynews.com/news/national/nasa-isolates-6-recruits-dome-simulate-life-mars-article-1.2343186?cid=msn

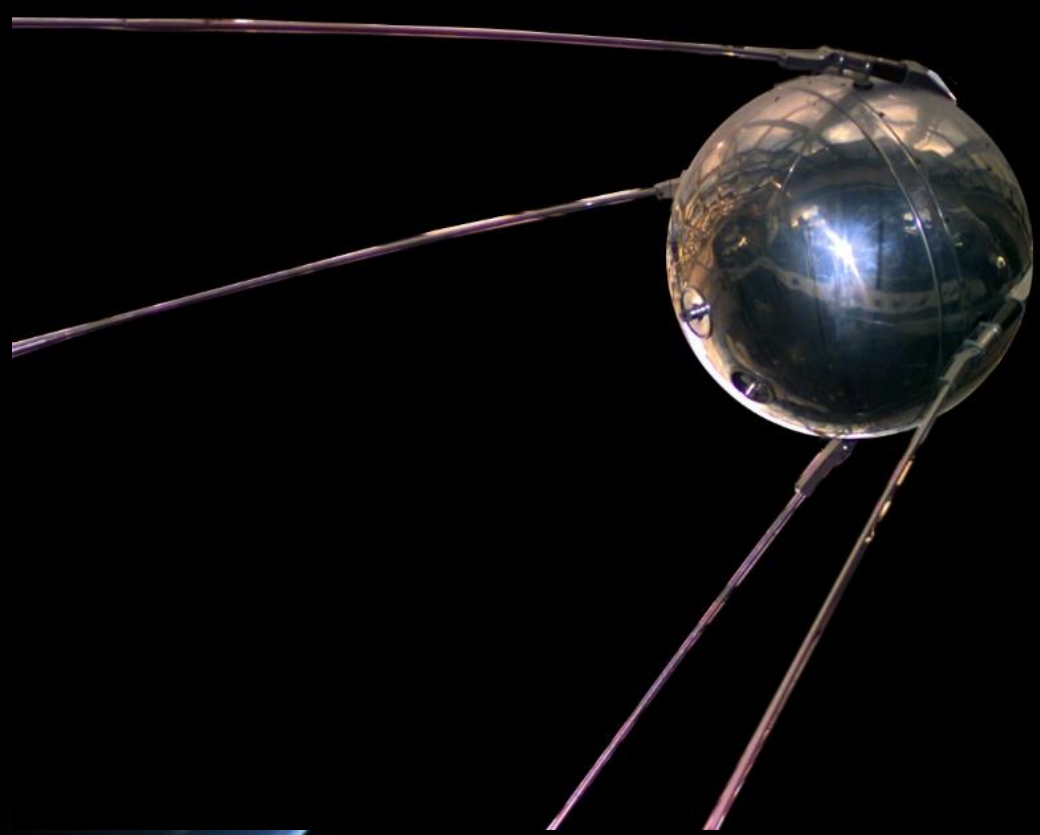


Satellites

Round and round and round and round and round and round….

Types of Satellites

- Astronomy satellites
- Atmospheric / weather satellites
- Communications satellites
- Navigation satellites
- Reconnaissance satellites
- Remote sensing satellites
- Search and rescue satellites
- Space exploration satellites
- Biosatellites
- Miniaturized satellites
- Earth observation satellites
- Manned space crafts
- Space stations
- Etc.



