NASA

Jose Nunez, Ph.D., P.E.
Acting Deputy, Mission Management Office

International Space Station and Spacecraft Processing Directorate
Kennedy Space Center

Agenda

- A bit of History
- Kennedy Space Center Overview
- Space Shuttle
- International Space Station
- Exploration
- Nuggets
- Q&A

December 1957

Explorer 1
The first successful American satellite launch

January 31, 1958

U.S. Army Ballistic Missile Agency, under the direction of Dr. Wernher von Braun.

It discovered radiation belts around Earth, which were named the Van Allen Belts after the scientist who led the research.

April 1, 1959 - First NASA Astronauts Selected

Alan Shepard
Virgil I. "Gus" Grissom
Gordon Cooper

Walter Schirra,
Donald "Deke" Slayton
John Glenn
Scott Carpenter

NASA Project Mercury thrust America into the space race They were the first seven Americans to go into space - and the only Americans to go into space alone.

May 5, 1961 -- First NASA Astronaut In Space

Alan Shepard

"Freedom-7"

Altitude: 116.5 statute miles
Orbits: 0
Duration: 0 Days, 0 hours, 15 min, 28 second
Distance: 303 statute miles
Velocity: 5,134 mph

Only 20 Days Later …

“I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to the earth “

President John F. Kennedy May 25, 1961

25 % of the Population?


LIVE FR
SURFACE O
www.moon

Mission Commander
Neil Armstrong,

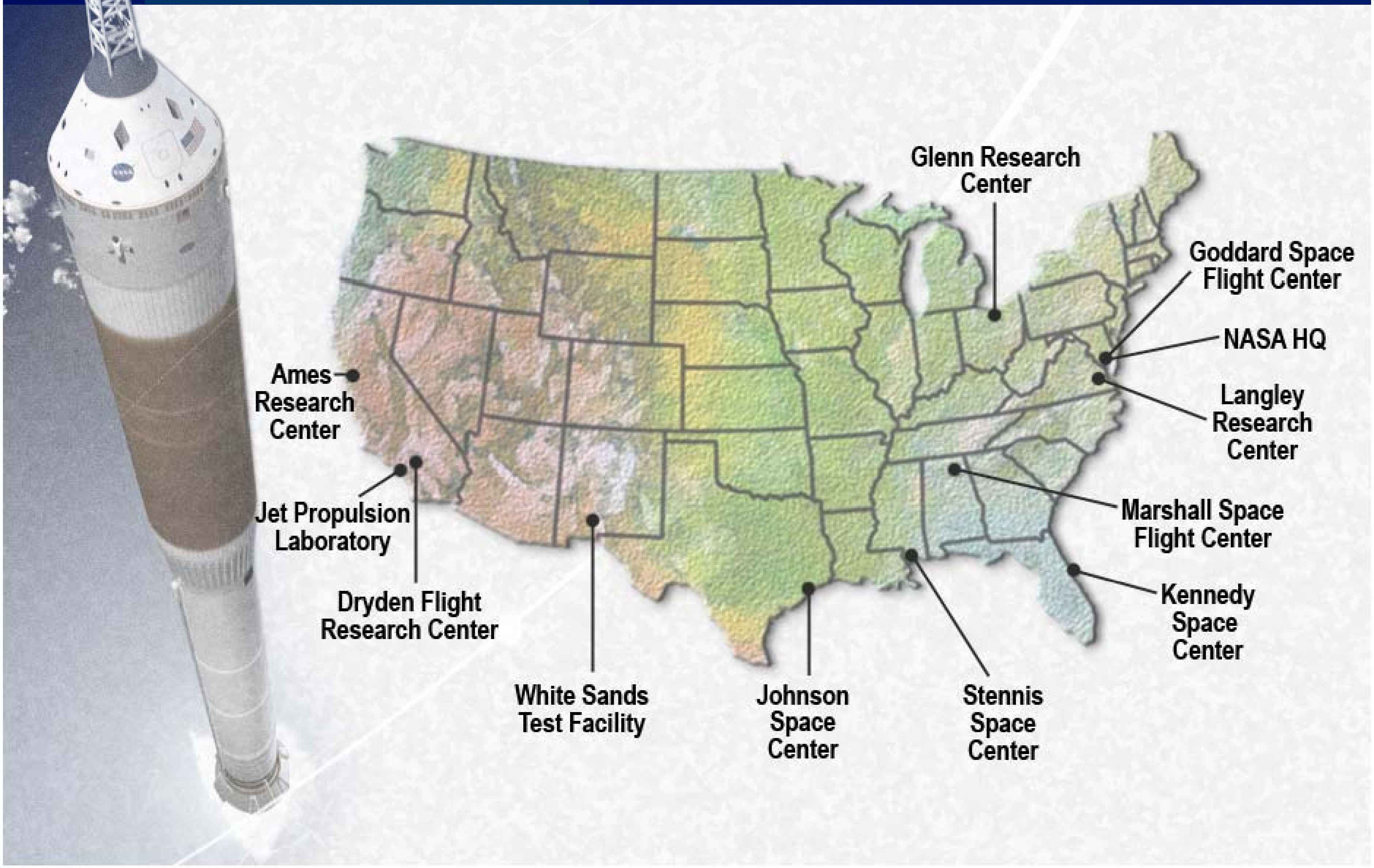
Command Module
Pilot Michael Collins

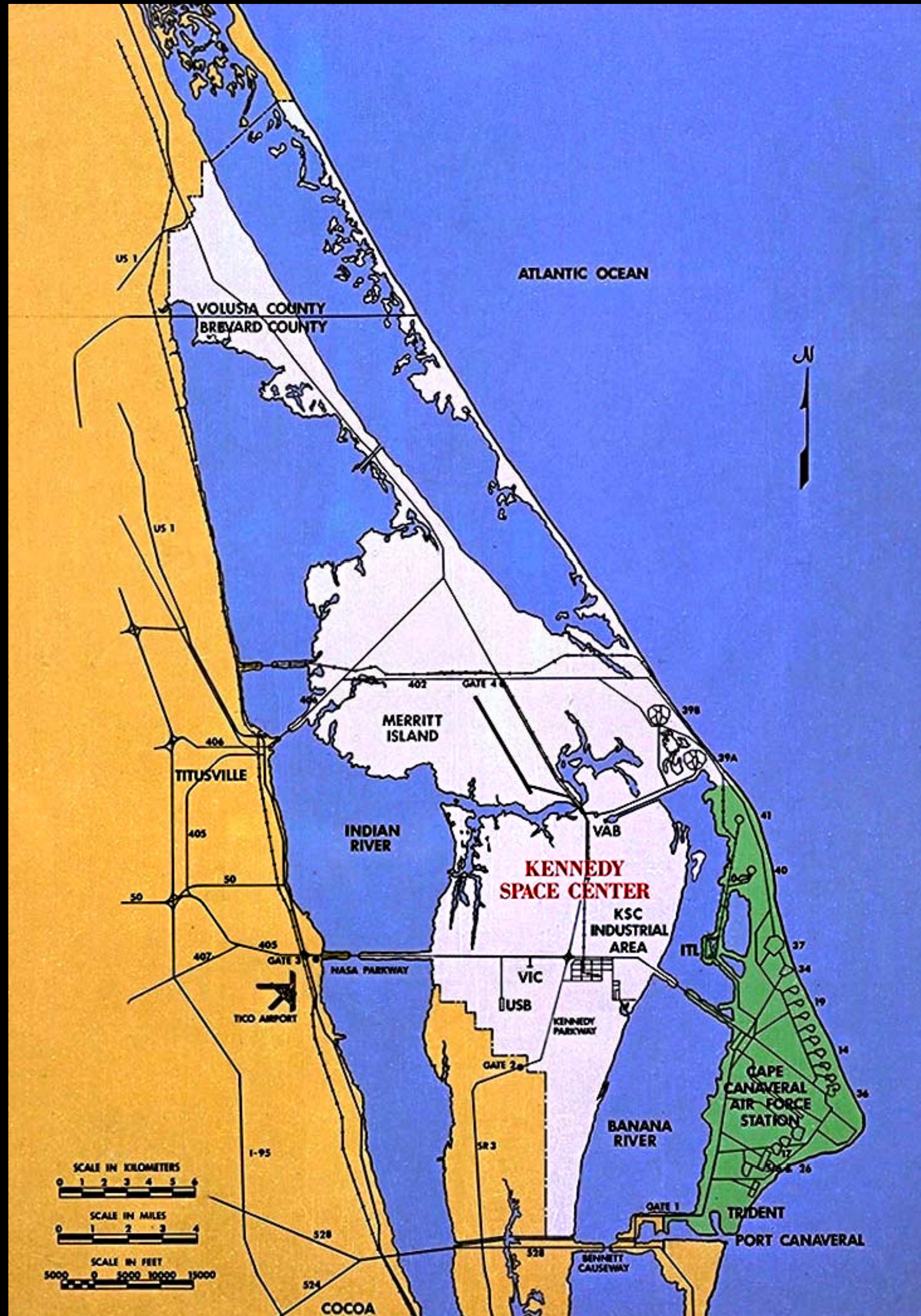
Lunar Module Pilot
Edwin E. Aldrin Jr.


Apollo 11 Moon Launch
July 1969

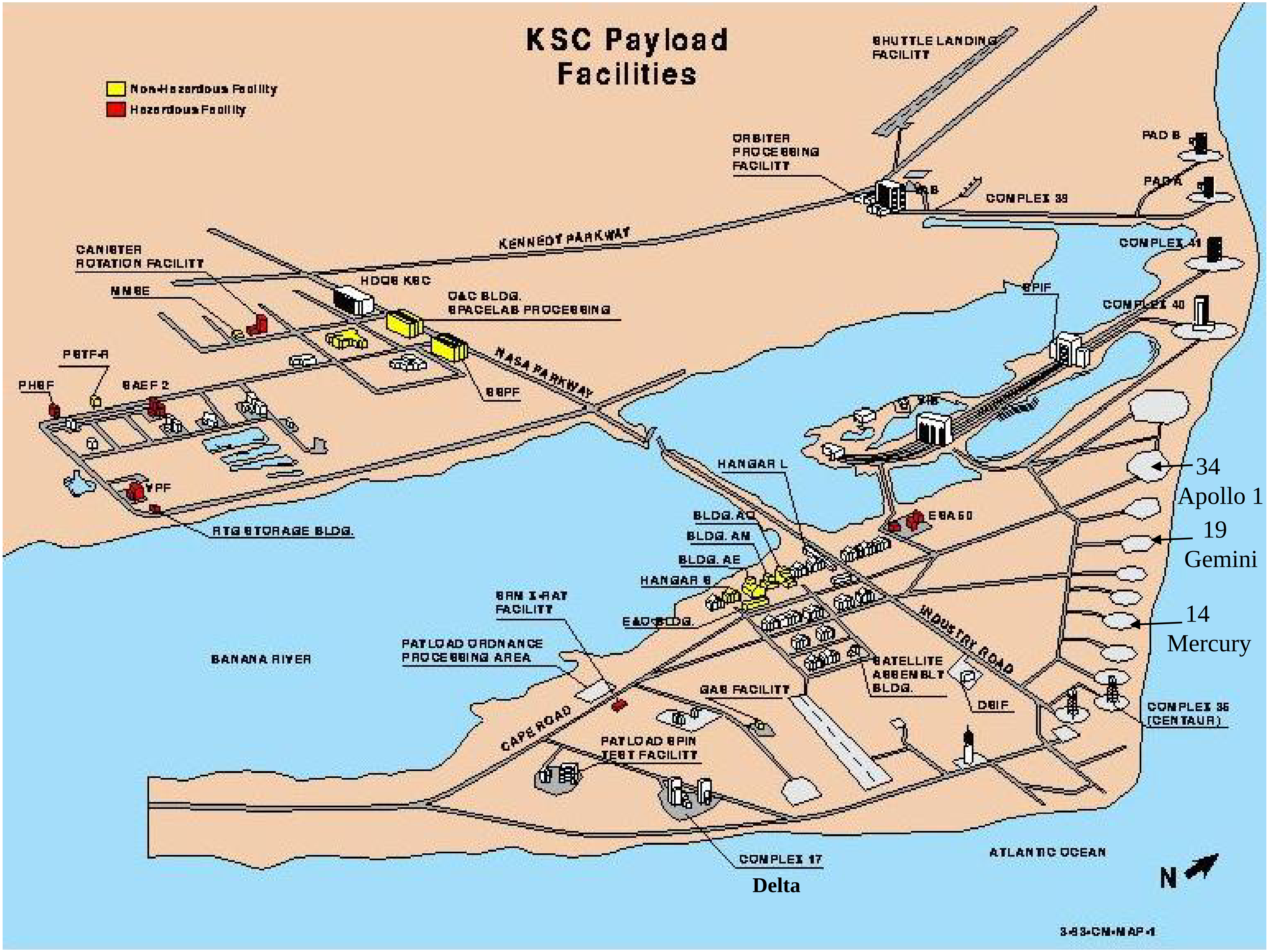
Apollo
Moon
Launch

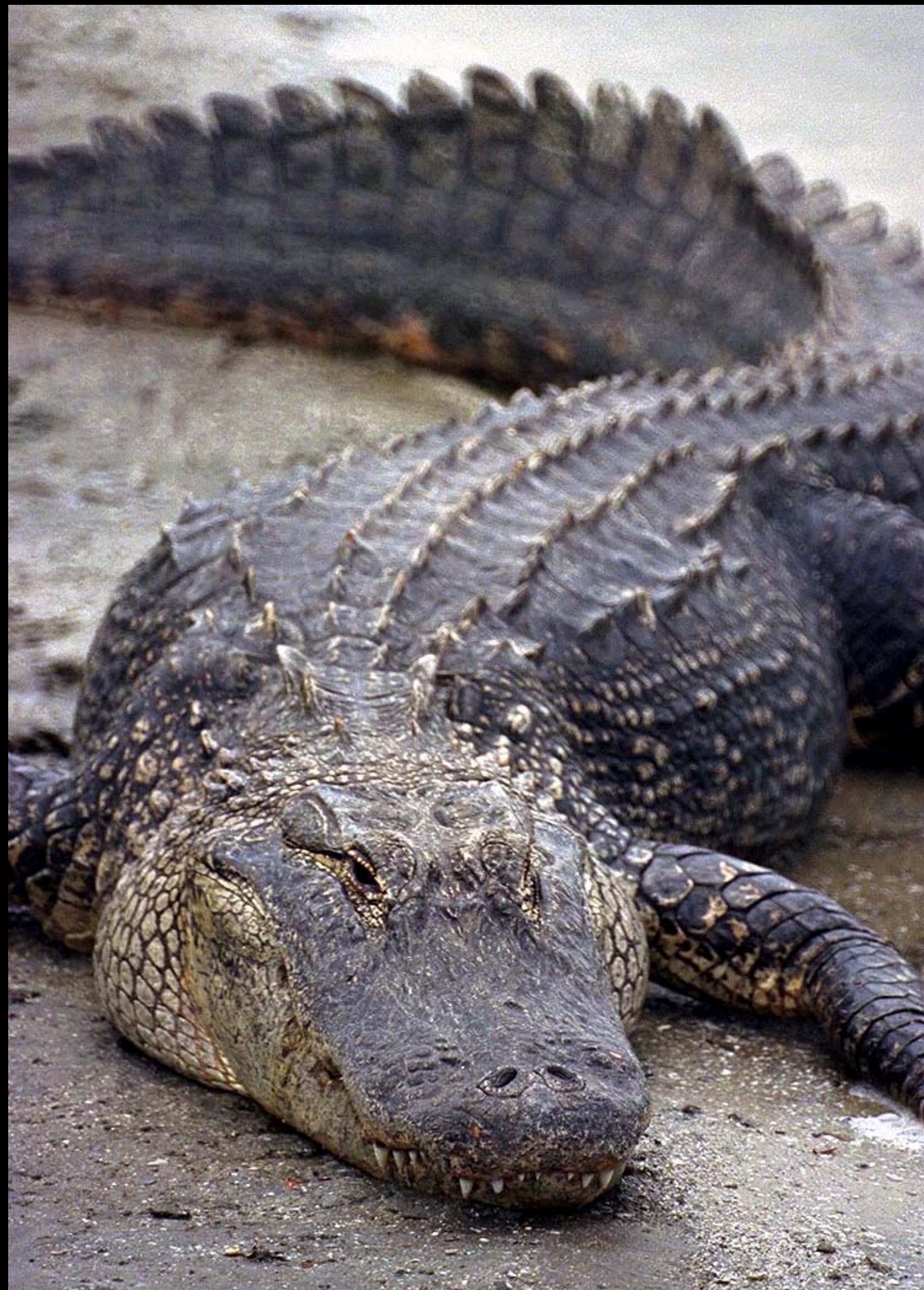
NASA – Where We Work

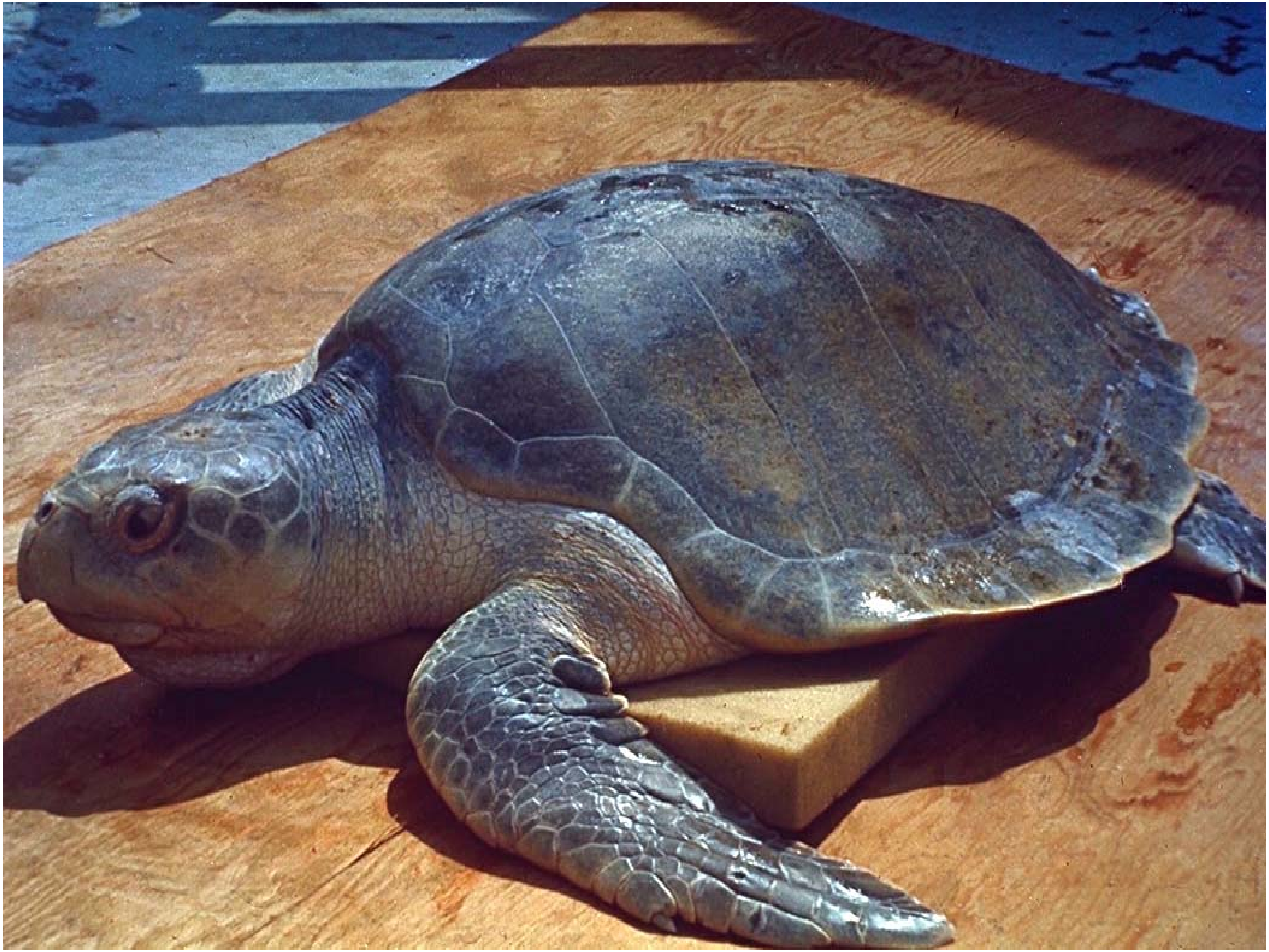




ATLANTIC OCEAN
VOLUSIA COUNTY
BREVARD COUNTY
US 1
MERRITT ISLAND
TITUSVILLE
INDIAN RIVER
VAB
KENNEDY SPACE CENTER
KSC INDUSTRIAL AREA
ITL
VIC
USB
GATE 3
NASA PARKWAY
TICO AIRPORT
KENNEDY PARKWAY
GATE 4
GATE 2
GATE 1
39B
39A
41
40
37
34
19
14
36
17
26
CAPE CANAVERAL AIR FORCE STATION
BANANA RIVER
TRIDENT
PORT CANAVERAL
BENNETT CAUSEWAY
402
406
405
50
407
I-95
SR 3
528
524
COCOA
SCALE IN KILOMETERS
SCALE IN MILES
SCALE IN FEET


KSC Payload Facilities
Non-Hazardous Facility
Hazardous Facility
SHUTTLE LANDING FACILITY
ORBITER PROCESSING FACILITY
VAB
COMPLEX 39
PAD B
PAD A
KENNEDY PARKWAY
COMPLEX 41
COMPLEX 40
SPIF
CANISTER ROTATION FACILITY
HDQS KSC
O&C BLDG. SPACELAB PROCESSING
NNSE
SSPF
NASA PARKWAY
PSTF-R
PHSF
SAEF 2
VPF
RTG STORAGE BLDG.
VIB
HANGAR L
ESA 60
BLDG. AO
BLDG. AM
BLDG. AE
HANGAR S
SRM X-RAY FACILITY
E&O BLDG.
PAYLOAD ORDNANCE PROCESSING AREA
BANANA RIVER
INDUSTRY ROAD
SATELLITE ASSEMBLY BLDG.
GAS FACILITY
DSIF
CAPE ROAD
PAYLOAD SPIN TEST FACILITY
COMPLEX 36 (CENTAUR)
COMPLEX 17
Delta
ATLANTIC OCEAN
34
Apollo 1
19
Gemini
14
Mercury
N
3-83-CN-MAP-1