Satellites Around Earth

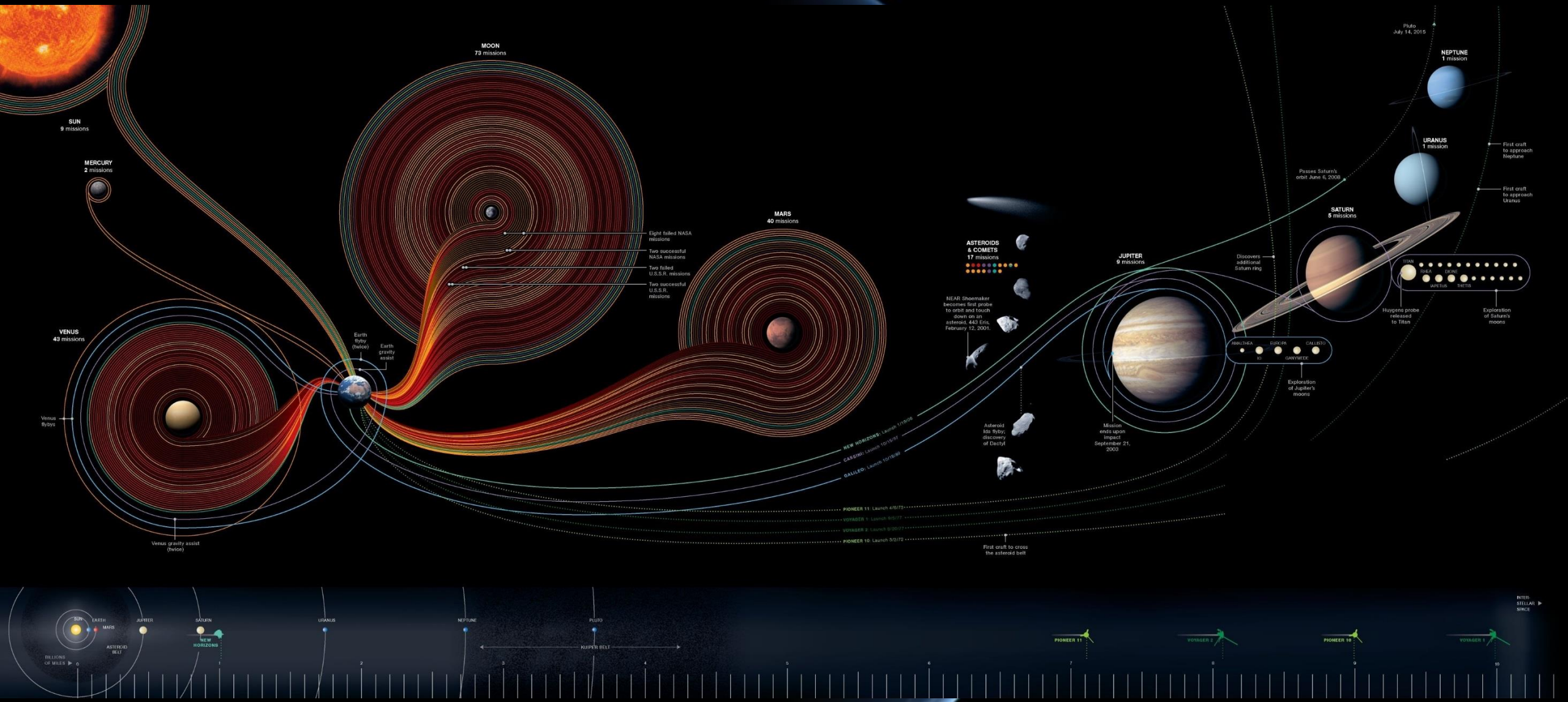
http://www.universetoday.com/42198/how-many-satellites-in-space/

Current Satellites in Orbit Around Other Planetary Bodies

- The Sun
  - ACE
  - Helios 1 / 2
  - IBEX
- The Moon
  - Lunar Reconnaissance Orbiter
  - LADEE
- Mercury
  - MESSENGER
- Venus
  - Venus Express
- Mars
  - Odyssey
  - Mars Reconnaissance Orbiter
  - MAVEN
  - Express
- Jupiter
  - **Juno**
- Saturn
  - Cassini
- Neptune
- Uranus
- Pluto
  - **New Horizons**
- Dwarf Planets / Asteroids
  - Dawn
- Comets
  - Rosetta (ESA)

First Indian Satellite to Mars!

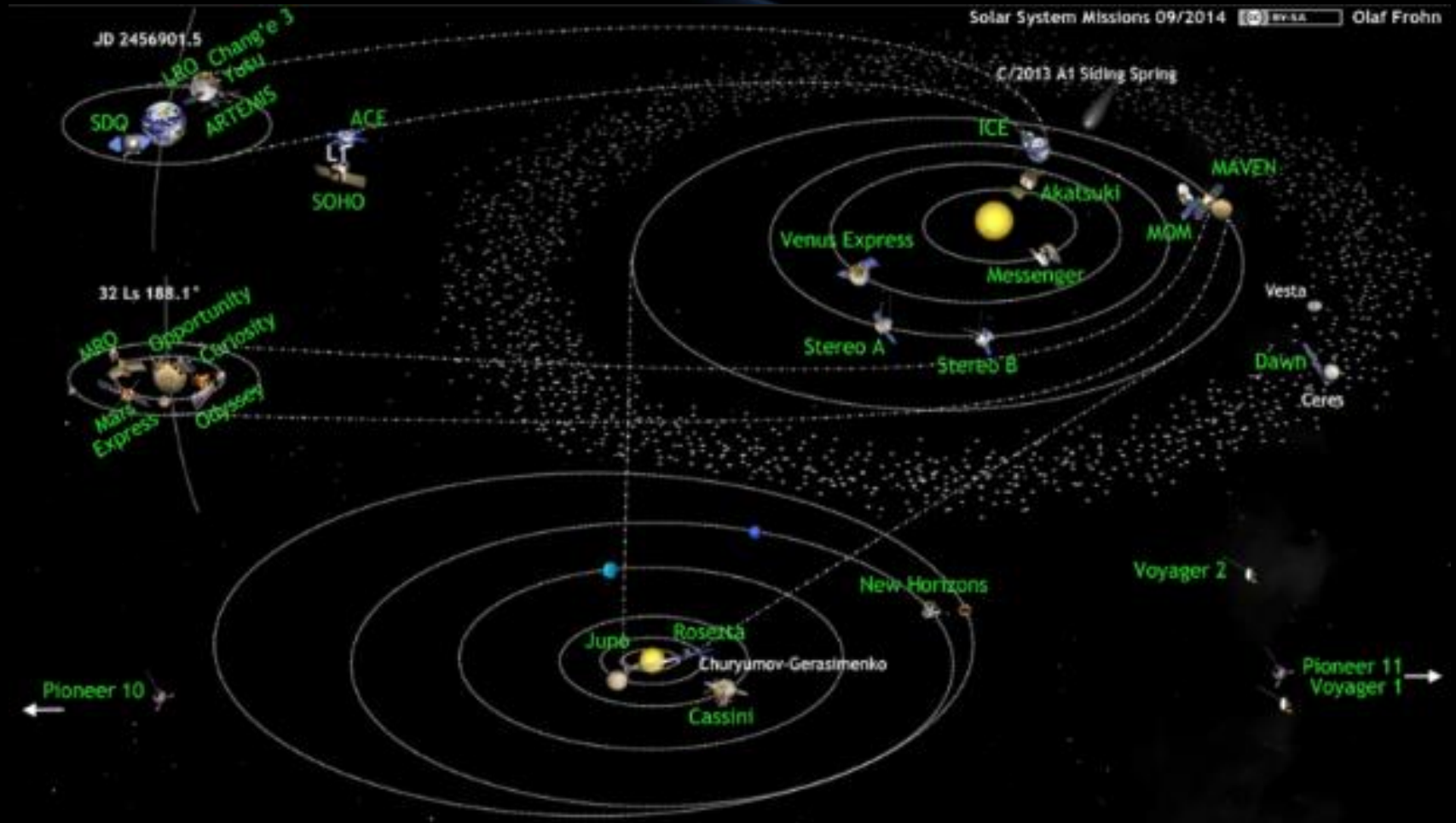
- Called Mangalyaan
- Cost less than the cost to make the movie Gravity


SUN
9 missions
MERCURY
2 missions
VENUS
43 missions
Venus flybys
Venus gravity assist (twice)
MOON
73 missions
Earth flyby (twice)
Earth gravity assist
Eight failed NASA missions
Two successful NASA missions
Two failed U.S.S.R. missions
Two successful U.S.S.R. missions
MARS
40 missions
ASTEROIDS & COMETS
17 missions
NEAR Shoemaker becomes first probe to orbit and touch down on an asteroid, 443 Eros, February 12, 2001.
Asteroid Ida flyby; discovery of Dactyl
First craft to cross the asteroid belt
JUPITER
9 missions
Mission ends upon impact September 21, 2003
Discovers additional Saturn ring
AMALTHEA
IO
EUROPA
GANYMEDE
CALLISTO
Exploration of Jupiter's moons
SATURN
5 missions
TITAN
RHEA
DIONE
APETUS
TETHYS
Huygens probe released to Titan
Exploration of Saturn's moons
Passes Saturn's orbit June 6, 2008
URANUS
1 mission
First craft to approach Neptune
First craft to approach Uranus
NEPTUNE
1 mission
Pluto July 14, 2015
NEW HORIZONS: Launch 1/19/06
CASSINI: Launch 10/15/97
GALILEO: Launch 10/18/89
PIONEER 11: Launch 4/6/73
VOYAGER 1: Launch 9/5/77
VOYAGER 2: Launch 8/20/77
PIONEER 10: Launch 3/2/72

SUN
EARTH
MARS
JUPITER
SATURN
NEW HORIZONS
URANUS
NEPTUNE
PLUTO
ASTEROID BELT
KUIPER BELT
BILLIONS OF MILES
0
1
2
3
4
5
6
7
8
9
10
PIONEER 11
VOYAGER 2
PIONEER 10
VOYAGER 1
INTER-STELLAR SPACE

Past Satellites You Should Know About

- Sputnik
  - First man made object in space (Russian)
- Explorer 1
  - First American satellite in space
- Voyager 1
  - Launched in 1977
  - Studied Jupiter and Saturn
  - Has gone the farthest and exited the solar system in 2013
- Voyager 2
  - Launched in 1977
  - Studied Jupiter, Saturn, Uranus and Neptune
  - Will exit the solar system soon
- Galileo
  - Launched in 1989
  - Did flybys of Venus and Earth (and the moon)
  - First study of two asteroids Gaspra and Ida
  - Orbited Jupiter and studied its moons



Upcoming Events

2014
Sep 22: MAVEN OI Mars
Sep 23: Mars Orbiter Mission OI Mars
Oct 19: Comet Siding Spring FB Mars
Oct 24: Chang'E 2.5 Launch/FB Moon
Nov 11: Rosetta/Philae SL Chu-Ger.
FB: Flyby; OI: Orbit Insertion; App: Approach; Dep: Departure; EDL: Entry, Descent and Landing; SL: Soft Landing; EOM: End of Mission

Dec: Hayabusa 2 Launch
+ PROCYON, ARTSAT2, Shin'en

2015
Jan: DSCOVR Launch
Feb: Dawn OI Ceres
May: Lightsail-A Launch
Jul: New Horizons FB Pluto

2016
Jan: Exomars-TGO Launch
Mar: InSIGHT Launch
Jul: Bepi-Colombo Launch
Jul: Juno OI Jupiter
Sep: OSIRIS-REx Launch
Chang'E 4 Launch/SL Moon
Lightsail-B Launch

Nov: Akatsuki OI Venus

2017
Sep: Cassini EOM
Oct: Juno EOM
Orion EM-1 Launch/FB Moon
[Chinese Asteroid Mission] Launch
Chandrayaan 2 Launch/SL Moon
Solar Orbiter Launch (2019)