Atlantis

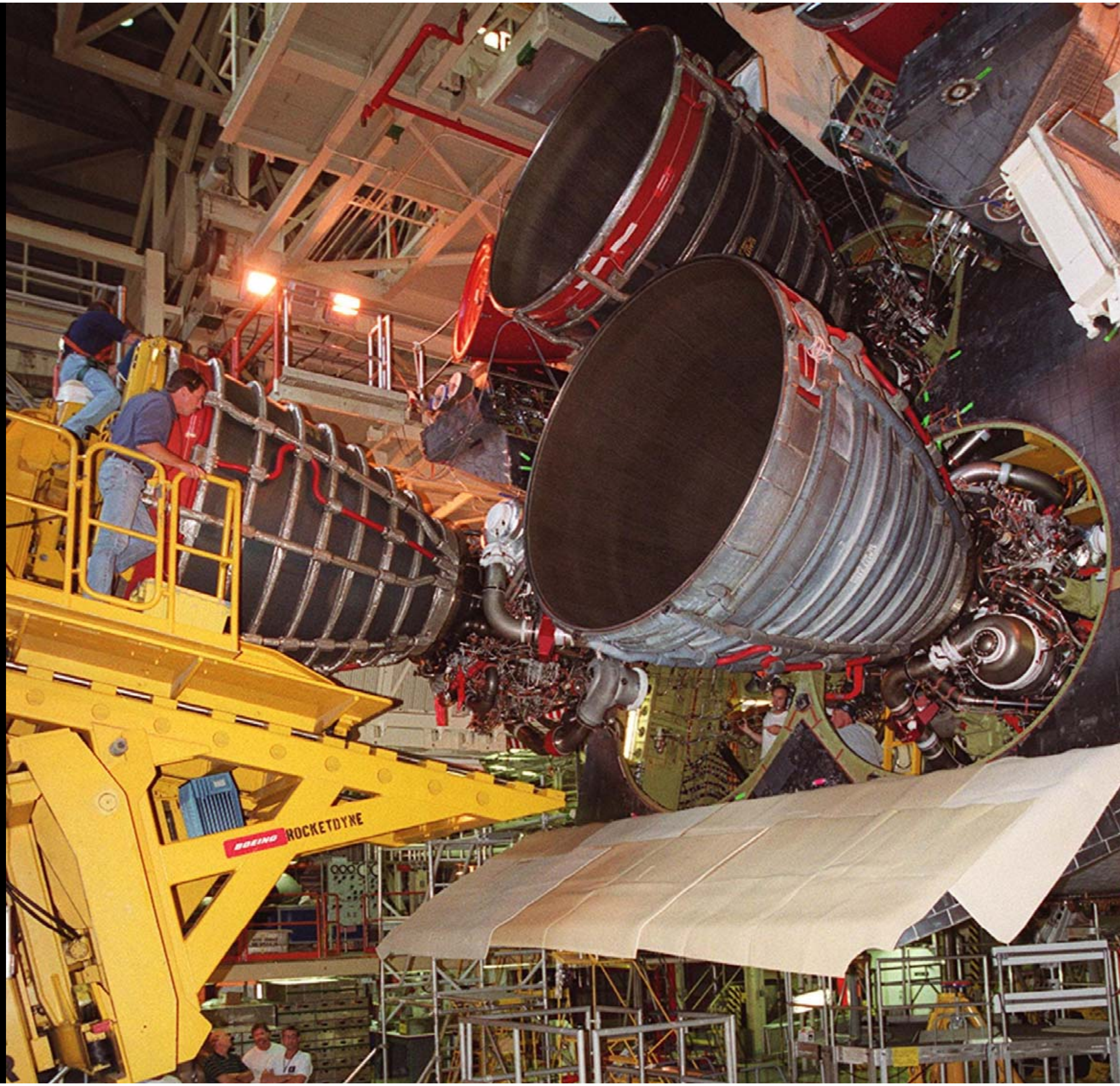
Discovery

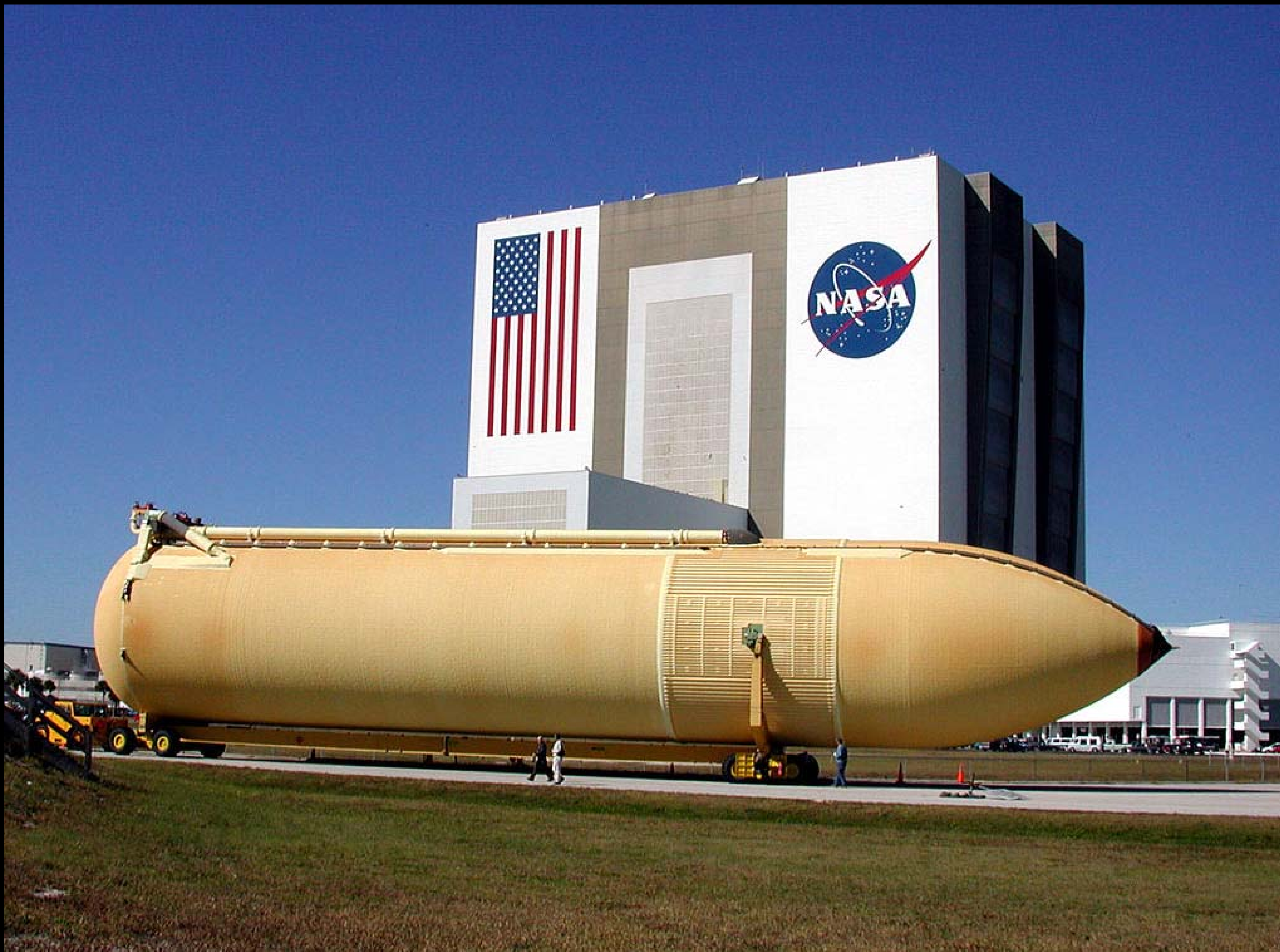
Endeavour

April 12, 1981 Space Shuttle STS-1


NASA
Atlantis

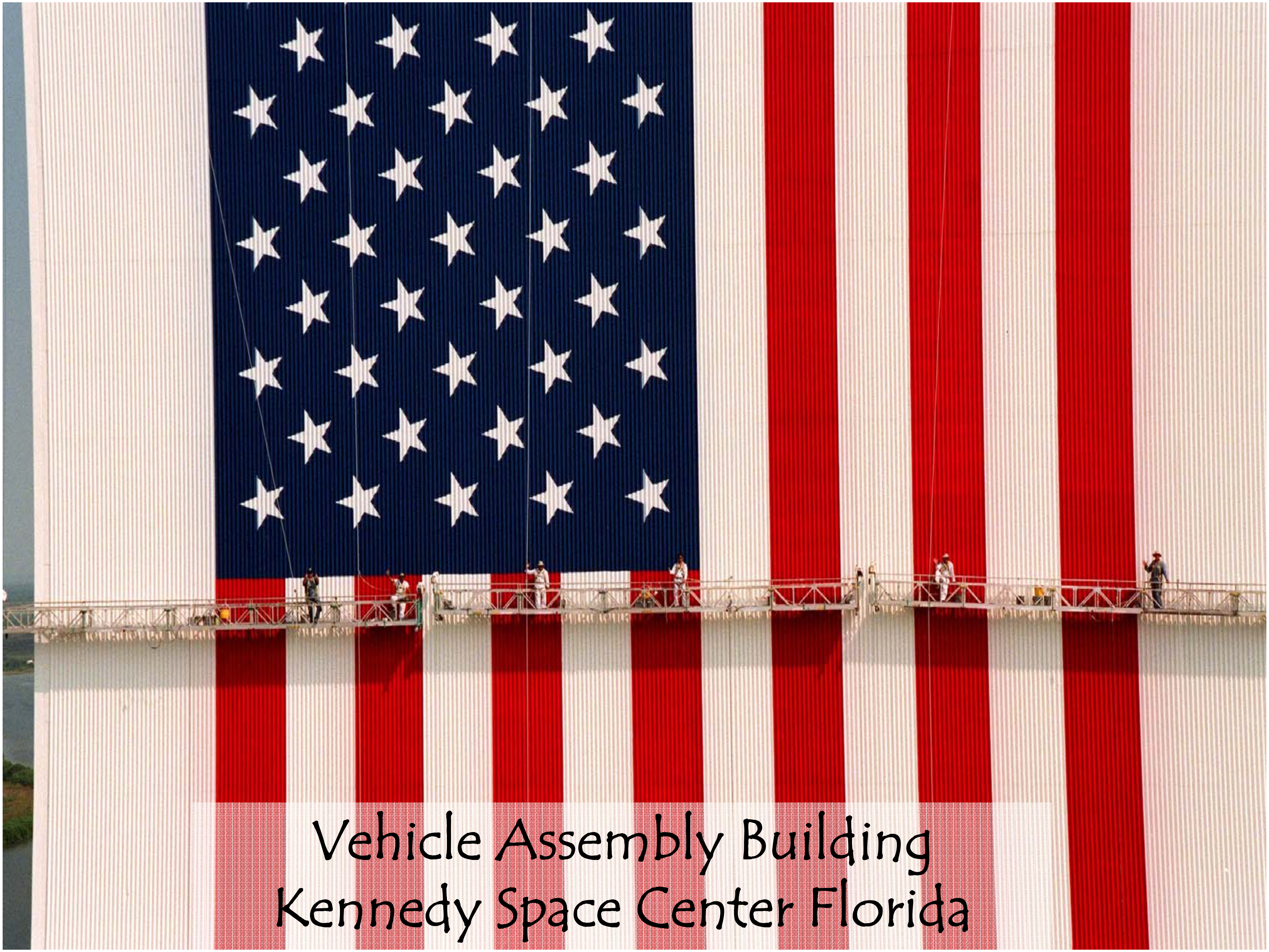
Orbiter Processing Facility

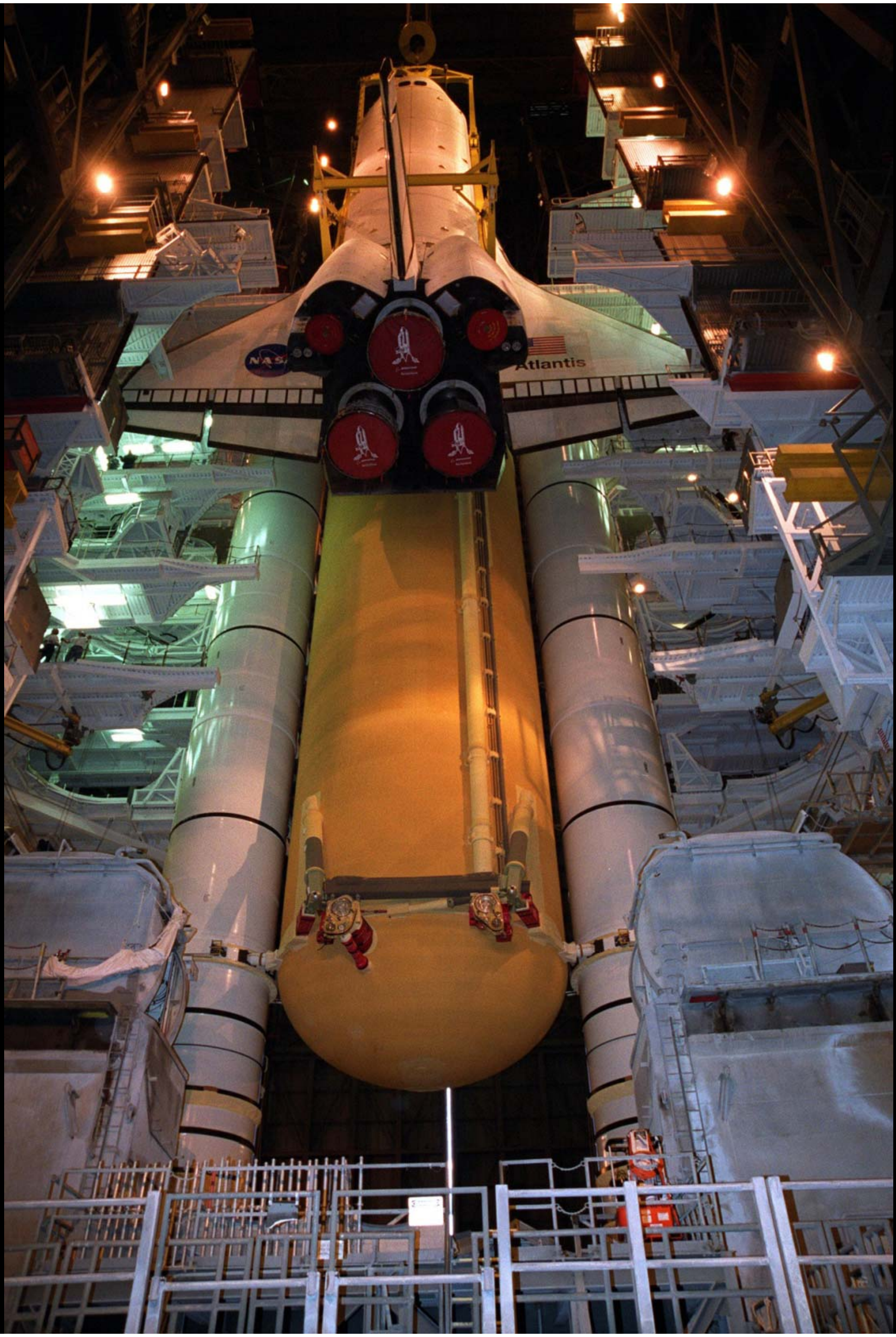

BOEING
ROCKETDYNE


NASA


Cape Canaveral - 1964

Vehicle Assembly Building
Kennedy Space Center Florida


Vehicle Assembly Building
Kennedy Space Center Florida


Atlantis


NASA
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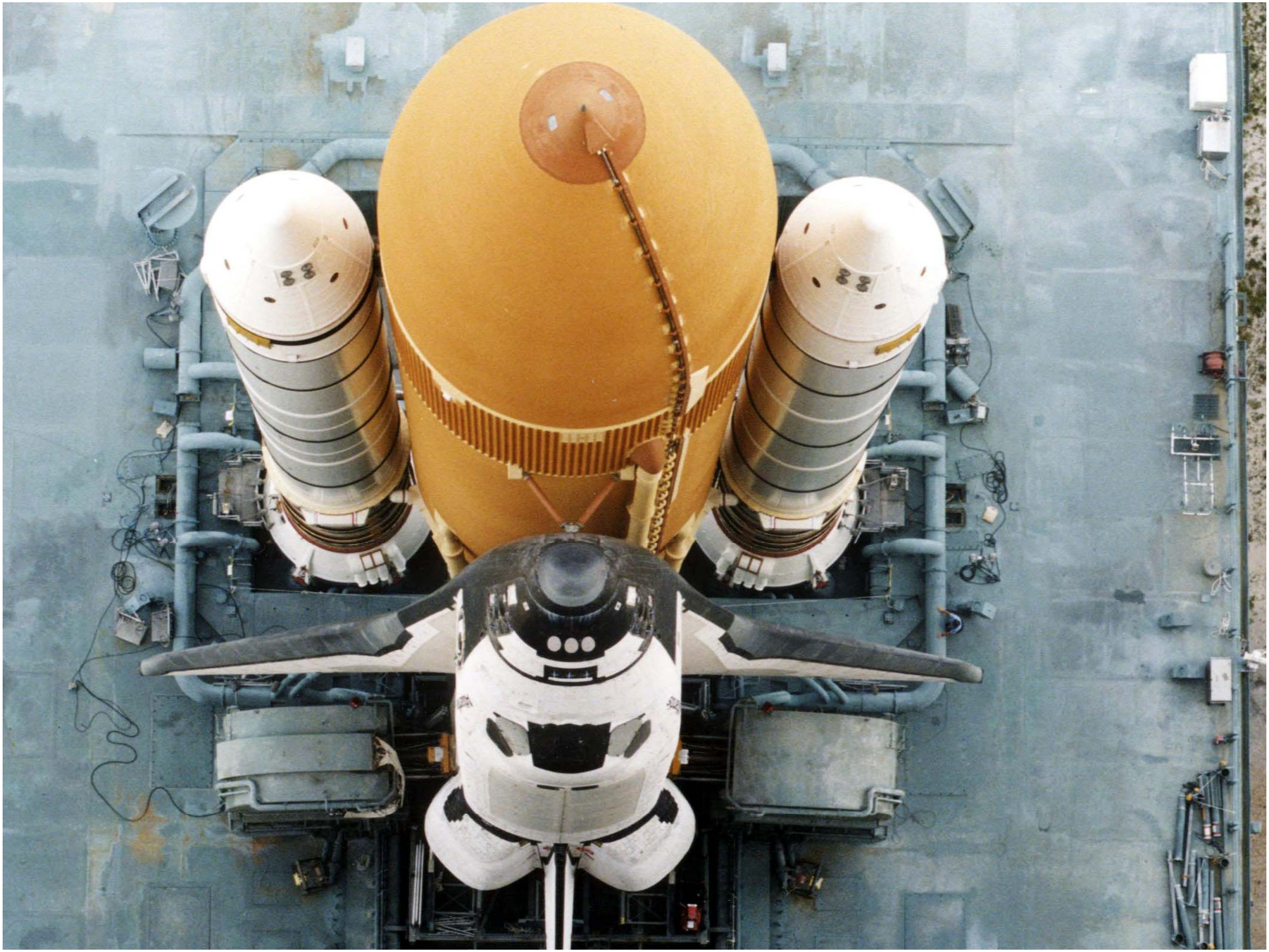