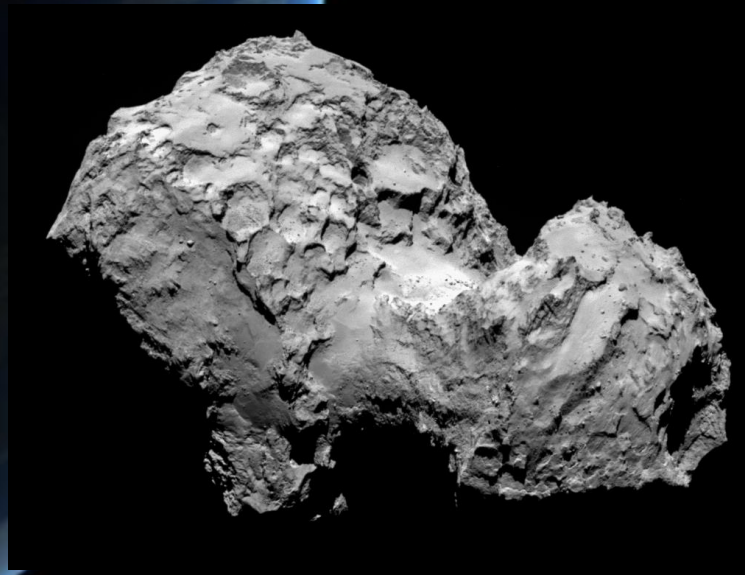
2018
Chang'E 5 Launch/SL Moon

Exomars Rover Launch
Solar Probe P__lus Launch
[Chinese Mars Mission] Launch

2019+
Luna 25 Lander Launch (2019)
2020 Mars Rover Launch (2020)
Luna 26 Orbiter Launch (2021)
JUICE Launch (2022)
Luna 27 Lander Launch (2023)

Rosetta and Philae

- Rosetta is the satellite and Philae is the lander which is on Comet 67P
- Philae landed on the comet and Rosetta is orbiting around the satellite
- http://www.usatoday.com/story/news/world/2014/11/12/spacecraft-descent-comet/18900867/
- http://www.telegraph.co.uk/news/science/space/11195744/The-Rosetta-mission-everything-you-need-to-know-about-the-quest-to-catch-a-comet.html



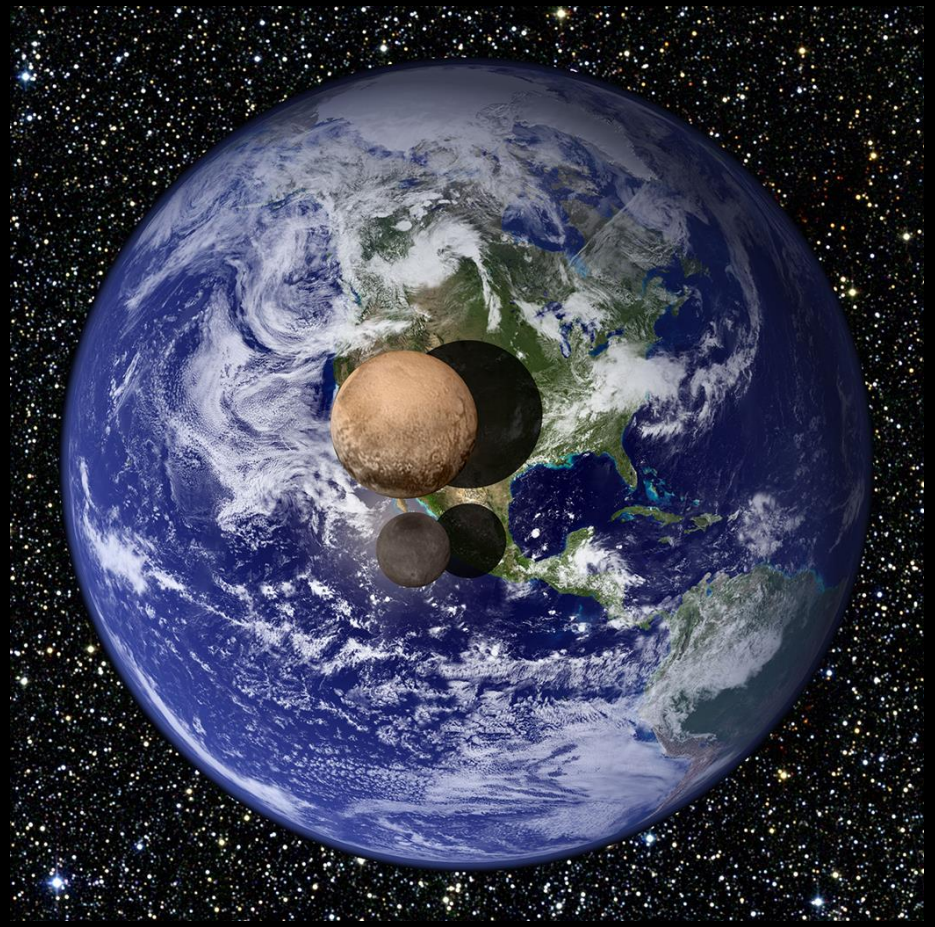
New Horizons

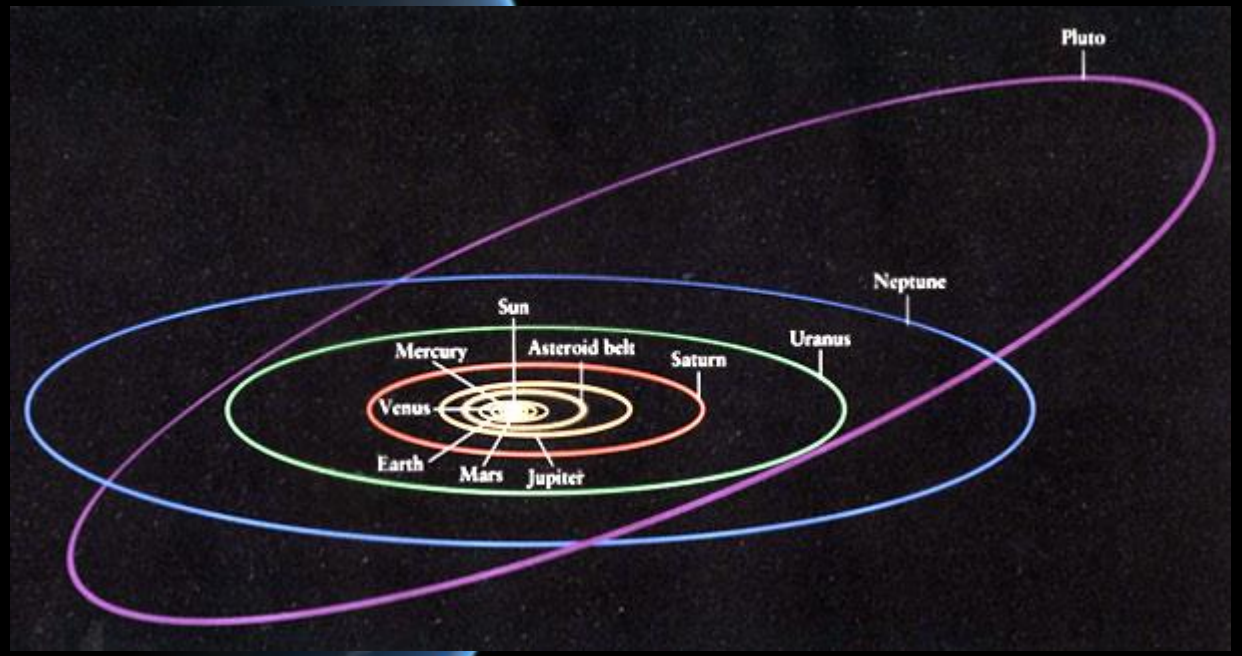
- Flyby of Pluto and its moons on July 14, 2015
- Zoomed within 7,800 miles of Pluto
- Now it is going through the Kuiper Belt sending data back to Earth

New Horizons

https://www.youtube.com/watch?v=33zw4yYNGAs&feature=youtu.be

Why is Pluto not a planet?





http://news.discovery.com/space/videos/what-did-we-learn-from-the-pluto-flyby-video-150805.htm