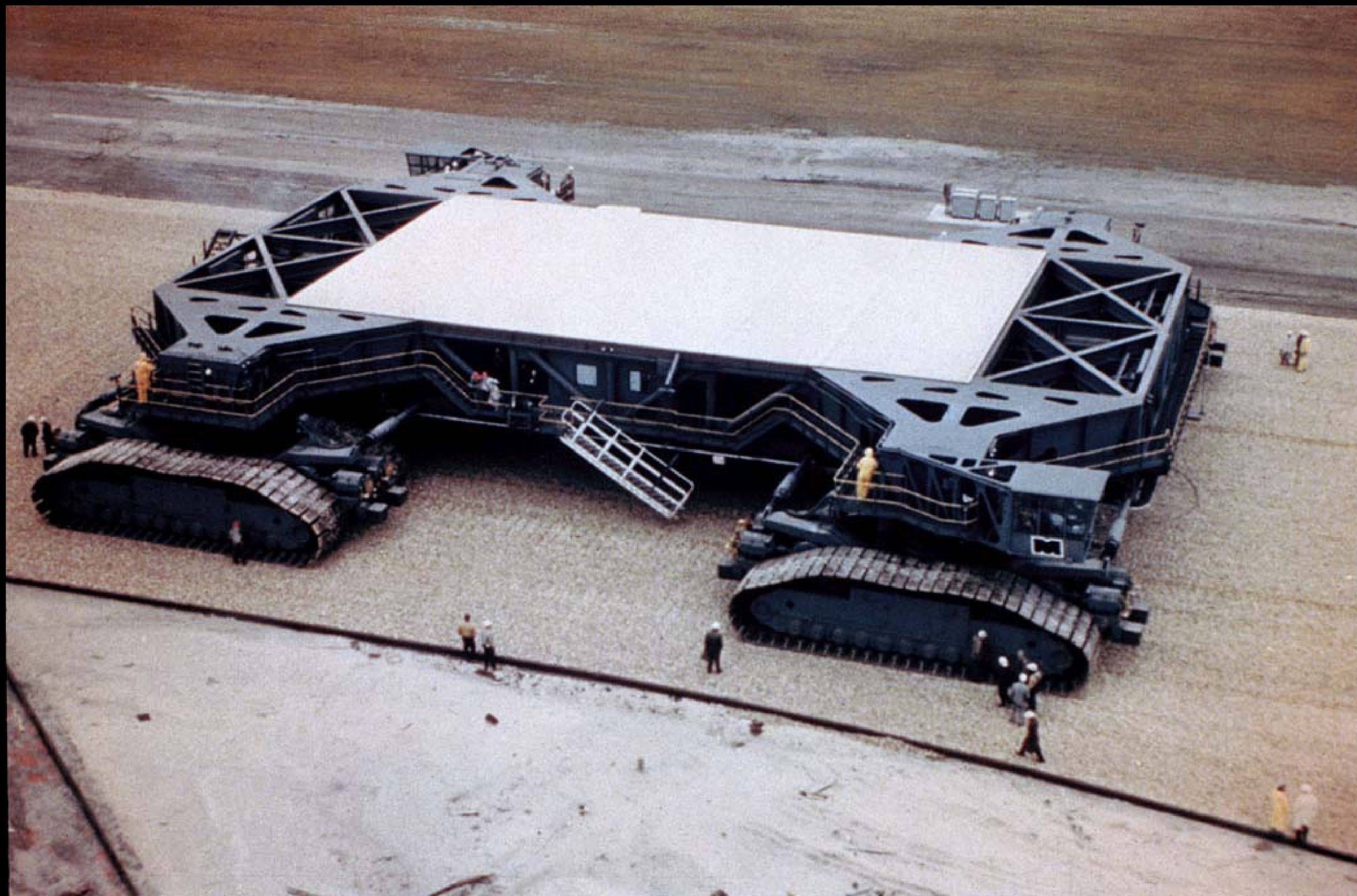

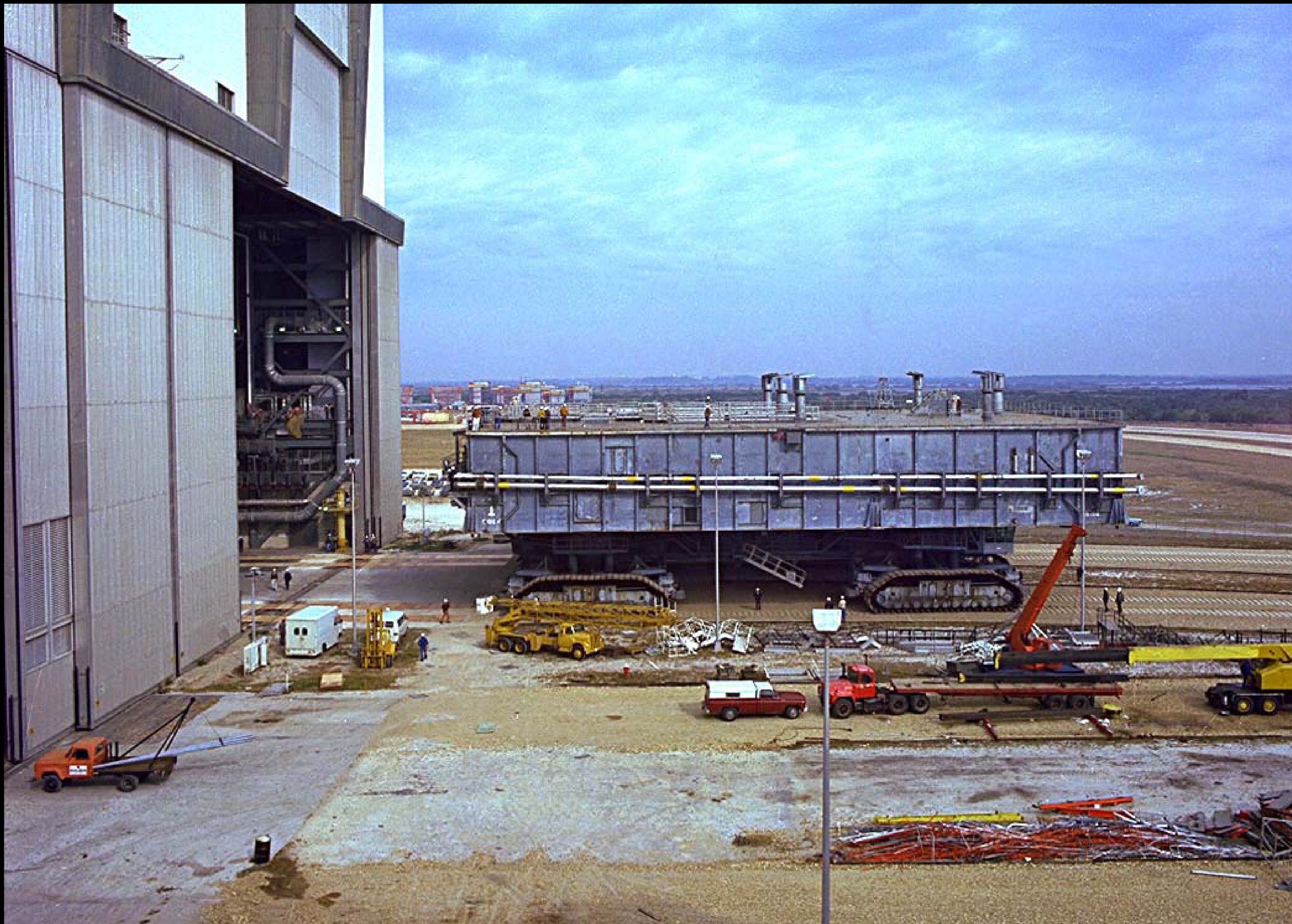


09/09/2006


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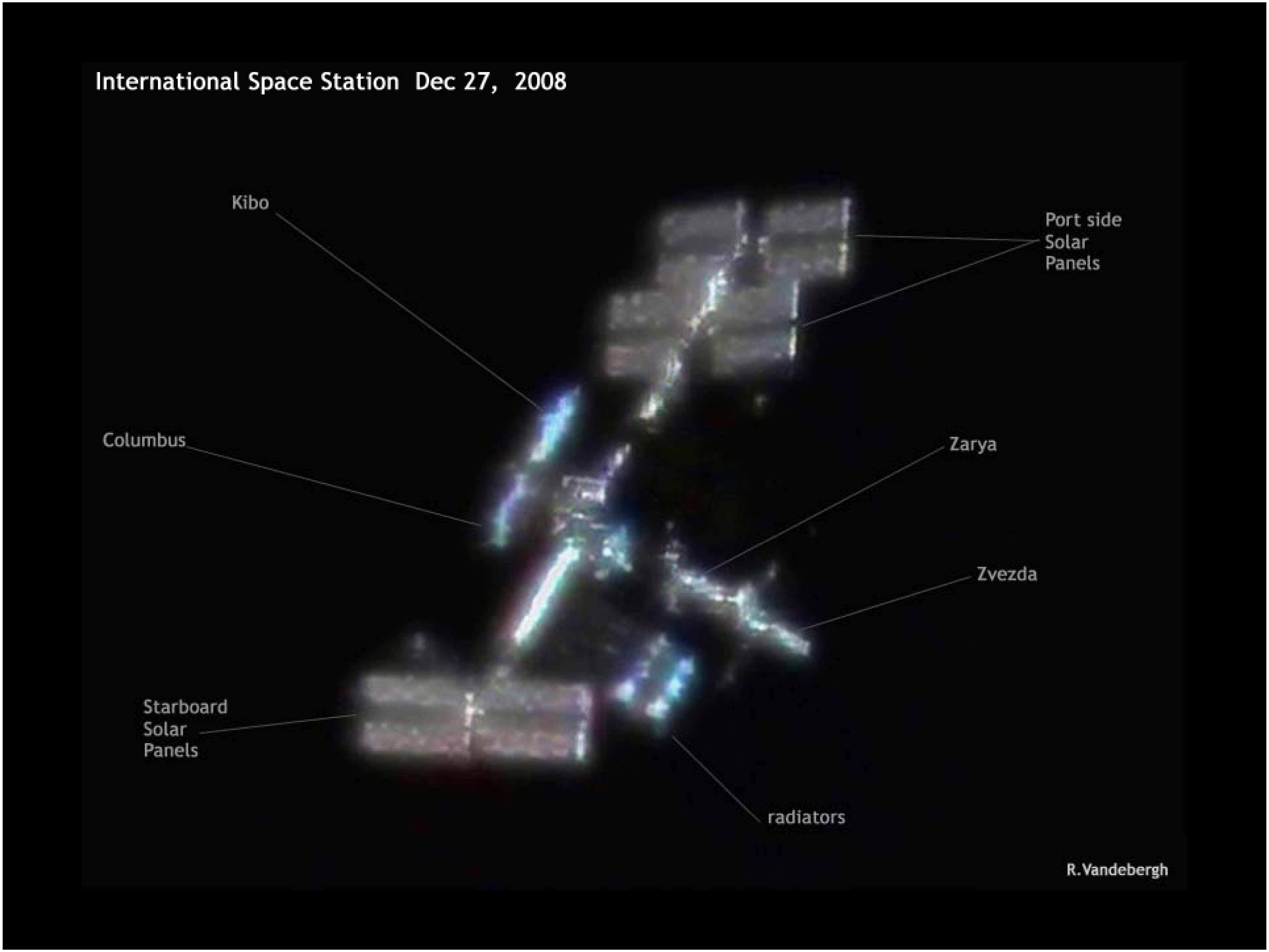
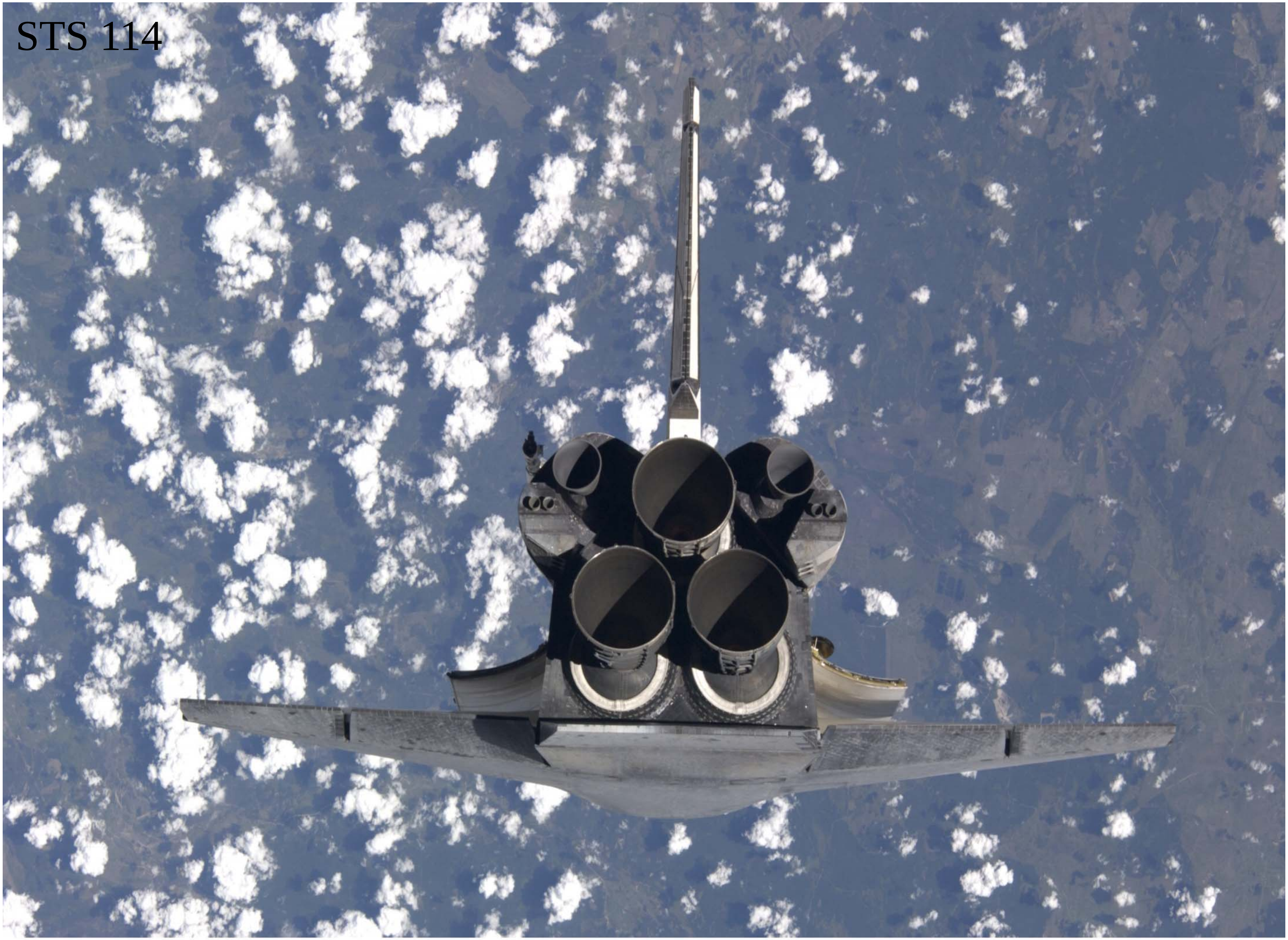

International Space Station Dec 27, 2008
Kibo
Port side
Solar
Panels
Columbus
Zarya
Zvezda
Starboard
Solar
Panels
radiators
R.Vandebergh