The Hunt for Aliens

AKA: The Hunt for Exoplanets

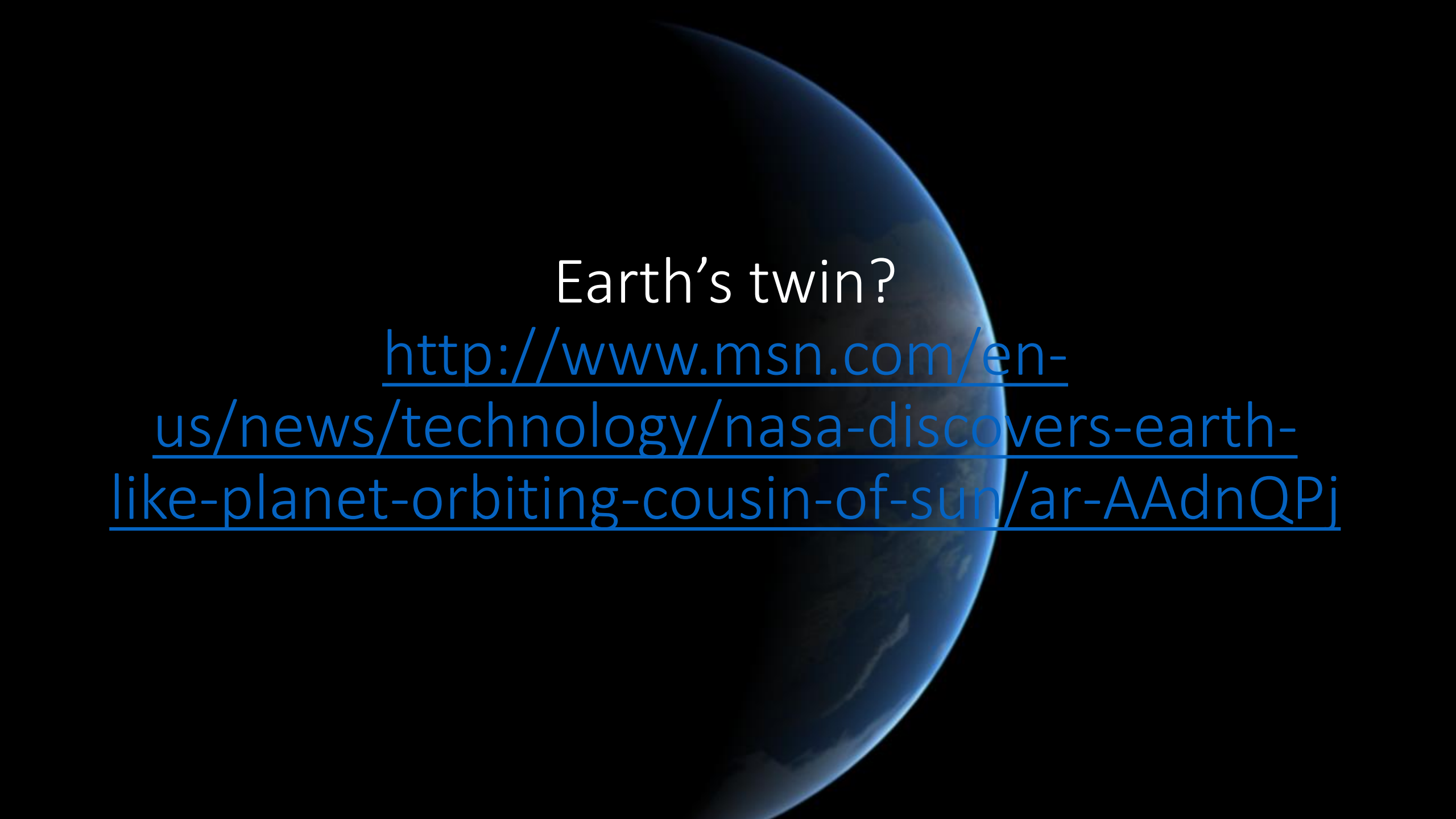
Kepler Mission

- Launched in 2009
- Mission is to find Earth-like planets
- In 2013, a second of four reaction wheels failed so it is broken now
- K2 mission started in September 2014
  - Still using Kepler but now only with dimmer red dwarf stars
- As of October 2014, Kepler has found 989 exoplanets
- There are 3, 269 unconfirmed planet candidates
- Basically, Earth is not that special
- https://www.youtube.com/watch?v=ppluB6qkPI4


Sunshade
Solar Arrays
RCS
Thruster
Module
(1 of 4)
Battery
Star
Tracker
Photometer
Electronics
Spacecraft
Electronics
FPA Radiator
Photometer
Deployable
Cover

Weird Exoplanets Discovered

- Kepler 10c - The biggest found so far (2.3 times Earth)
- Kepler 10b - The smallest found so far
- KOI-314c - Gassy planet with the same mass as Earth
- Epsilon Eridani b - Closest exoplanet to Earth (10.5 light years)
- MOA-192 b - Orbits a purple star
- 55 Cancri 3 - Diamond planet (?)
- HD 188753 - Has multiple sunsets (Tatooine anyone??)
- HAT-P-1 - Half as massive as Jupiter but lighter than a ball of cork
- GJ 1214b - Rocky planet that has a confirmed atmosphere (40 ly)


Earth’s twin?
http://www.msn.com/en-us/news/technology/nasa-discovers-earth-like-planet-orbiting-cousin-of-sun/ar-AAdnQPj

Spitzer

- Looks at the universe in infrared
- Has found exoplanets like Kepler just in a different way
- http://www.nasa.gov/mission_pages/spitzer/news/spitzer20120508.html

Europa?

- Galileo satellite helped with research
- Surface covered in about 3 miles of ice
- Surface keeps moving seen by break up of ice
- Probably liquid water under a layer of ice
- Submarine life anyone?
- http://sploid.gizmodo.com/2030-space-odyssey-nasa-will-search-for-alien-life-in-1536952180
- http://www.usatoday.com/story/tech/sciencefair/2014/11/21/jupiter-moon-europa/19369661/

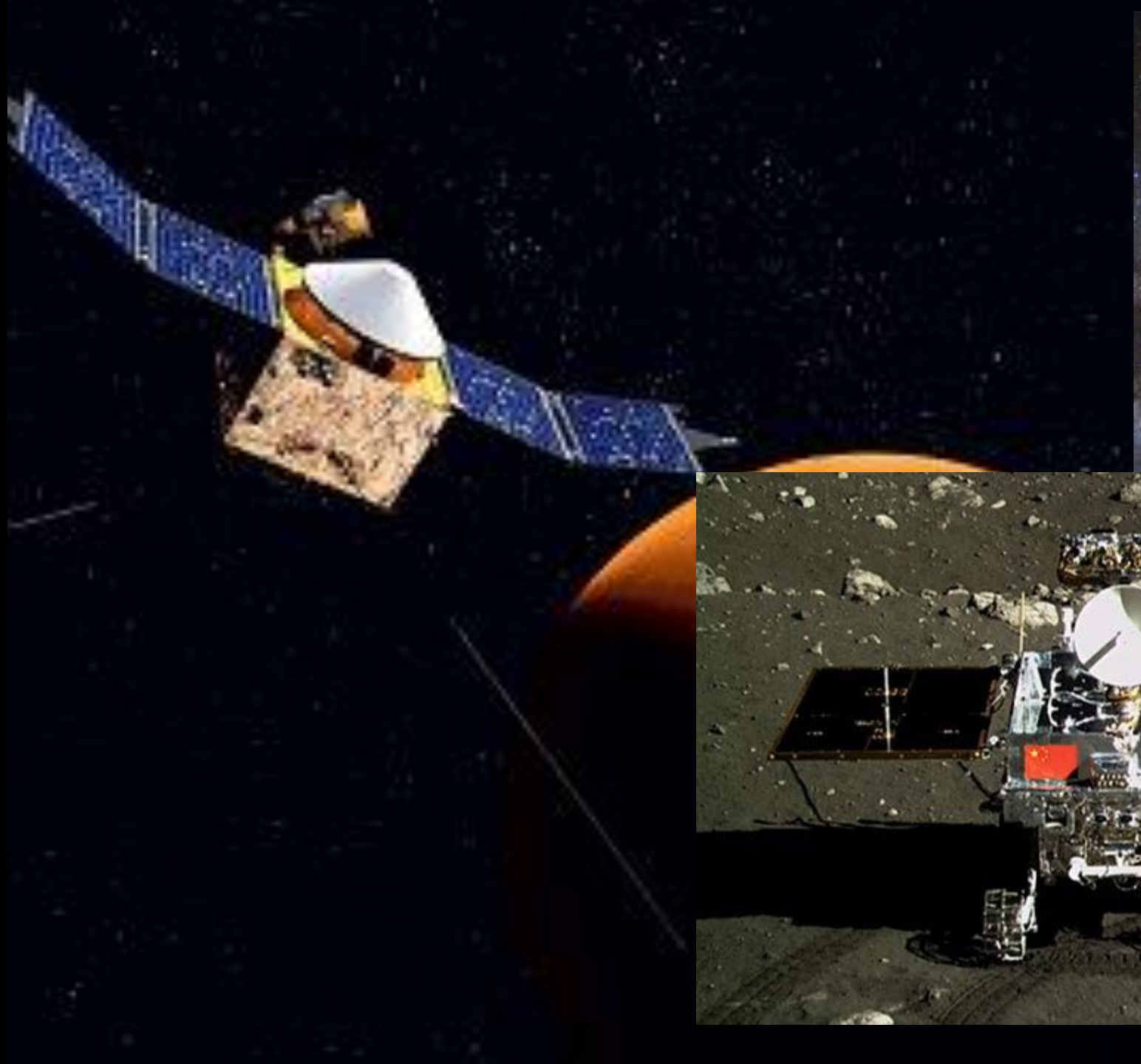
How to tell if there is life on an exoplanet
http://www.pbs.org/wgbh/nova/space/finding-earth-planets.html

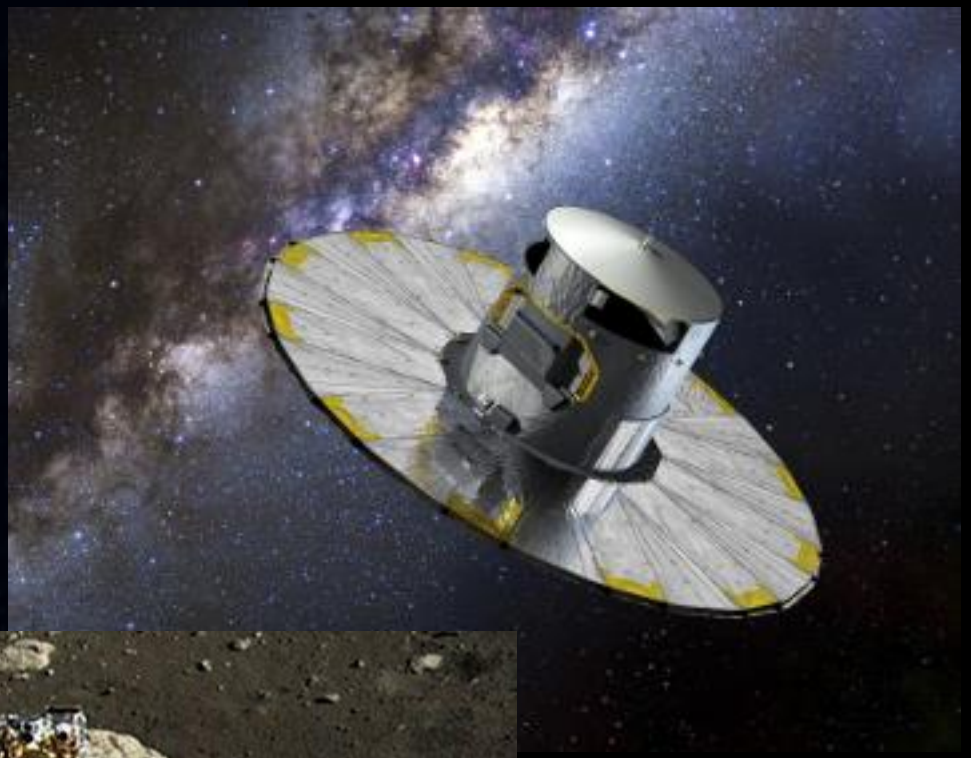
Current Space Culture

Let’s go to Mars, yo!