ISS011E11269

ISS011E11263

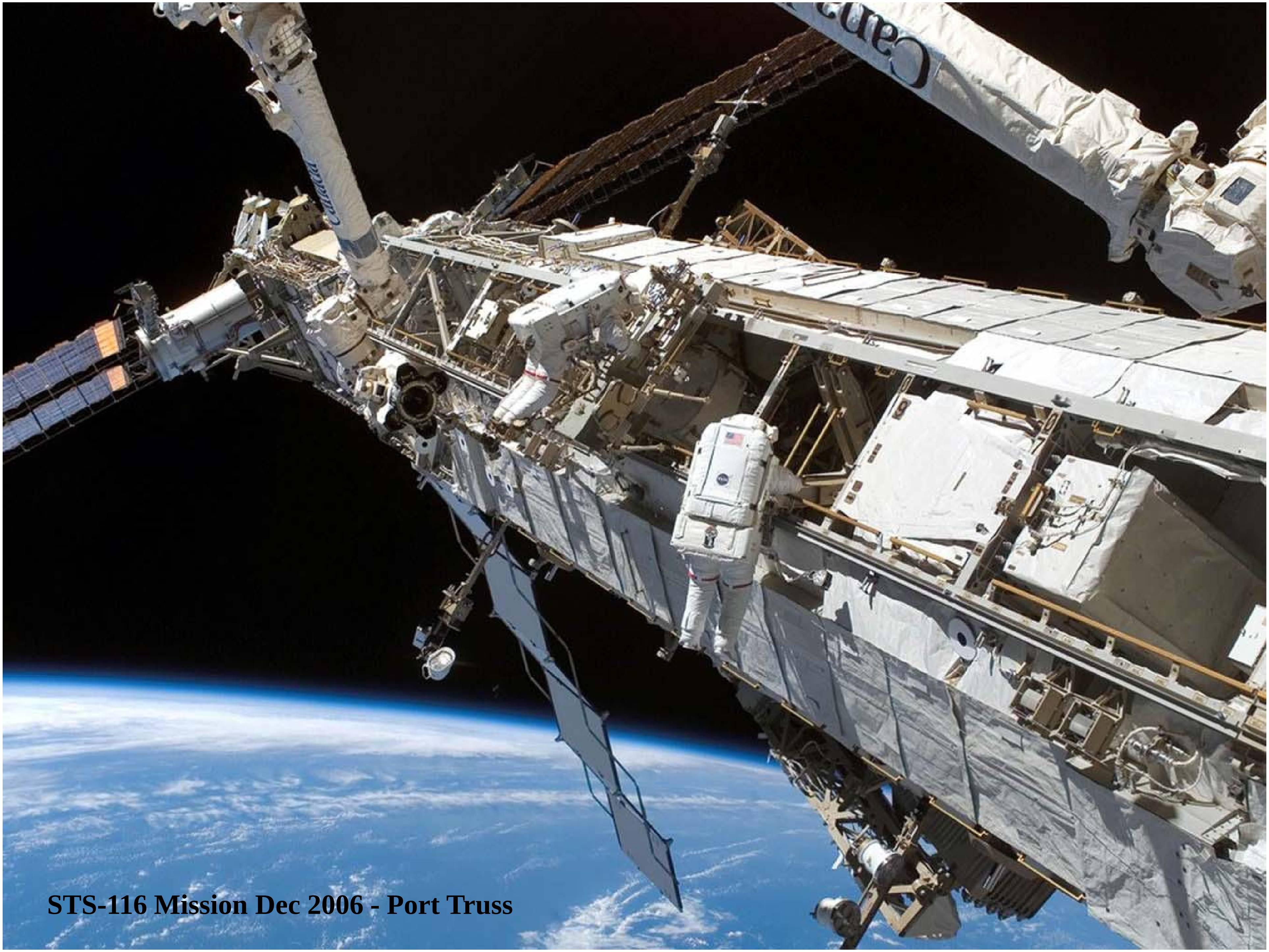
ISS011E11260

ISS011E11258

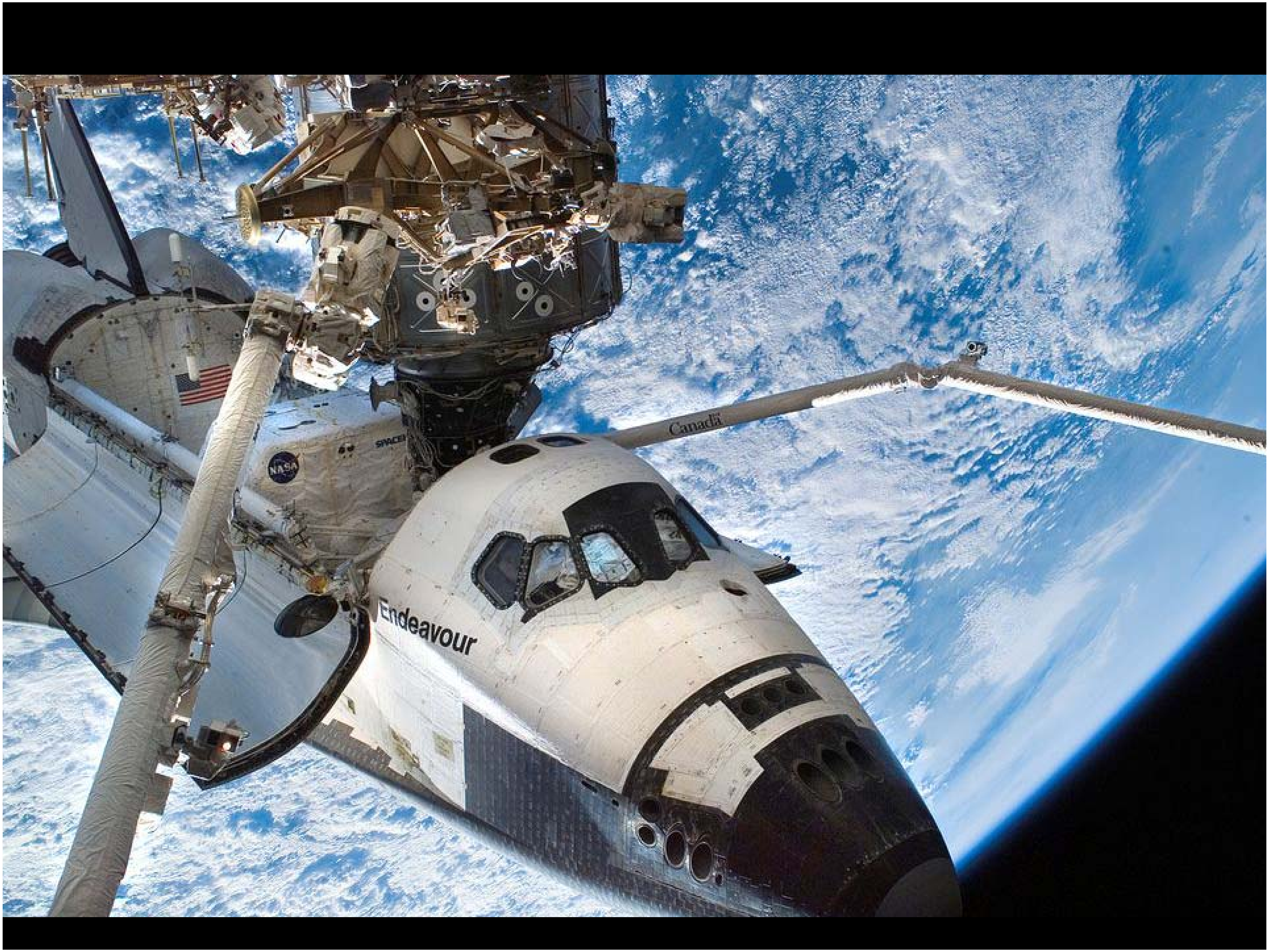
ISS011E11257

ISS011E11255

ISS From STS 118 August 9 2007



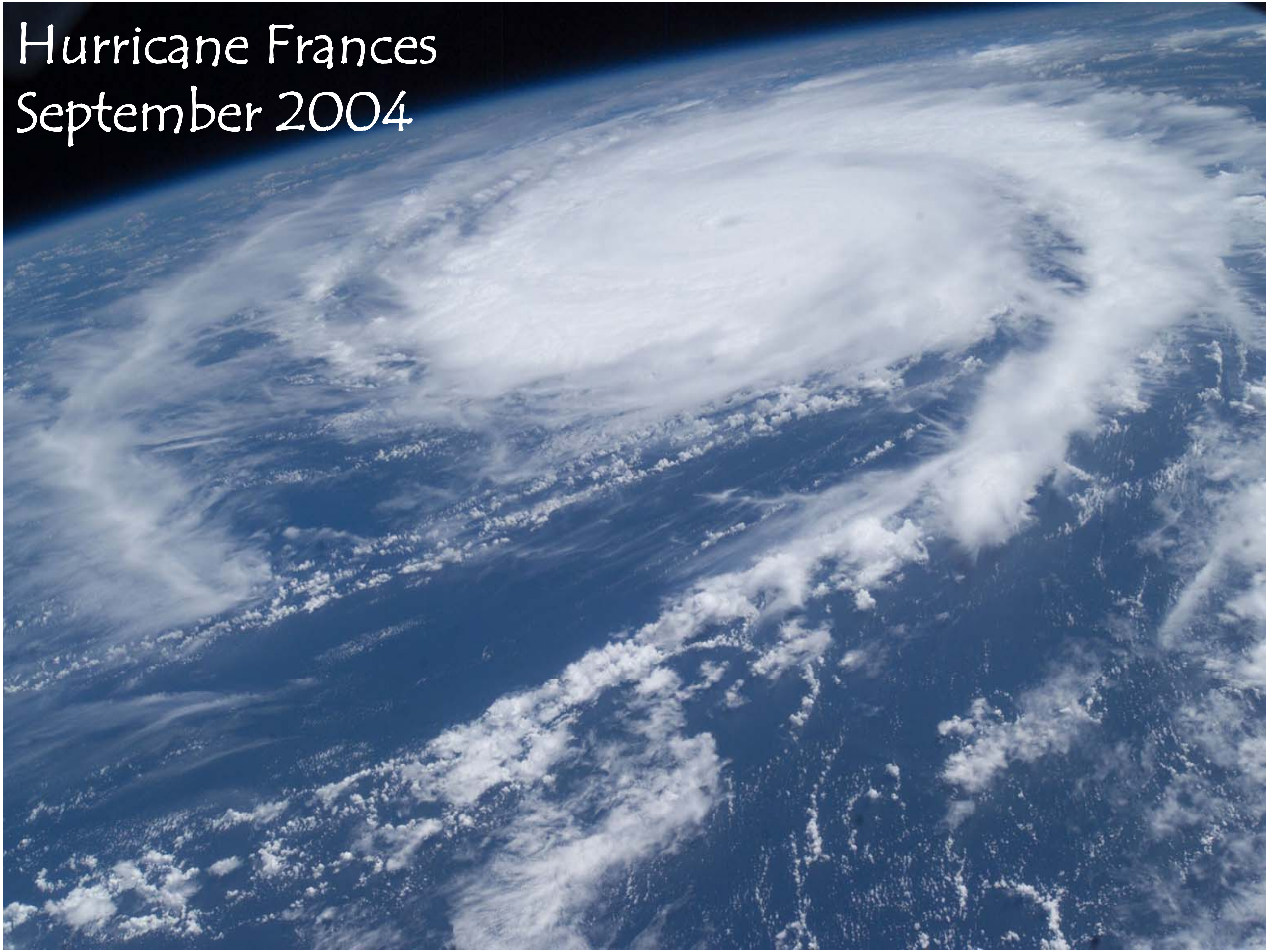
STS-116 Mission Dec 2006 - Port Truss

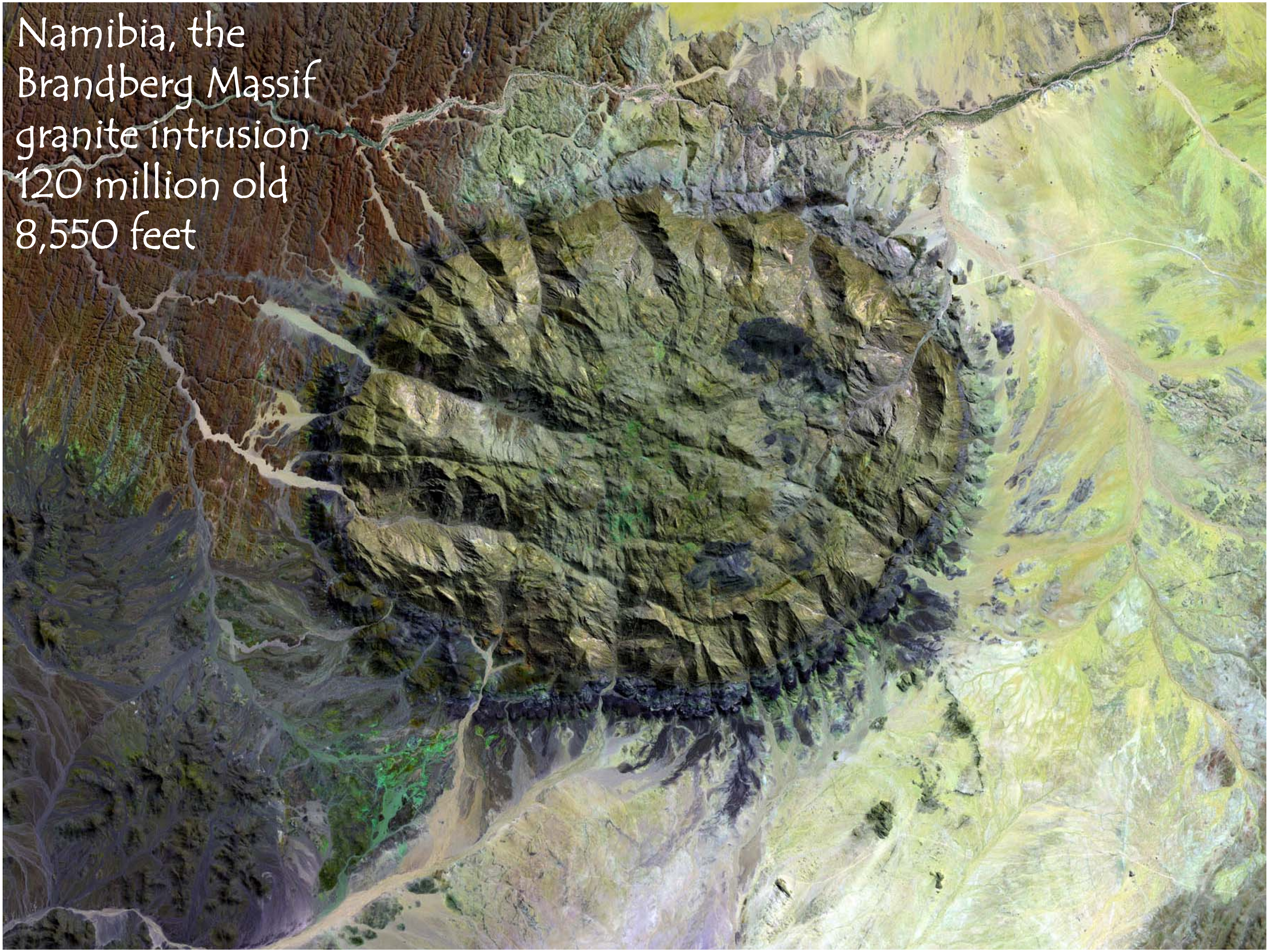

Canada
Endeavour

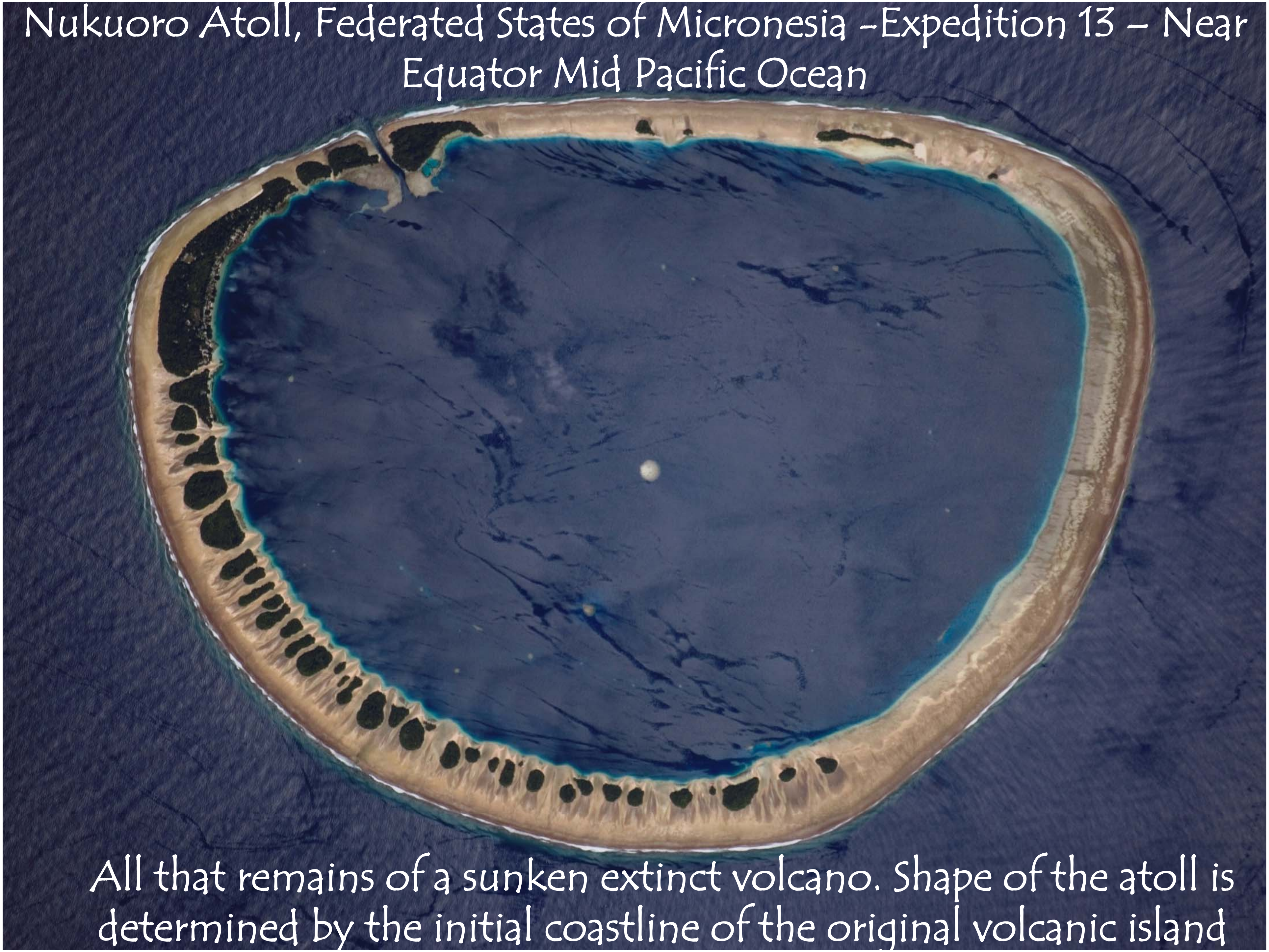
1984 STS-41B Bruce McCandless

Fires in the Everglades

Northern half of Long Island, Bahamas


Hurricane Frances
September 2004

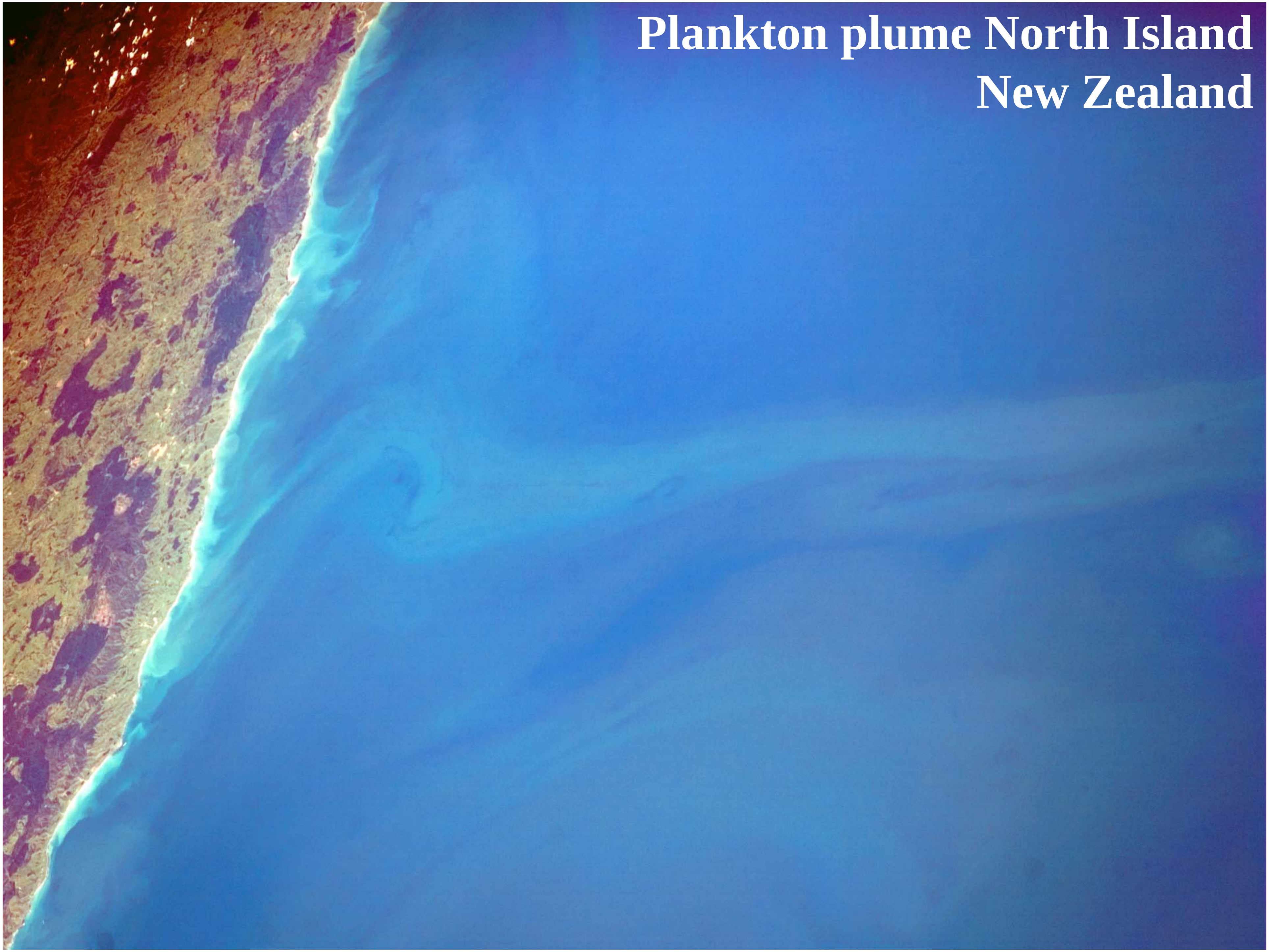

Namibia, the
Brandberg Massif
granite intrusion
120 million old
8,550 feet

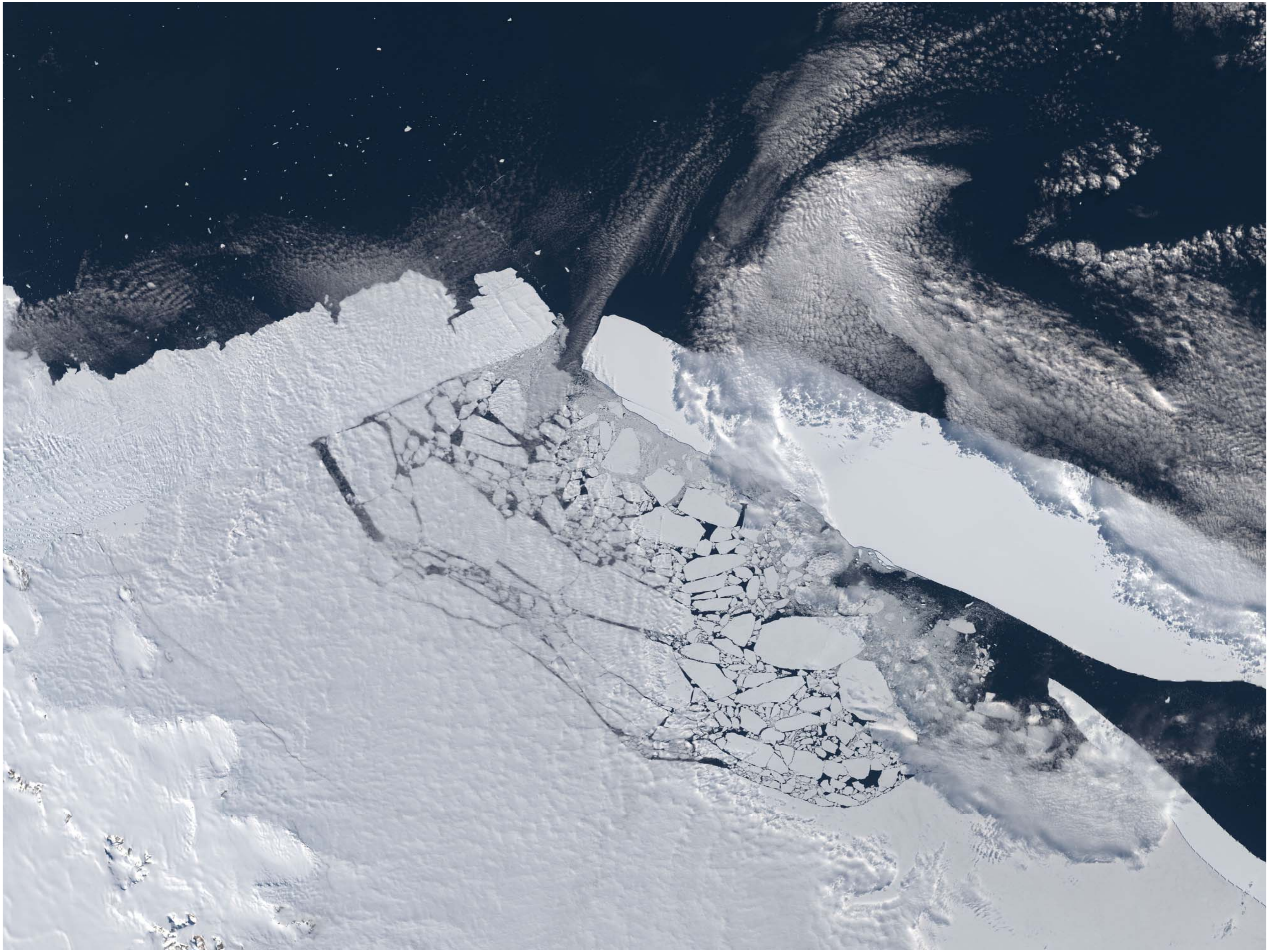

Nukuoro Atoll, Federated States of Micronesia -Expedition 13 – Near Equator Mid Pacific Ocean
All that remains of a sunken extinct volcano. Shape of the atoll is determined by the initial coastline of the original volcanic island


Sediment laden drainage, Betsiboka
River, Madagascar


Cabo San Lucas
Baja California Mexico


Strait of Homuz in the Persian Gulf
Iran


Plankton plume North Island
New Zealand

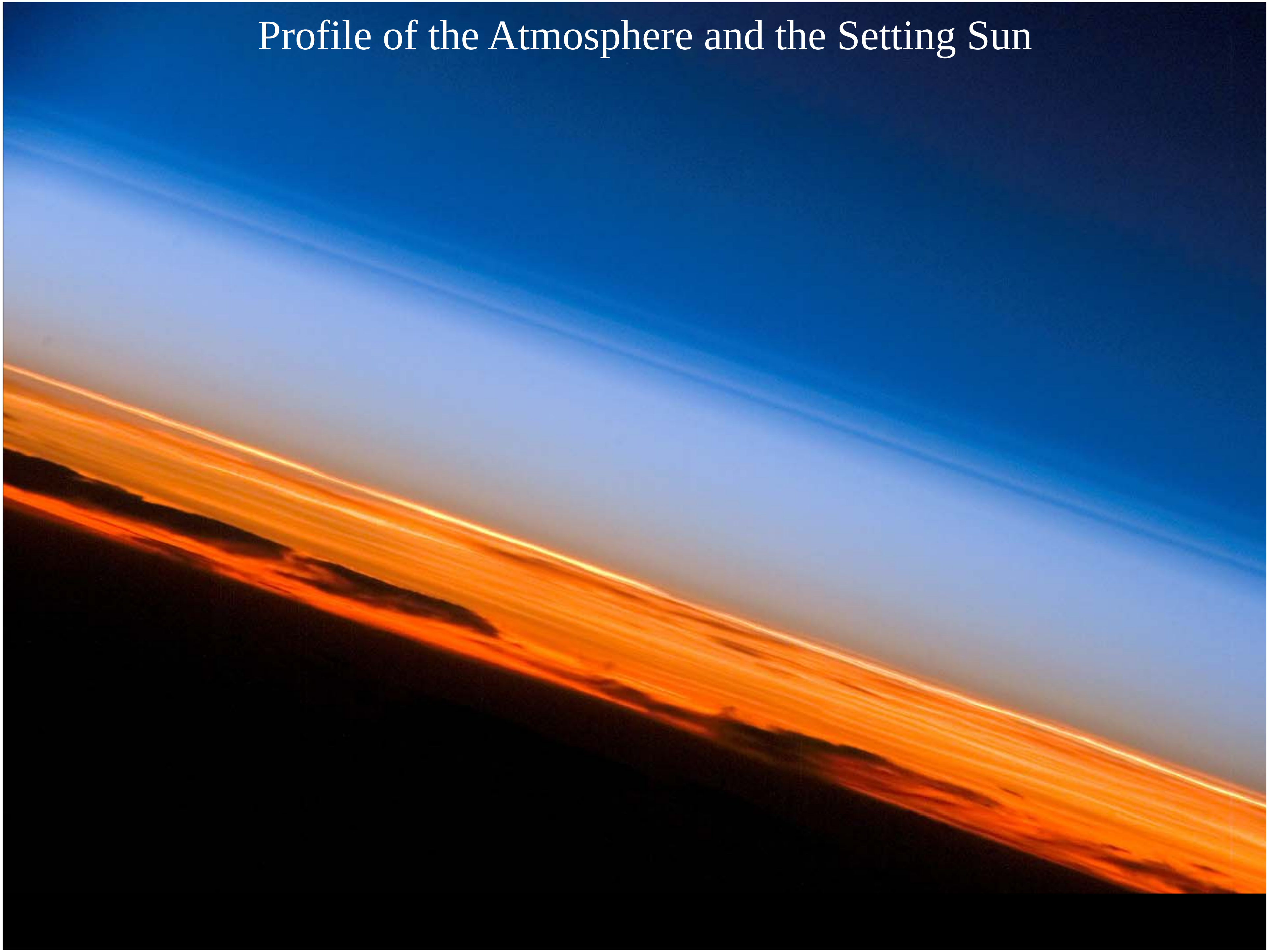



Hurricane Emily – July 2005
ISS Expedition 11


South Georgia Island
British territory in the South Atlantic Ocean 1300 kilometers east of the Falkland Islands.

Nile River, the Nile River Delta, Sinai Peninsula, the Suez Canal, Red Sea and part o the Mediterranean Sea

Profile of the Atmosphere and the Setting Sun




Navajo Mountain, Utah

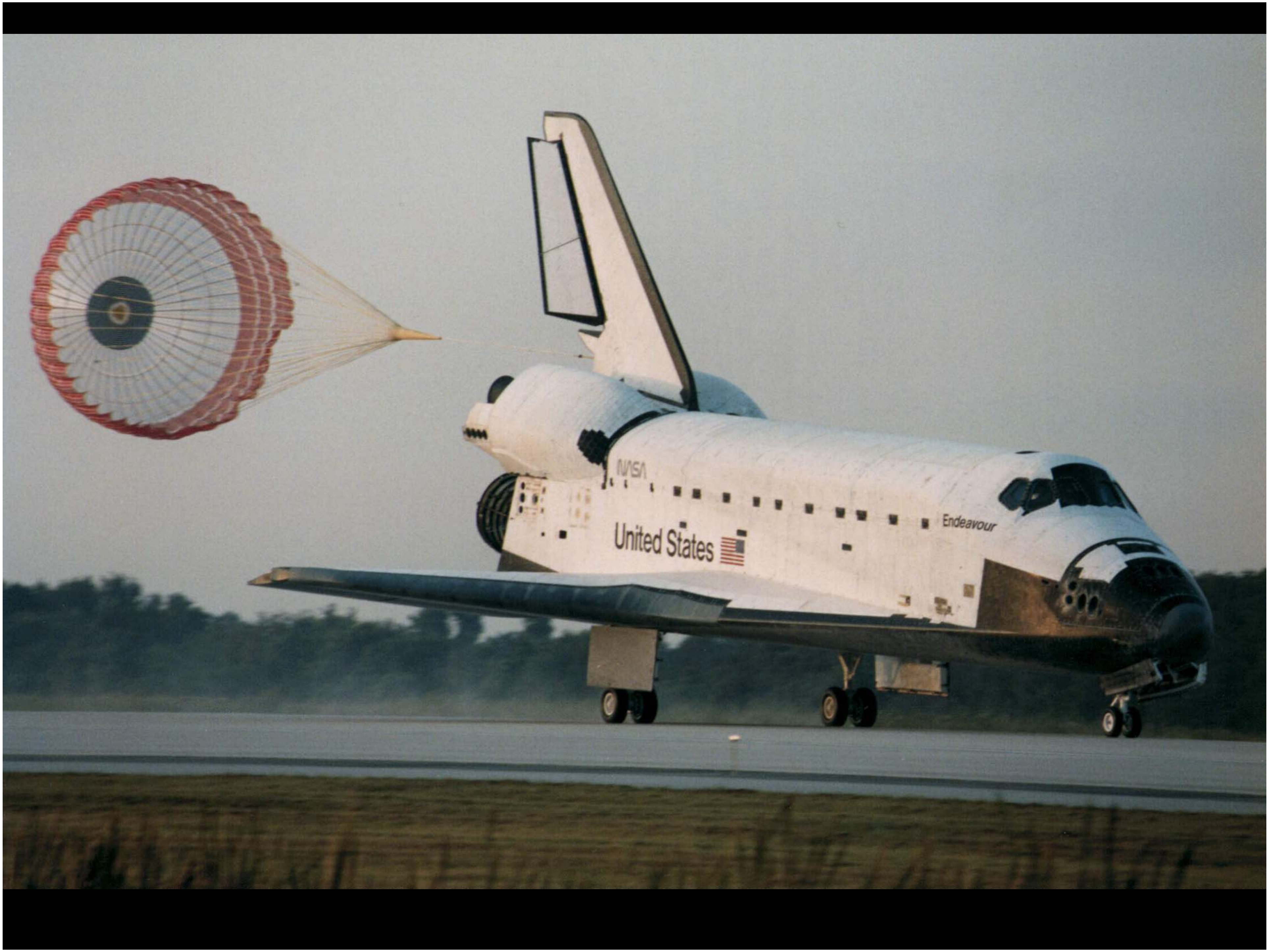

Alaskan Volcano Erupts
Taken by ISS Expedition 13 Crew
May 25, 2006


Great Barrier Reef – East
Coast of Australia


Saharan Dust over Italy

Strait of Messina (center), which runs between Italy's "foot" part of the so-called "boot" (bottom) and the heavily cloud-covered **Sicily** (top)


United States


NASA
United States
Endeavour

NASA's Exploration Mission

- Safely fly the Space Shuttle until 2010
- Complete the International Space Station
- Develop and fly the Crew Exploration Vehicle no later than 2015
- Return to the moon no later than 2020
- Conduct human expeditions to Mars
- Implement a sustained and affordable human and robotic program
- Extend human presence across the solar system and beyond

NASA's Exploration Mission

- **Safely fly the Space Shuttle until 2010**
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- Return to the moon no later than 2020
- Conduct human expeditions to Mars
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International Space Station


International Space Station

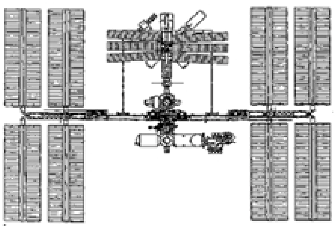
ISS Overview & Capabilities

Wingspan End-to-End --	**356 feet** **(356 ft. today)**
Operating Altitude --	**220 mile average**
Length --	**199 feet** **(199 ft. today) (pressurized modules)**
Weight --	**Approx. 925,000 lbs.** **(629,465 lbs. today)**
Inclination --	**51.6 degrees to the equator covering 90% of the worlds population**
Volume --	**Approx 34,000 cubic feet of pressurized living** **(21,083 cf. today)**
Crew --	**Up to 6 people** **(3 crew members today)**
Atmosphere --	**14.7 pounds per square inch (same as Earth)**
Speed --	**17,500 mph orbiting the Earth 16 times a day**

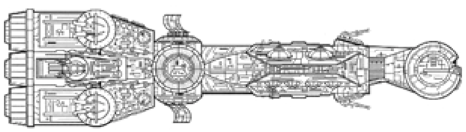
Sizemodo: How big is the International Space Station?

20 m.

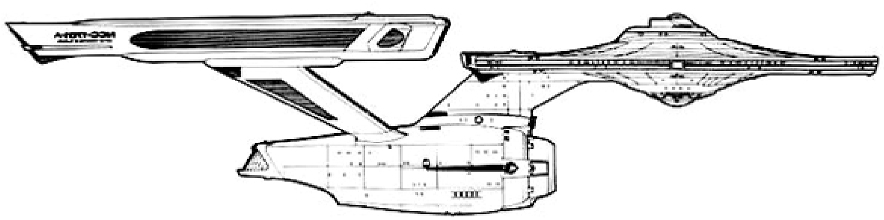
Colonial Viper Mk I: 8.7 meters



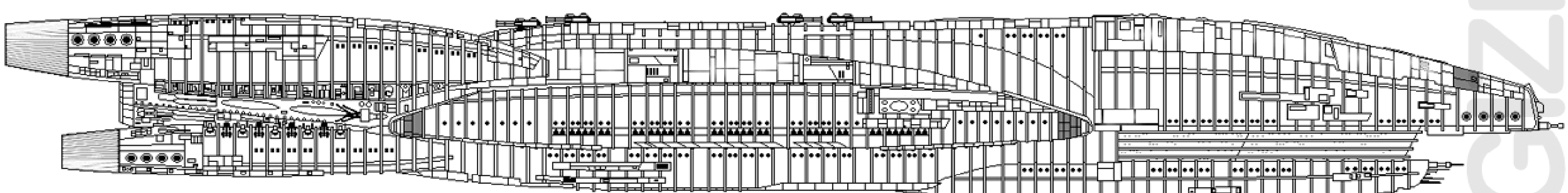
Interational Space Station: 107.4 meters



Corellian corvette: 150 meters



USS Enterprise (NCC-1701-A): 288.6 meters

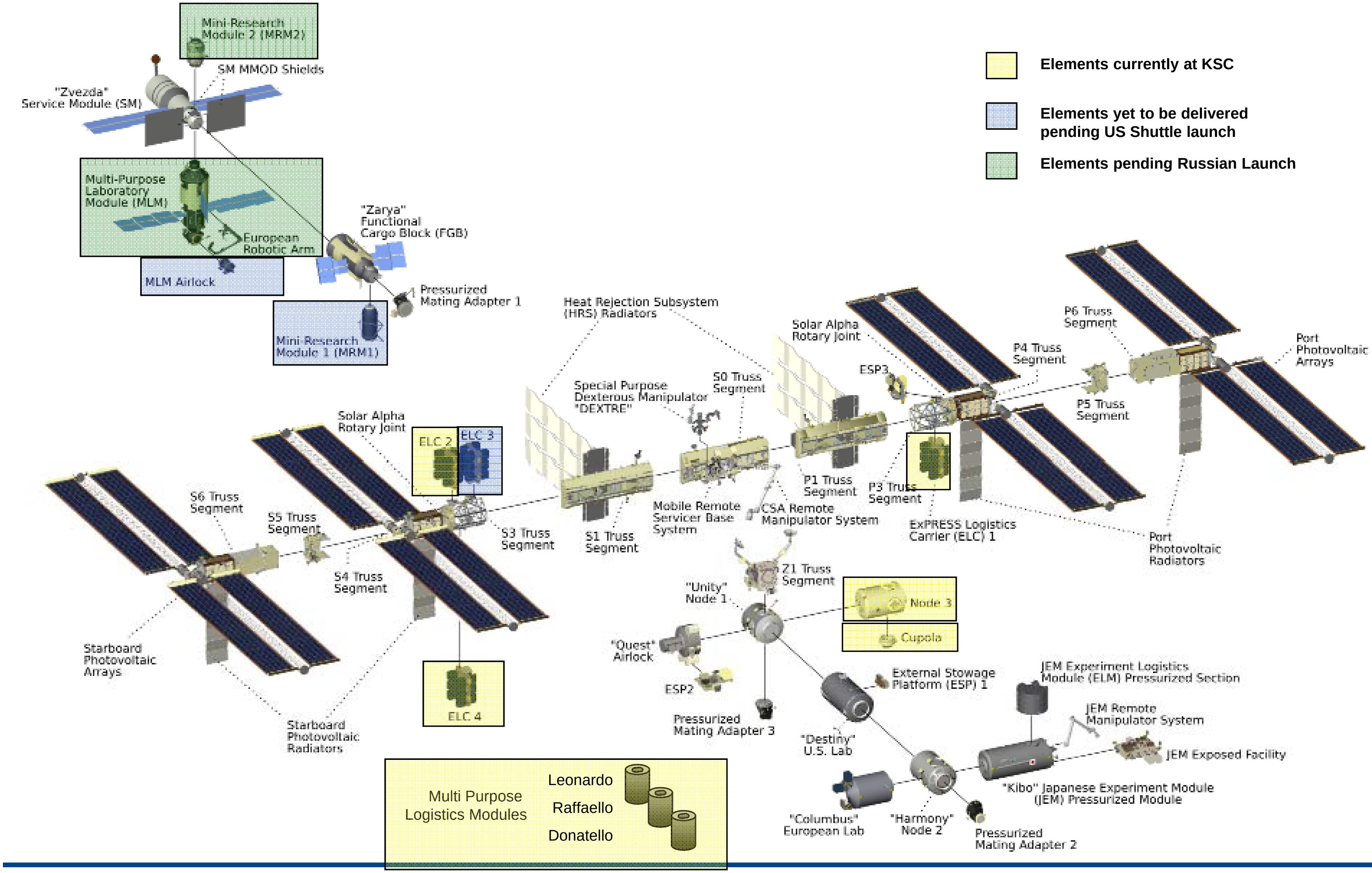


Battlestar Galactica (New Series): 615 meters

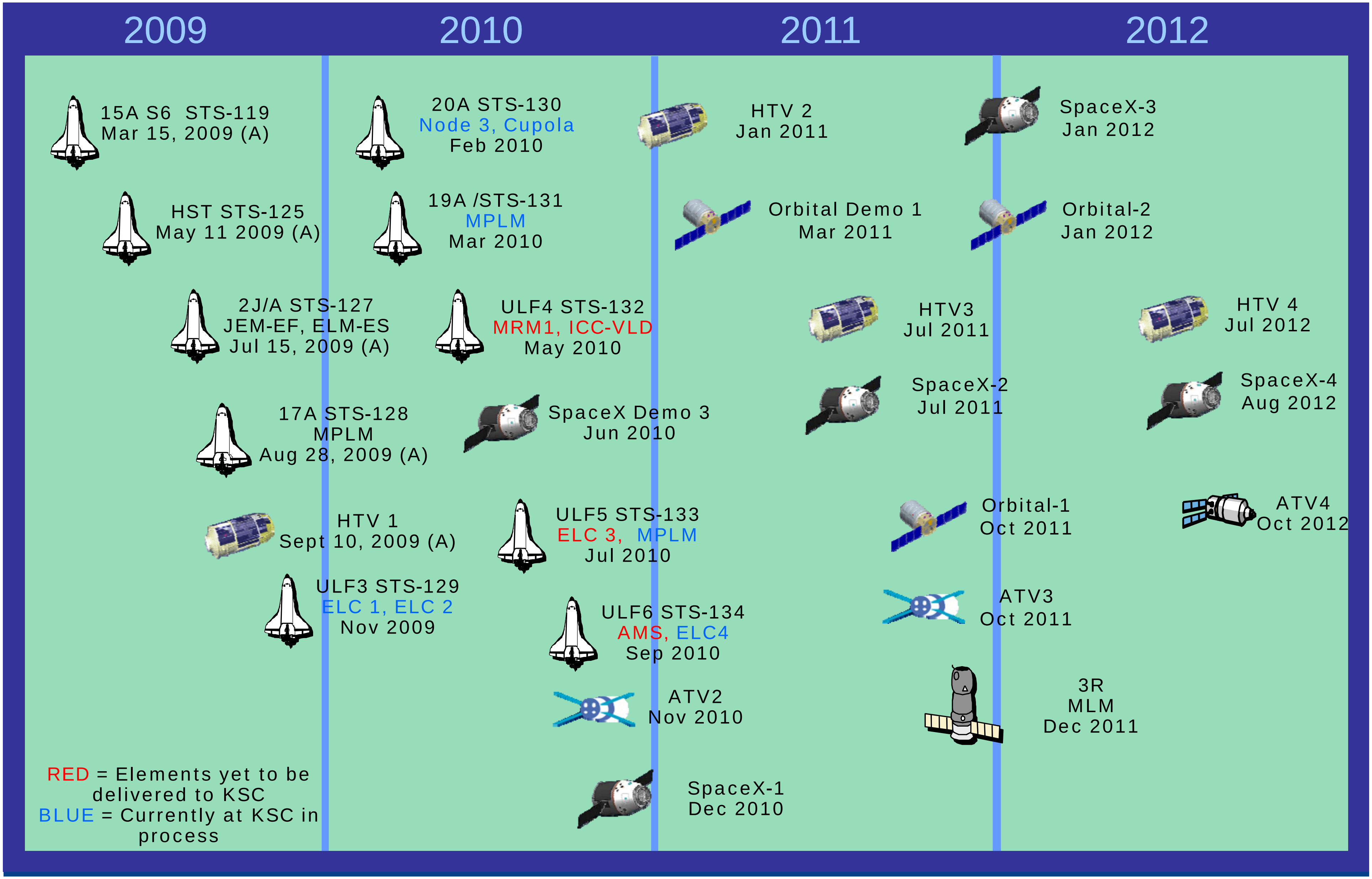
Jesús Díaz – Gizmodo

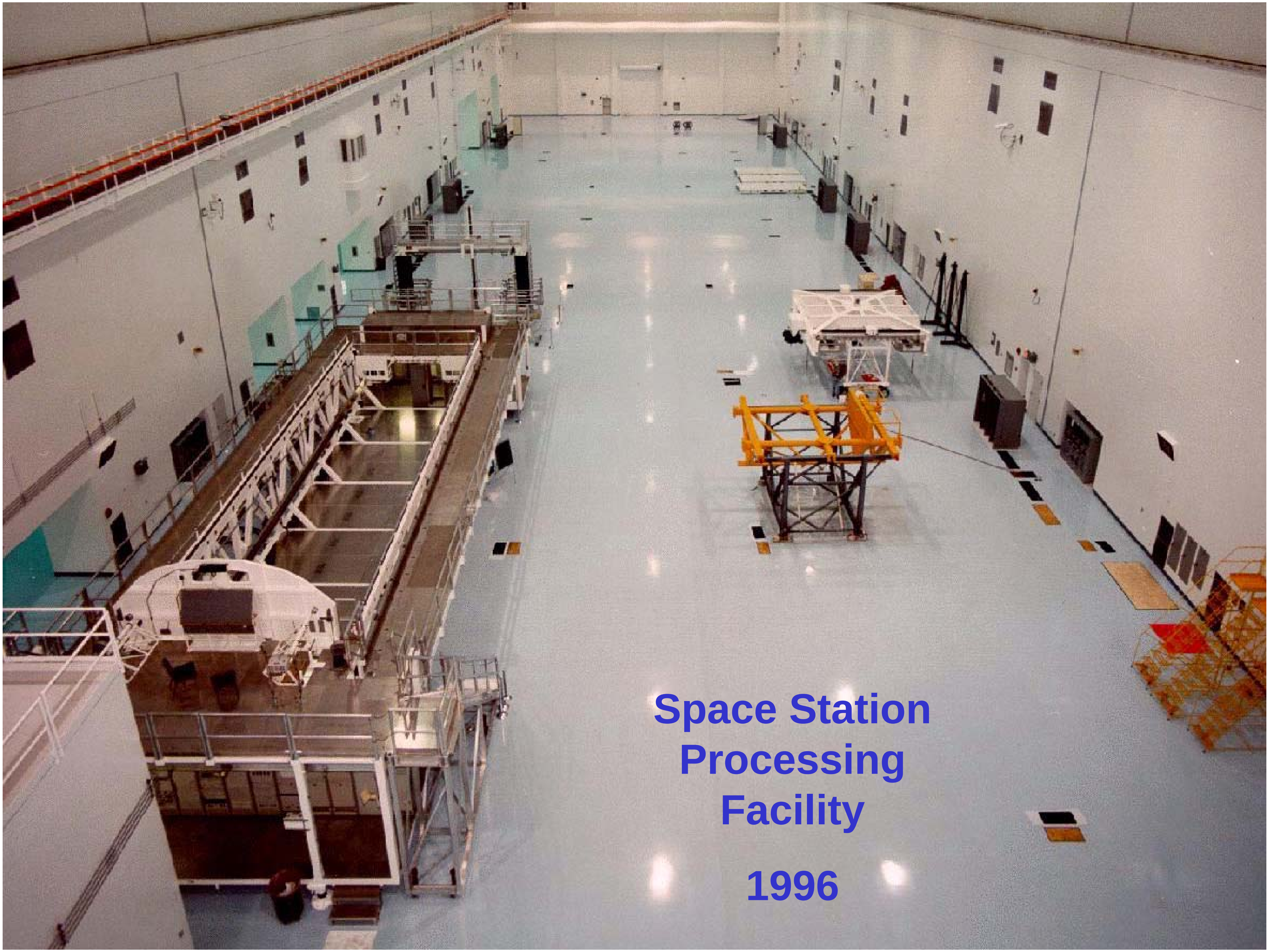

Belgium
France
Spain
The Netherlands
Germany
INTERNATIONAL
SPACE STATION
Japan
Sweden
Denmark
Canada
Switzerland
Norway
Italy
Russia
United Kingdom
United States

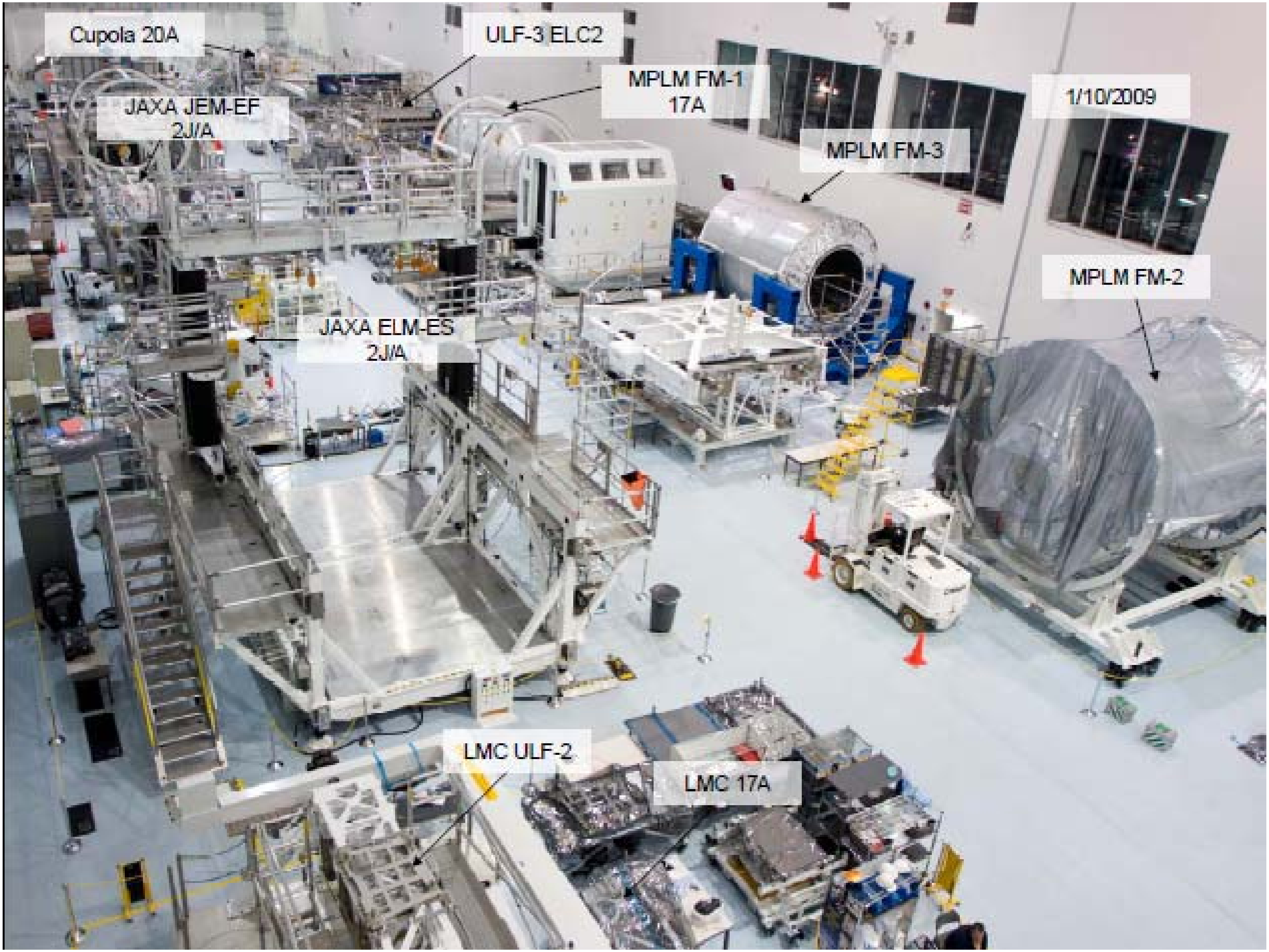
ISS Configuration



Projected Launch Schedule




Space Station
Processing
Facility
1996



Cupola 20A
ULF-3 ELC2
MPLM FM-1
17A
1/10/2009
JAXA JEM-EF
2J/A
MPLM FM-3
MPLM FM-2
JAXA ELM-ES
2J/A
LMC ULF-2
LMC 17A

Risk Prevention

National Aeronautics and Space Administration

INTERNATIONAL SPACE STATION

Safety Assurance and Engineering:

- Developed close working relationships with International Partner (Russia, ESA, JAXA) S&MA organizations and exchanged methods

- Example: After the IP subcontractor attended a “Working at Heights” class and Started using the safety harness used at KSC, they were so impressed with the improved safety and comfort of the harnesses that they requested their primary company to adopt the KSC-type safety harness in lieu of the belt-type harness.

Ground Safety Review Panel:

- Combined phase reviews in early program to leverage work of the Mission Processing Teams

- Implemented Checklist for simple items in lieu of a Ground Safety Data Package

- Made multiple flight/life of program approvals.