New Countries in the Mix

- India now has a Mars orbiter
  - Mangalyaan (The Mars Orbiter Mission) started orbiting Sept 2014
- China landed a rover on the surface of the moon for the first time
  - Yutu (literally Jade Rabbit) rover landed in Dec 2013
- The European Space Agency launched a spacecraft
  - Gaia will map out more then 1 billion stars in the Milky Way (Dec 2013)
- Iran has sent two monkeys into space in 2011 and 2013
  - One (named Fargam) actually survived!
  - Announced a plan for a manned mission



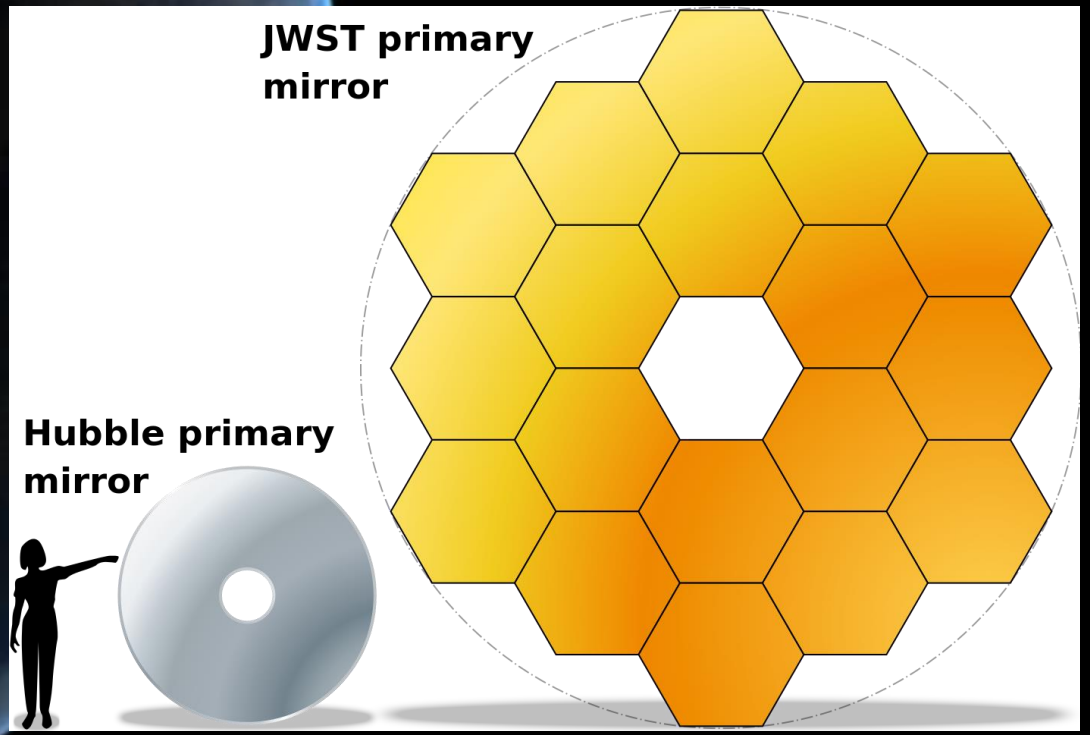


Future NASA Missions

- Exoplanet Survey Satellite
  - Launch date of 2017
  - Will use the transit method to search for exoplanets
  - Specifically looking for Earth-sized planets
  - Hopefully will work for at least 2 years
  - Replacement for Kepler?

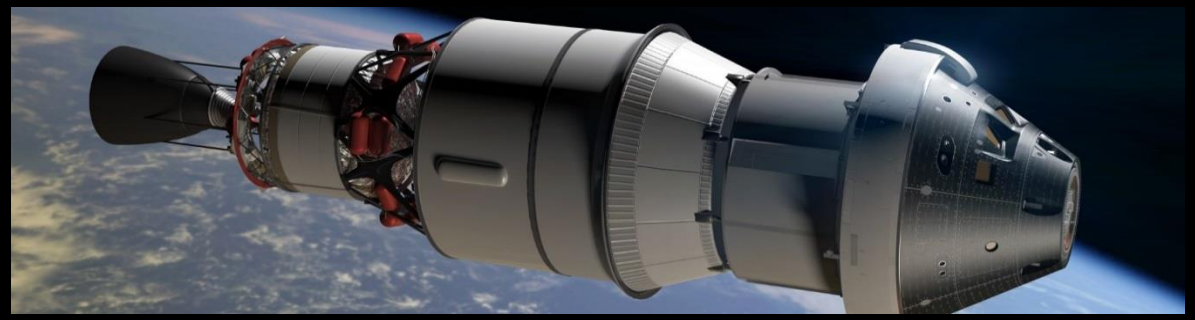
Future NASA Missions

- James Webb Telescope
  - Said to replace Hubble Telescope
  - Supposed to launch in 2014 but is pushed back to possibly 2018
    - Way over budget (like 8 billion dollars so far)
  - Hopefully will work for 10 years
  - Mission is to see more distance light
  - Bigger mirror = more light



Future NASA Missions

- The Orion spacecraft
  - Going back to the Apollo capsule like design
  - Hopefully back to the moon then Mars
- The Space Launch System (SLS)
  - New rocket to take humans to space
  - Hopefully to space for a long time
  - Will be reusable



http://www.usatoday.com/story/news/nation-now/2014/12/10/orion-recovery-spacecraft-landing-us-military/20186399/

http://www.usatoday.com/story/tech/2014/10/28/antares-rocket-explodes-nasa/18084251/

Heat Shield of the Orion Capsule

And we can do stuff like this…

http://abcnews.go.com/Technology/astronaut-sweet-message-space/story?id=30303097