Science Onboard the ISS

- *Expedition crews conduct science daily. Over 1000 U.S. investigations have been conducted on the ISS to date with many of these experiments ongoing.*

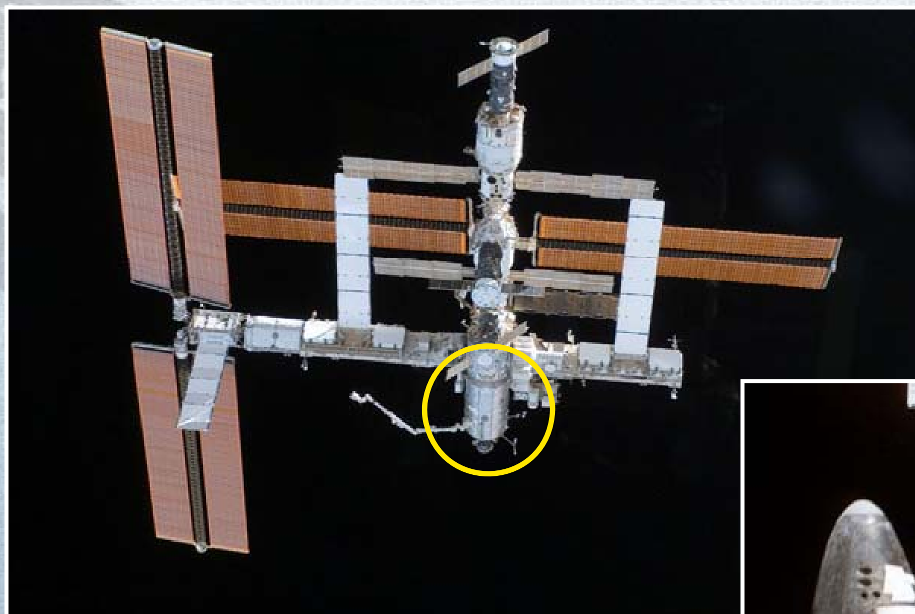
- *Through Expedition 18, ~140 scientists, from as many institutions, have been principal investigators on ISS research that has been completed or is ongoing.*

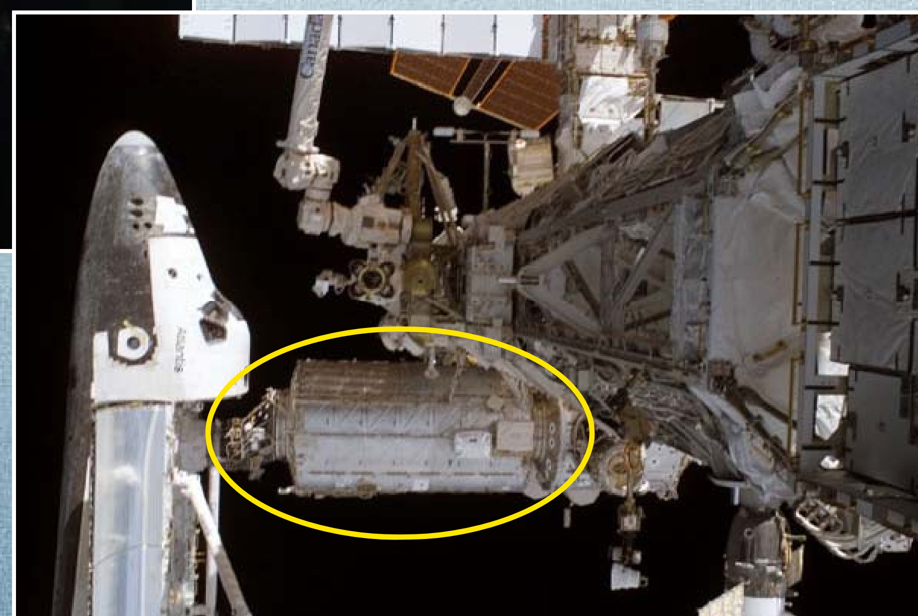
- *NASA research has included lead investigators from in the U.S., Belgium, Canada, France, Germany, Italy, Japan, Netherlands, and Spain.*

- *The ISS provides an excellent viewing platform for Earth, covering more than 90 percent of the populated Earth. Station crews have taken more than 191,800 images of Earth.*

- *Students from hundreds of schools in the United States and other countries participate directly in ISS research activities. Thousands of other schools use video clips and imagery from ISS to supplement their science curricula.*

U.S. lab "Destiny"





Science Onboard the ISS

National Aeronautics and Space Administration

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ADUM - ***Advanced Diagnostic Ultrasound in Microgravity tests the accuracy of using ultrasound technology in the novel clinical situation of space flight. This investigation includes assessing health problems in the eyes and bones, as well as sinus infections and abdominal injuries. ADUM further tests the feasibility of using an in-flight ultrasound to monitor bone density during long-duration space flights*.**

SPHERES – ***The Synchronized Position Hold, Engage, Reorient, Experimental Satellites use the internal ISS environment as a test bed for the development and testing of multi-body formation flying and other multi-spacecraft control algorithms. Bowling-ball-sized spheres perform various maneuvers (or protocols) on board, with one to three spheres operating simultaneously while communicating with each other and an ISS laptop.***

Science Onboard the ISS

DAFT - ***designed to test the effectiveness of a device that counts ultra-fine dust particles in a microgravity environment, a precursor to the next generation of fire detection equipment for exploration vehicles. This investigation is a risk mitigation activity on the development path for the next generation of spacecraft fire detection hardware.***

MISSE - ***The Materials International Space Station Experiment exposes panels attached to the outside of the ISS containing materials and coatings which are being evaluated for the effects of atomic oxygen, direct sunlight, and extremes of heat and cold. This experiment allows the development and testing of new materials to better withstand the rigors of space environments.***

Science Onboard the ISS

National Aeronautics and Space Administration

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POEMS – *(Passive Observatories for Experimental Microbial Systems in Micro-G) The primary objective will be a demonstration of a passive system for microbial cultivation in the spaceflight environment to observe the generation and maintenance of genetic variation within microbial populations in microgravity. POEMS will support experiments to describe the growth, ecology, and performance of diverse assemblages of microorganisms in space required for maintaining human health and bioregenerative function in support of NASA Exploration Systems requiring Advanced Life Support.*

BCAT-3-SC - *(Binary Colloidal Alloy Test - 3: Surface Crystallization) Astronauts photograph samples of colloidal particles (tiny nanoscale spheres suspended in liquid) to document the formation of colloidal crystals, both on the surface of the sample container walls and in the bulk of the sample container. Results will help scientists develop fundamental physics concepts previously hindered by the effects of gravity.*

Current onboard U.S. Research Facilities (Racks)

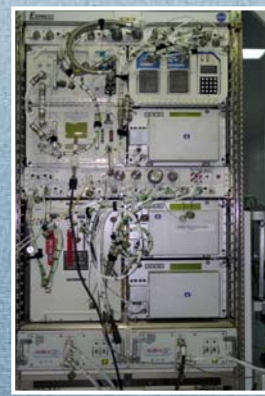
Human Research Facility Racks

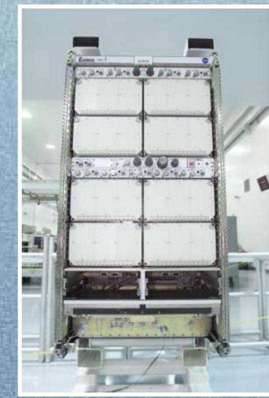
Microgravity Science Glovebox

MELFI

EMCS

5 EXPRESS Racks

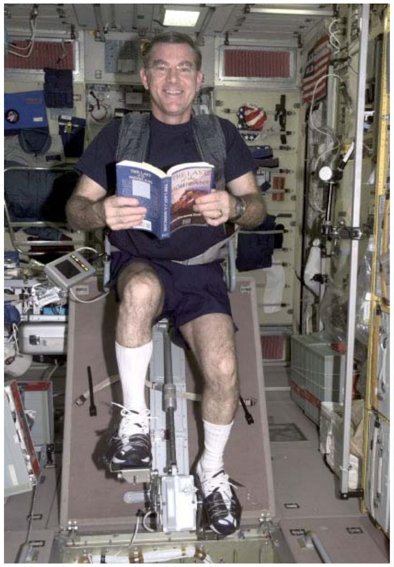


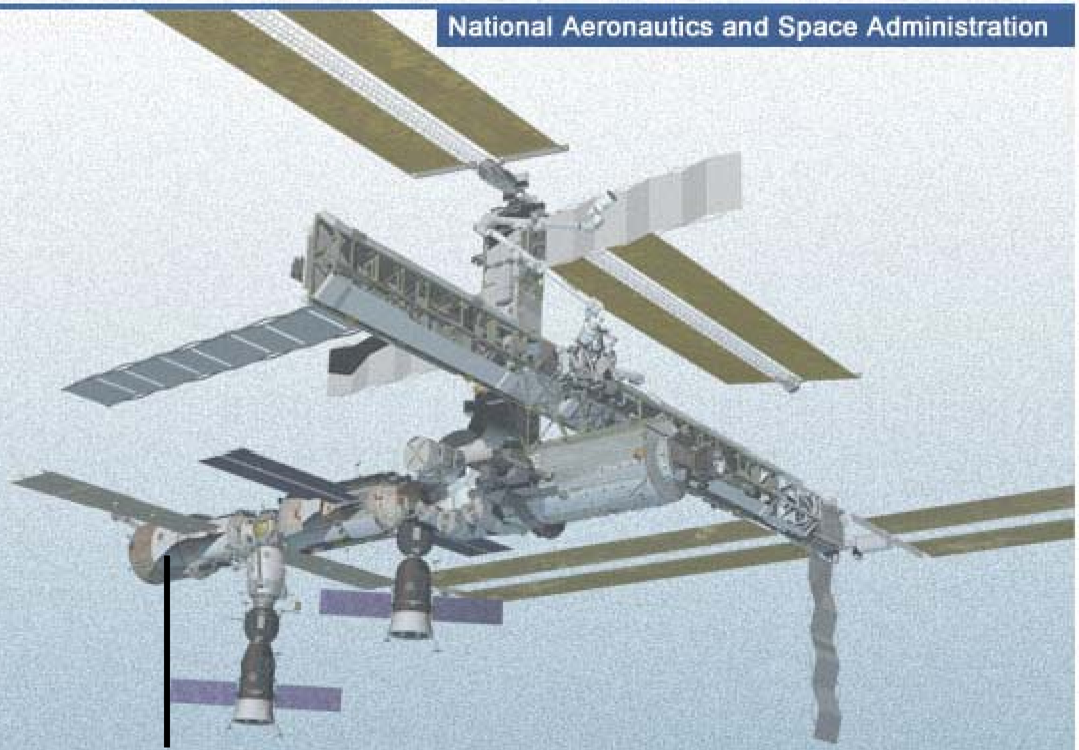


Living Quarters

National Aeronautics and Space Administration

INTERNATIONAL SPACE STATION



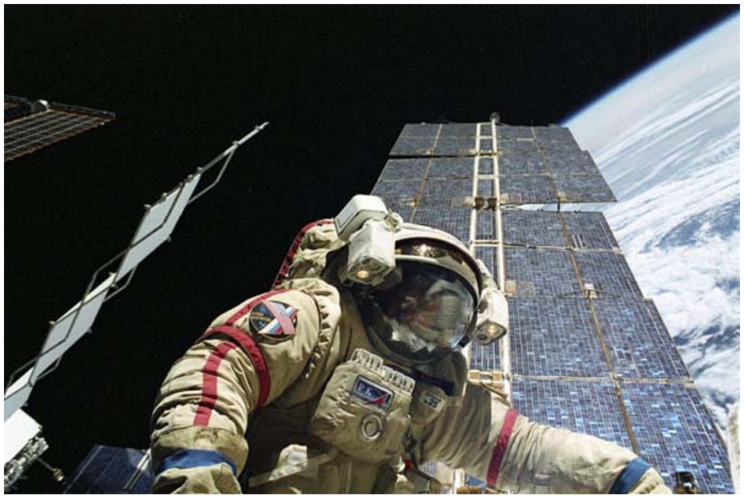


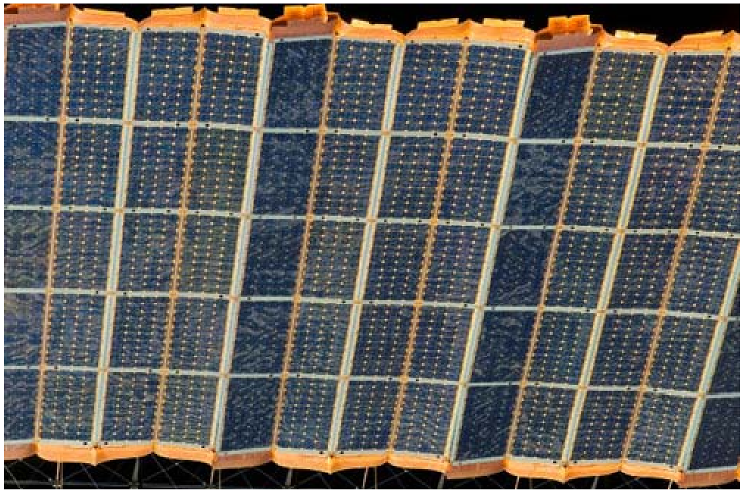
"Zvezda", or the Service Module, serves as the Station's crew quarters, providing a place for the astronauts to eat, live, rest, and conduct science experiments.

Electrical Power Subsystem

National Aeronautics and Space Administration

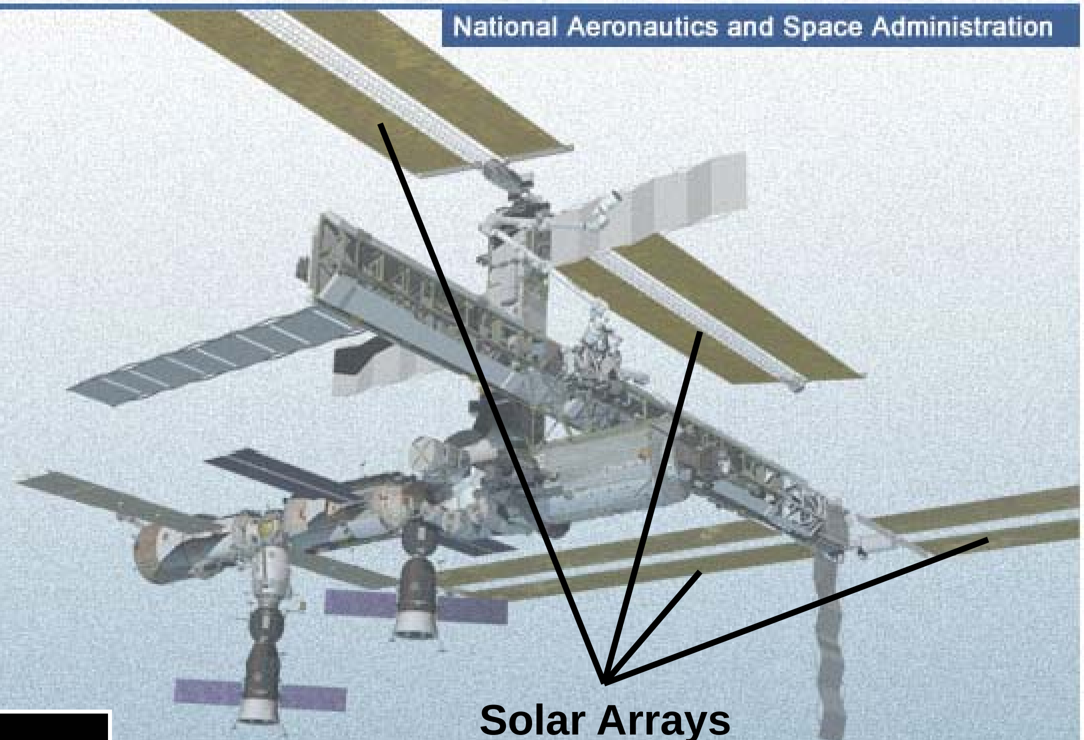
INTERNATIONAL SPACE STATION





In Earth orbit, the most practical source of power for the ISS is sunlight. Together all of the arrays contain a total of 262,400 solar cells and cover an area of about 2,500 m^2 (27,000 sq. ft.) -- more than half the area of a football field!

Solar Arrays

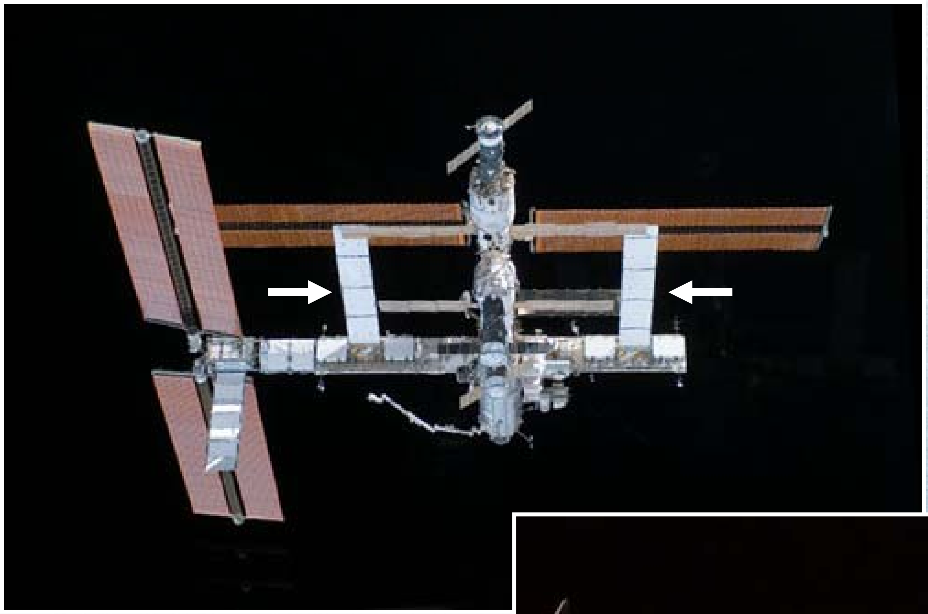


The Solar Arrays are the main source of power for the Station. During the shadow phase, the Space Station relies on banks of nickel-hydrogen rechargeable batteries to provide a continuous power source

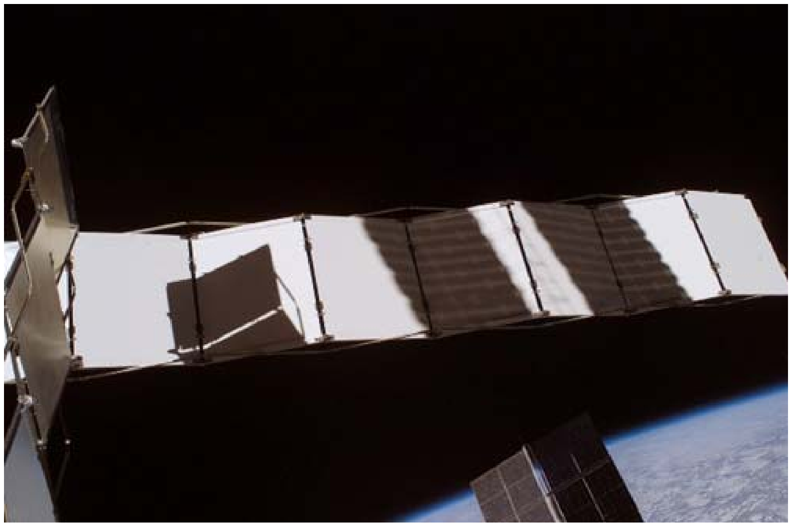
Thermal Control Subsystem

National Aeronautics and Space Administration

INTERNATIONAL SPACE STATION



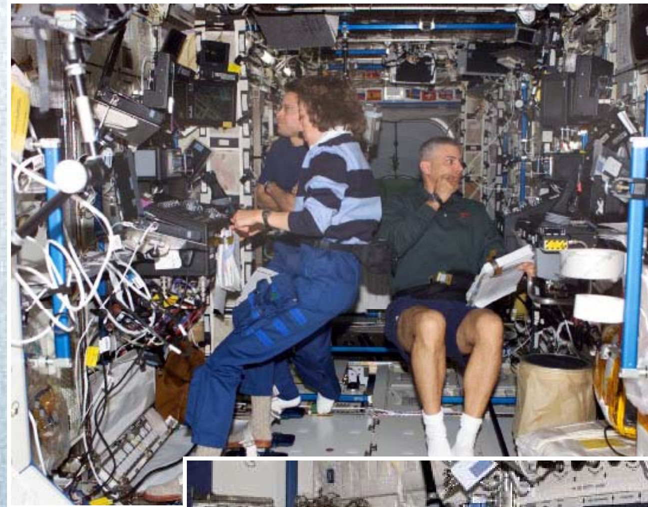
The Station's outstretched radiators are made of honey-comb aluminum panels. There are 14 panels, each measuring 6 by 10 feet for a total of 1680 square feet of ammonia-tubing-filled heat exchange area.



Command data and Handling

National Aeronautics and Space Administration

INTERNATIONAL SPACE STATION



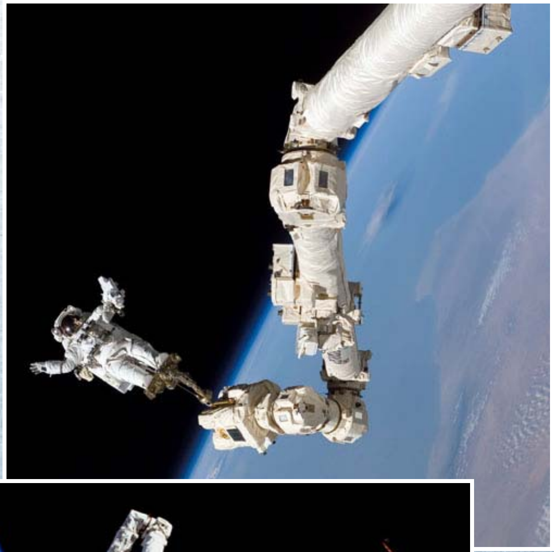
The Space Station systems are controlled by nearly 4 million lines of software code, about half provided by the US in core computers (MDMS) and laptops and the balance from Russia and Canada controlling their systems. Still to be added are another 2.5 millions lines of code controlling the European and Japanese modules.

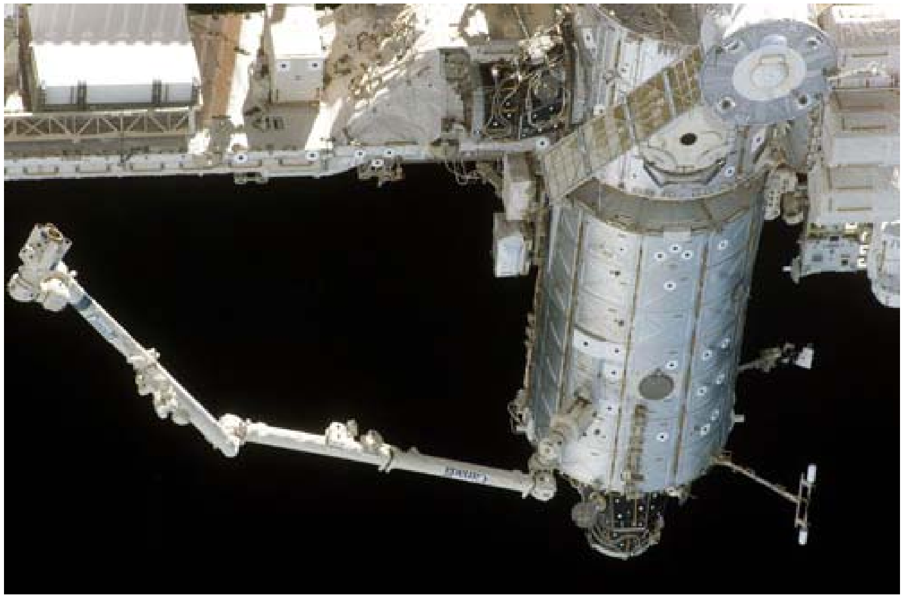
Robotics

National Aeronautics and Space Administration

INTERNATIONAL SPACE STATION

Canadarm2 represents next-generation robotics. By flipping end-over-end between anchor points it can move around the ISS like an inchworm. With its seven joints, Canadarm2 is more maneuverable than its predecessor on the shuttle and even more agile than a human arm.

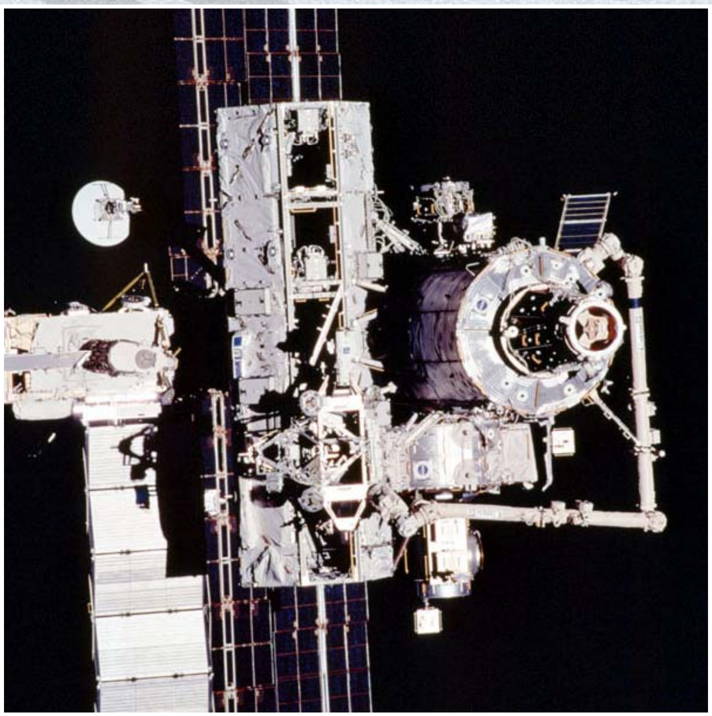




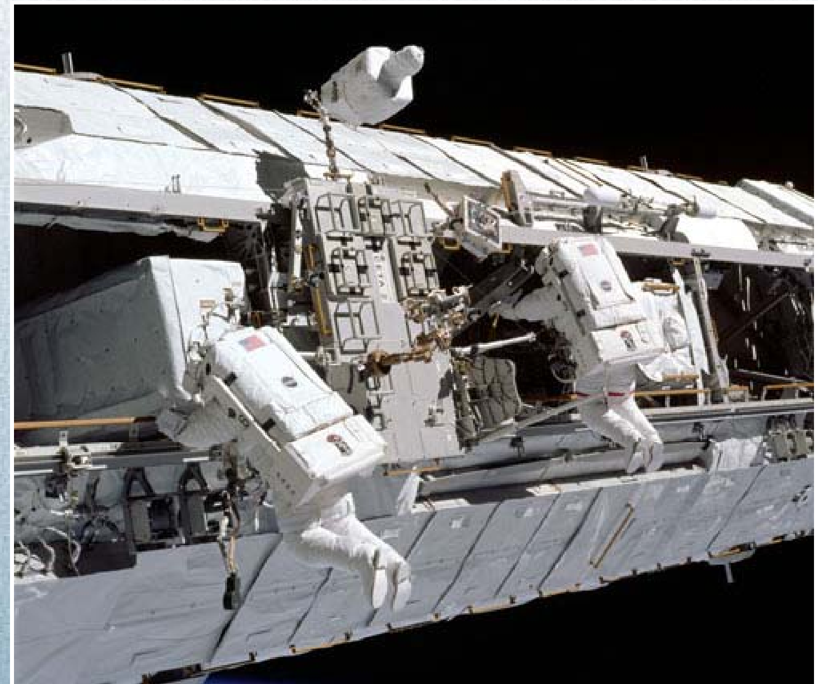
Robotics

National Aeronautics and Space Administration

INTERNATIONAL SPACE STATION



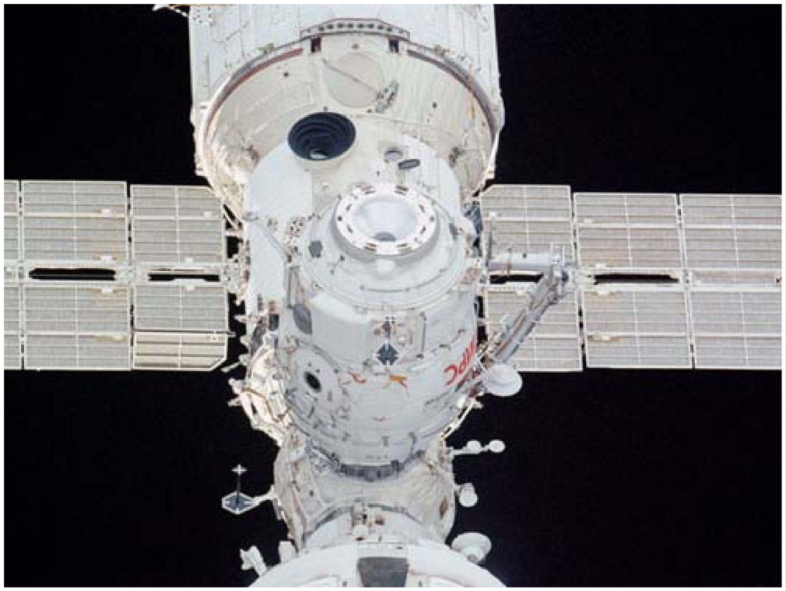
Mobile Base System



Crew Equipment and Translation Aid Cart (CETA)

A U.S. and Russian Door to Space

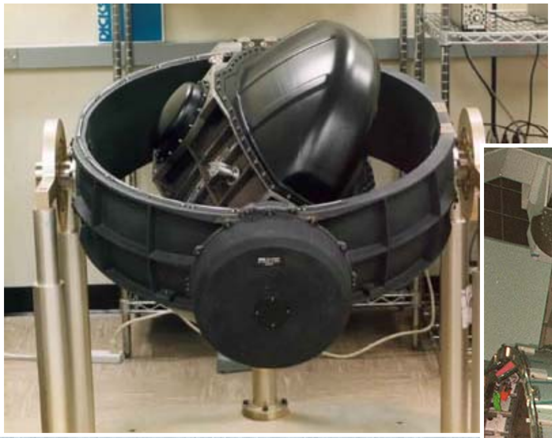
Joint Airlock “Quest”



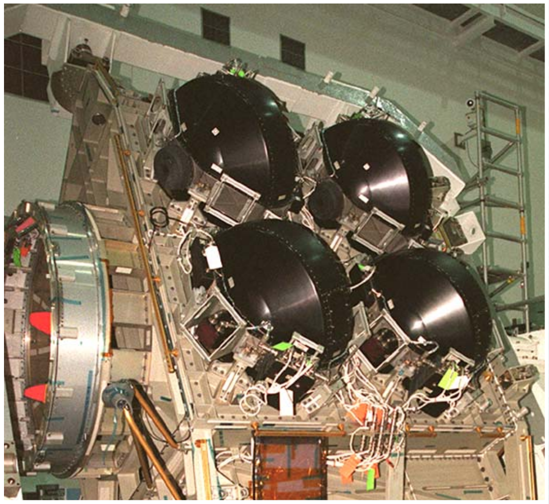
Russian “Pirs” Docking Compartment/Airlock

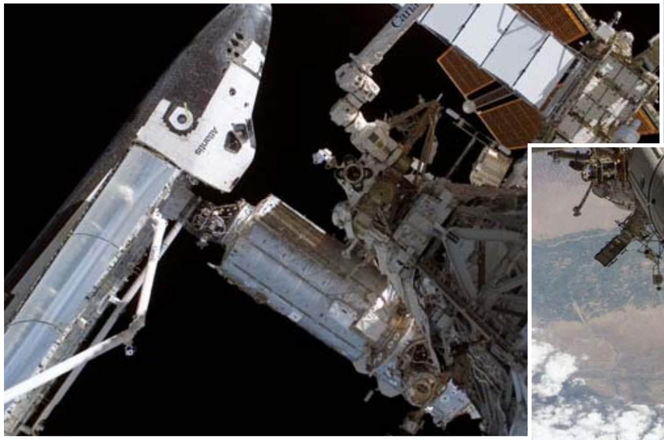
Guidance, Navigation, Control, and Propulsion

Electrical powered attitude control provided by U.S. Control Moment Gyros. Service Module jets can also be used.



CMGs





Progress

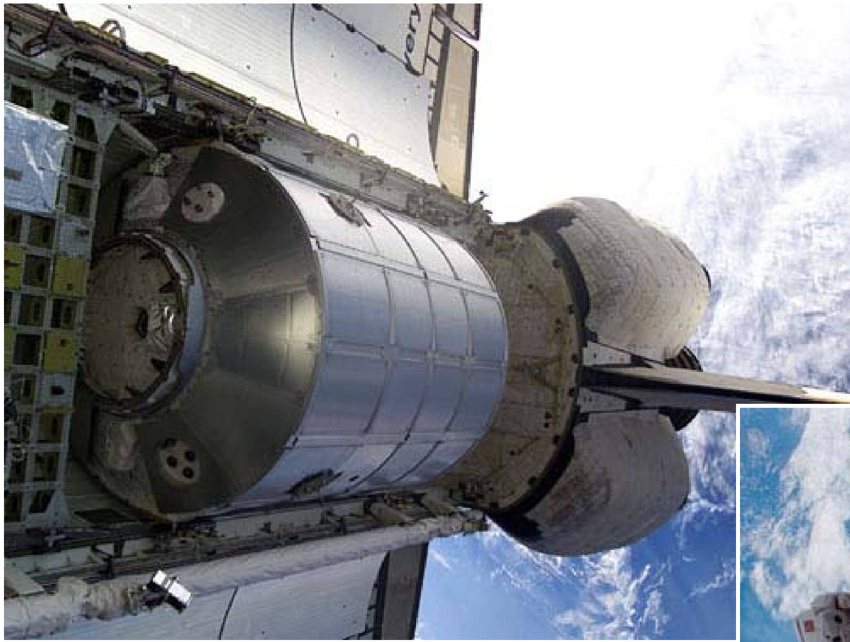
The Shuttle and the Progress boosts the Station when docked.

INTERNATIONAL SPACE STATION

Logistics and Re-supply Today

National Aeronautics and Space Administration

INTERNATIONAL SPACE STATION



A fleet of pressurized modules and un-pressurized logistic carriers, bring tons of equipment and supplies to the station.

Seventeen Expeditions on Orbit

Expedition 1 Crew
Krikalev, Gidzenko, Sheperd
Oct 2000 – Mar2001

Expedition 2 Crew
Helms, Usachev, Voss
Mar2001 – Aug 2001

Expedition 3 Crew
Dezhurov, Turin, Culbertson
Aug 2001 – Dec 2001

Expedition 4 Crew
Onufrienko, Walz, Bursch
Dec 2001 – Jun 2002

Expedition 5 Crew
Korzun, Whitson, Treschev
Jun 2002 – Nov 2002

Expedition 6 Crew
Bowersox, Pettit, Budarin
Nov 2002 – May 2003

Expedition 7 Crew
Malenchenko, Lu
Apr 2003 – Oct 2003

Expedition 8 Crew
Kaleri, Foale
Oct 2003 – Apr 200

Expedition 9 Crew
Fincke, Padalka
Apr 2004 – Oct 2004

Expedition 10 Crew
Chiao, Sharipov.
Oct 2004 – Apr 2005

Expedition 11 Crew
Phillips, Krikalev
Apr 2005– Oct 2005

Expedition 12 Crew
McArthur, Tokarev
Oct 2005– Apr 2006

Expedition 13 Crew
Vinogradov,, Williams
Apr 2006 – Jul 2006

Vinogradov, Williams, Reiter
Jul 2006 – Sep 2006

Expedition 14 Crew
Reiter, Lopez-Alegria, Tyurin
Oct 2006 – Dec 2006

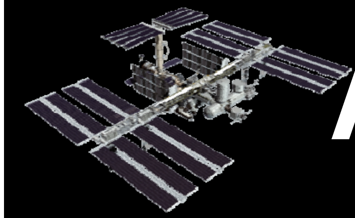
Williams, Lopez-Alegria, Tyurin
Dec 2006 – Apr 2007

Expedition 15 Crew
Williams, Yurchikhin, Kotov
Apr 2007 – Jun 2007

Anderson , Yurchikhin, Kotov
Jun 2007 – Oct 2007

Expedition 16 Crew
Eyharts, Reisman, Tani,
Malenchenko, Whitson, Shukor
Oct 2007 – Apr 2008

Expedition 17 Crew
Yi, Volkov, Kononenko,
Reisman, Chamitoff
Today



ISS Launch Vehicles

Shuttle

Proton

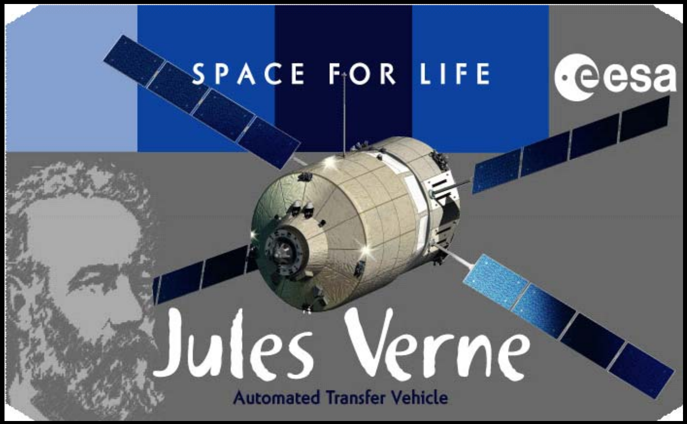
Soyuz

Ariane & ATV

HIIA & HTV

The Automated Transfer Vehicle

- ISS depends on regular deliveries of experimental equipment and spare parts as well as food, air and water for its permanent crew.
- From 2007 onward, Europe's Automated Transfer Vehicle (ATV) will be one of the indispensable ISS supply spaceships



- Every 12 months or so, the unmanned ATV will haul **7.5 tons** of cargo from its Kourou launch site in French Guiana to the Station
- Automatically dock with the Station's Russian service module
- The ATV will remain there as a pressurized and integral part of the Station for up to six months until its final mission: a fiery one-way trip into the Earth's atmosphere to dispose of up to ***6.5 tons of Station waste.***

The H-II Transfer Vehicle

- Japan’s transfer vehicle is called the H-II Transfer Vehicle (HTV)
- The HTV is an unmanned orbital carrier, designed to deliver up to **__six tons__** of goods to the ISS in orbit at an altitude of about 400 kilometers and return with spent equipment, used clothing, and other waste materials on the return trip
- These waste materials will be incinerated when HTV makes re-entry into the atmosphere.

The system uses Japan's H2 launch vehicle

- HTV has 2 types of logistics carrier: pressurized section where crewmembers can work when HTV is being berthed to the ISS; and unpressurized section that accommodates Kibo’s Exposed Facility payloads on an Exposed Pallet

NASA's Exploration Mission

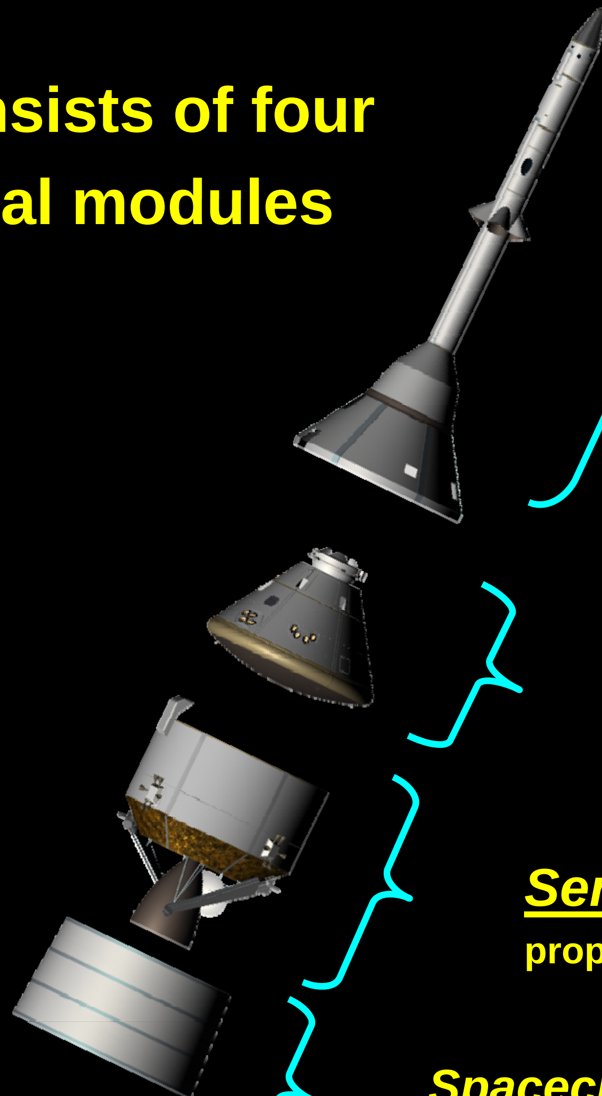
- Safely fly the Space Shuttle until 2010
- Complete the International Space Station
- **Develop and fly the Crew Exploration Vehicle no later than 2015**
- **Return to the moon no later than 2020**
- **Conduct human expeditions to Mars**
- Implement a sustained and affordable human and robotic program
- Extend human presence across the solar system and beyond

Crew Launch Vehicle

- **Serves as the long term crew launch capability for the U.S.**
- **5 Segment Shuttle Solid Rocket Booster**
- **Upper Stage**
  - updated version of the J-2 engine that was used on NASA's Saturn 5 rocket
- **Payload capability**
  - 55,115 lbs (25 metric tons) to low Earth orbit
  - Growth to 70,547 lbs (32 metric tons) with a 5th solid segment

Orion System Elements

Orion consists of four functional modules



***Launch Abort System* --**
emergency escape during launch

***Crew Module* –**
crew and cargo transport

***Service Module* –**
propulsion, electrical power, fluids storage

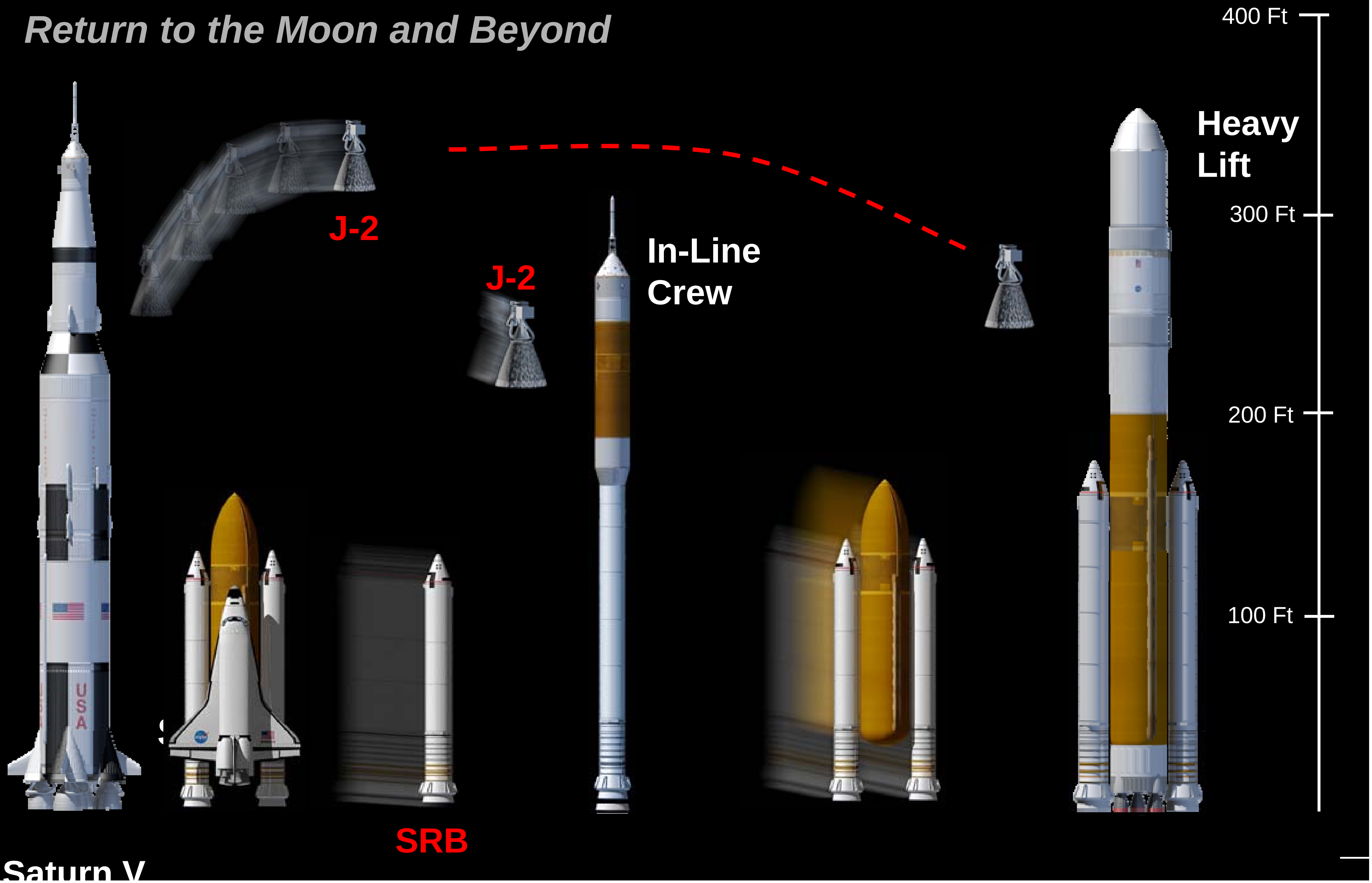
***Spacecraft Adapter* –**
structural transition to launch vehicle

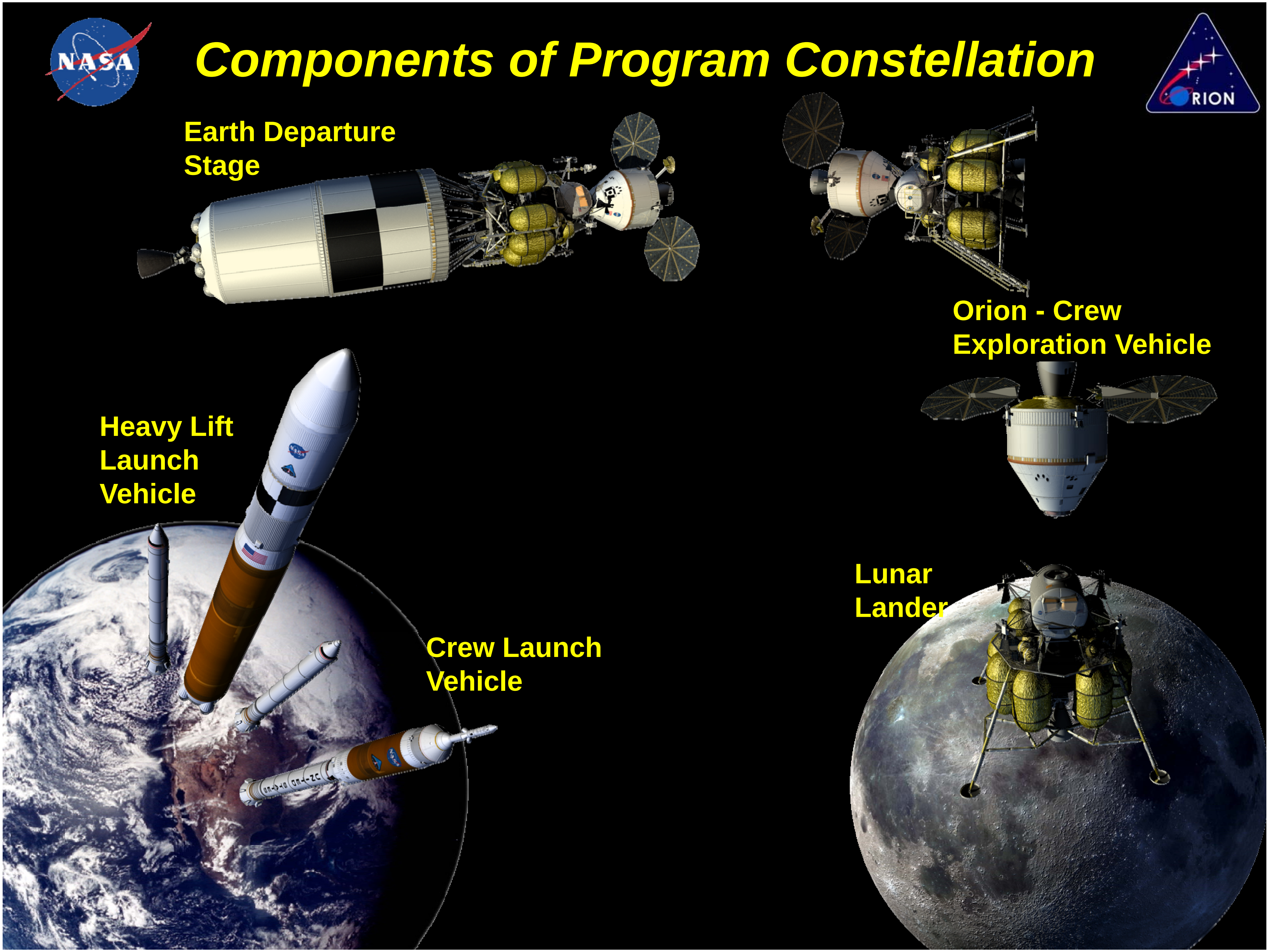
Lunar Heavy Cargo Launch Vehicle

- **5 Segment Shuttle Solid Rocket Boosters**
- **Liquid Oxygen / liquid hydrogen core stage**
  - Heritage from the Shuttle External Tank
  - 5 RS-68 Main Engines
- **Payload Capability**
  - 233,687 lbs (106 Metric tons) to low Earth orbit
  - 275,575 lbs (125 Metric tons) to low Earth orbit using earth departure stage
  - 121,253 lbs (55 metric tons) trans lunar injection capability using earth departure stage
- **Cargo with later evolution to crew if needed**

Heritage Derived Launch Vehicles

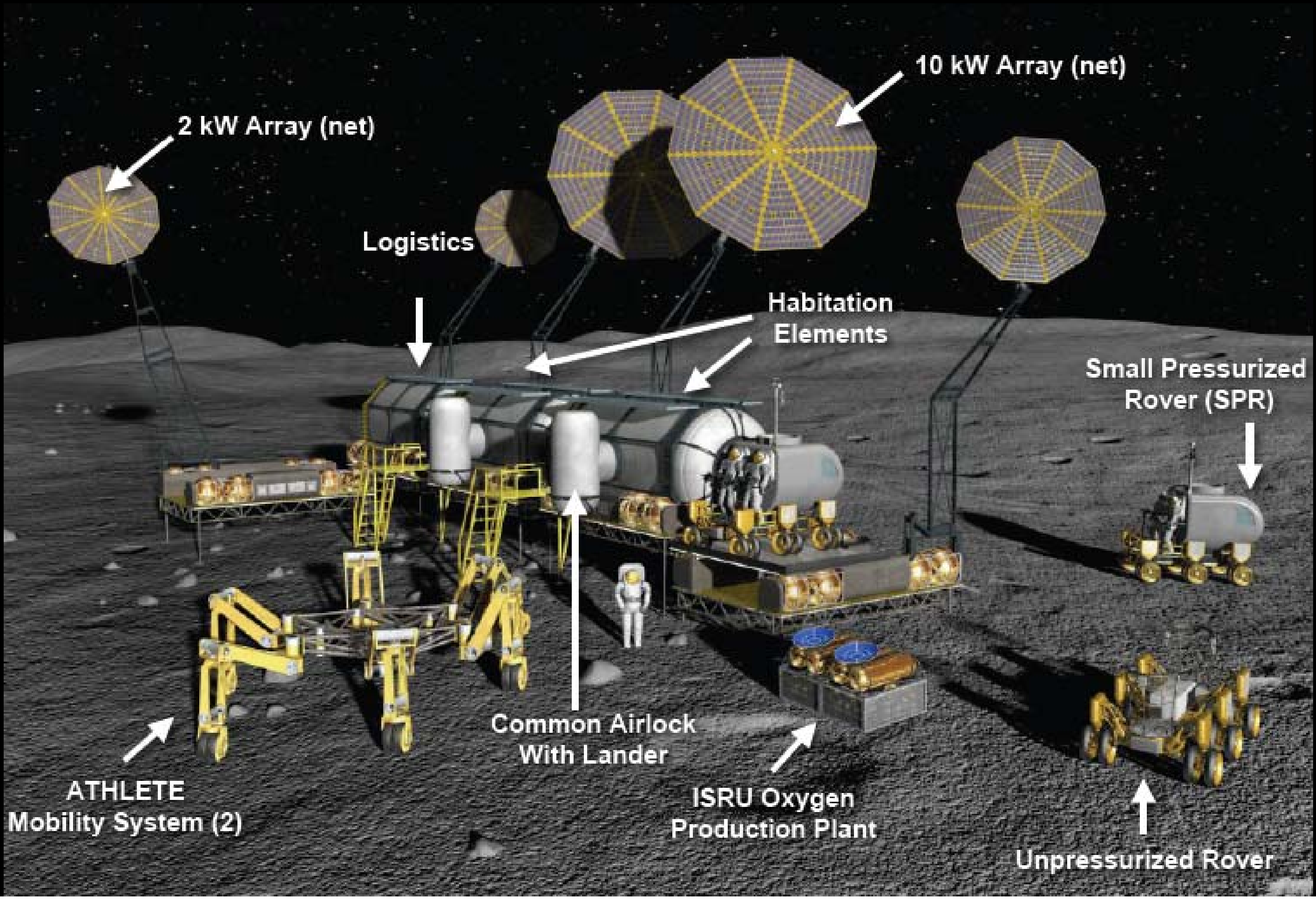
Return to the Moon and Beyond

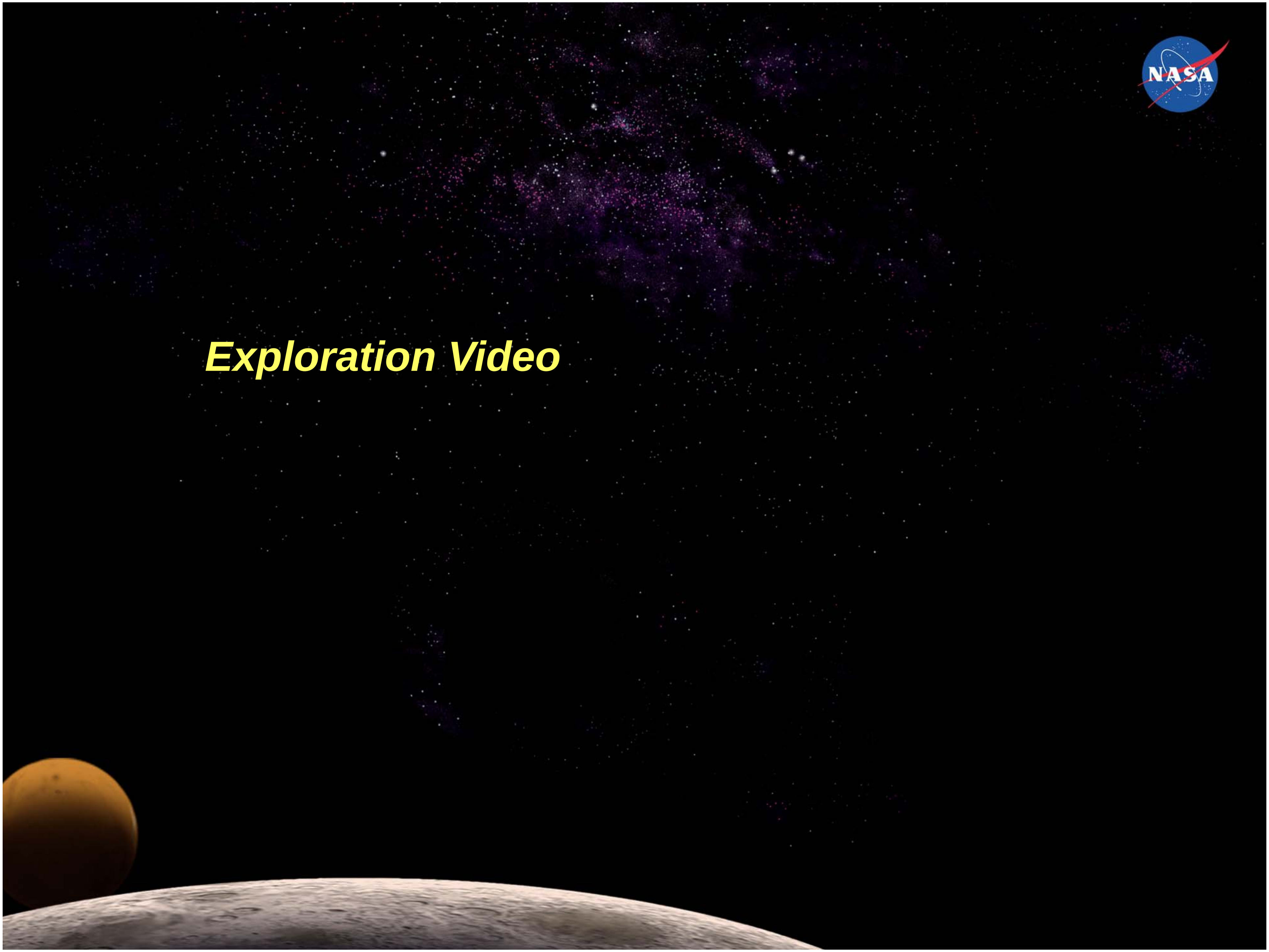




Components of Program Constellation
Earth Departure Stage
Orion - Crew Exploration Vehicle
Heavy Lift Launch Vehicle
Crew Launch Vehicle
Lunar Lander
ORION
NASA

Conceptual Lunar Outpost Surface Systems




Exploration Video

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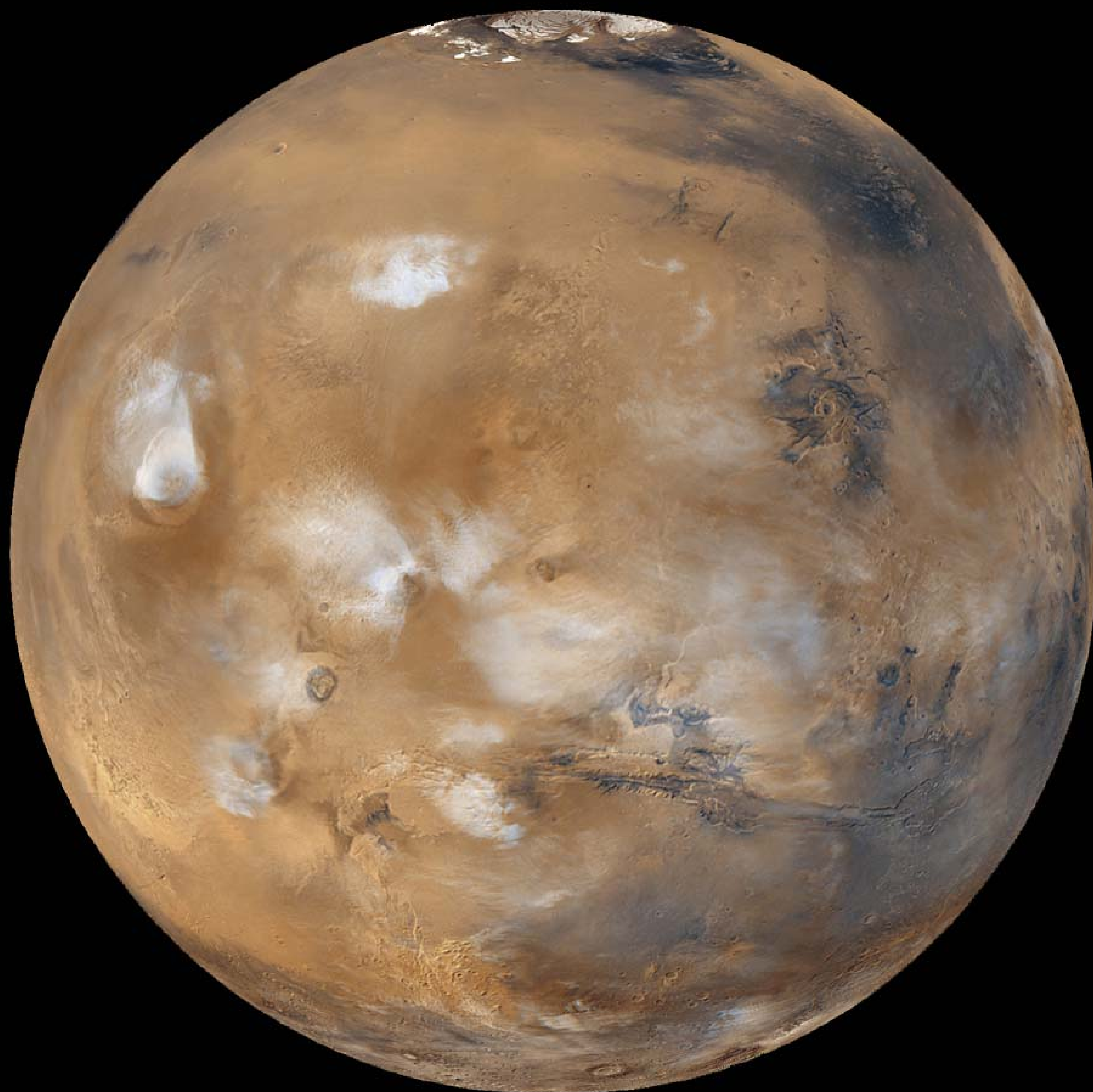
- Complete the International Space Station
- Develop and fly the Crew Exploration Vehicle no later than 2012
- Return to the moon no later than 2020
- Conduct human expeditions to Mars
- **Implement a sustained and affordable human and robotic program**
- Extend human presence across the solar system and beyond



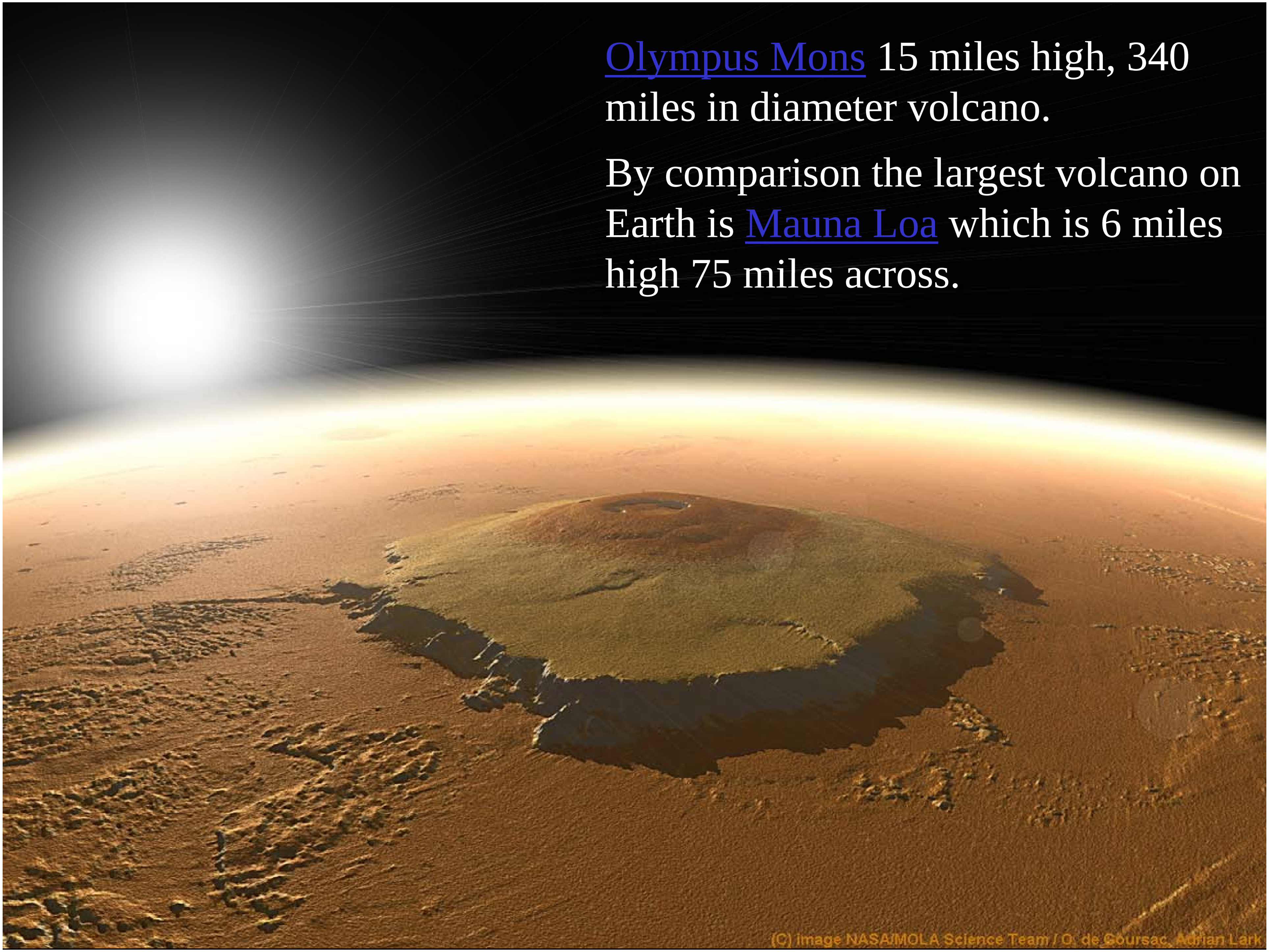
Exploring
Mars

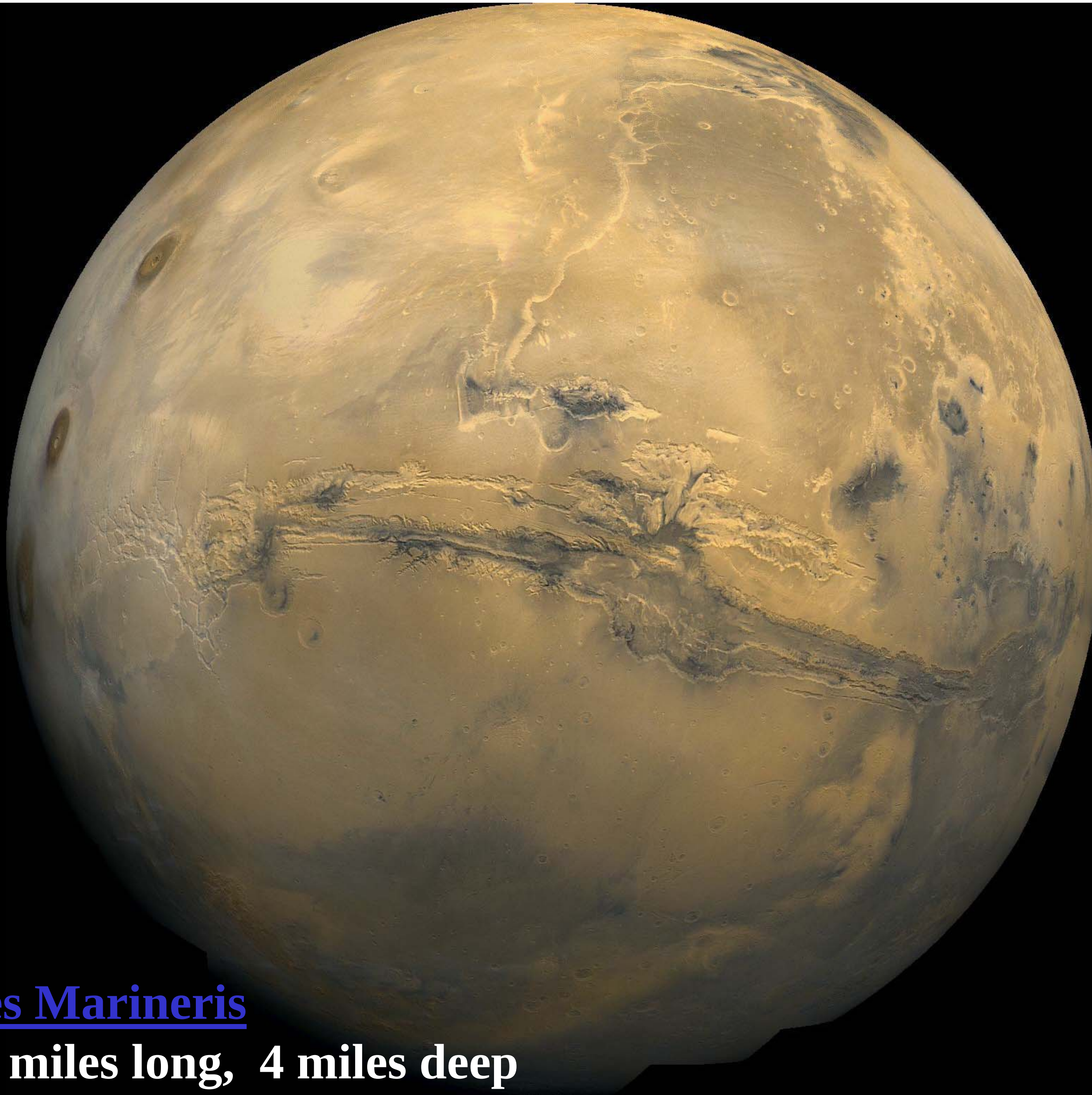
Mars Fact Sheet

- Average Distance from Sun 142 million miles
- Mass 0.107 Earth's mass
- Diameter 4,222 miles (Earth =7,926 m)
- Length of Day 24.6 Earth hours
- Length of Year 687 Earth days
- Surface Gravity 0.377 that of Earth (If you weigh 80 pounds, you would weigh about 30 pounds on Mars.)
- Known Moons 2 Phobos & Deimos
  Escape Velocity 11,229 mph (Earth is 25,022 mph)
- Temperatures on Mars average about -67 degrees F. However, temperature's range from around -207 degrees F. in the wintertime at the poles, to +80 degrees F. over the lower latitudes in the summer. (Earth -129 to +136 F)

Olympus Mons 15 miles high, 340 miles in diameter volcano.

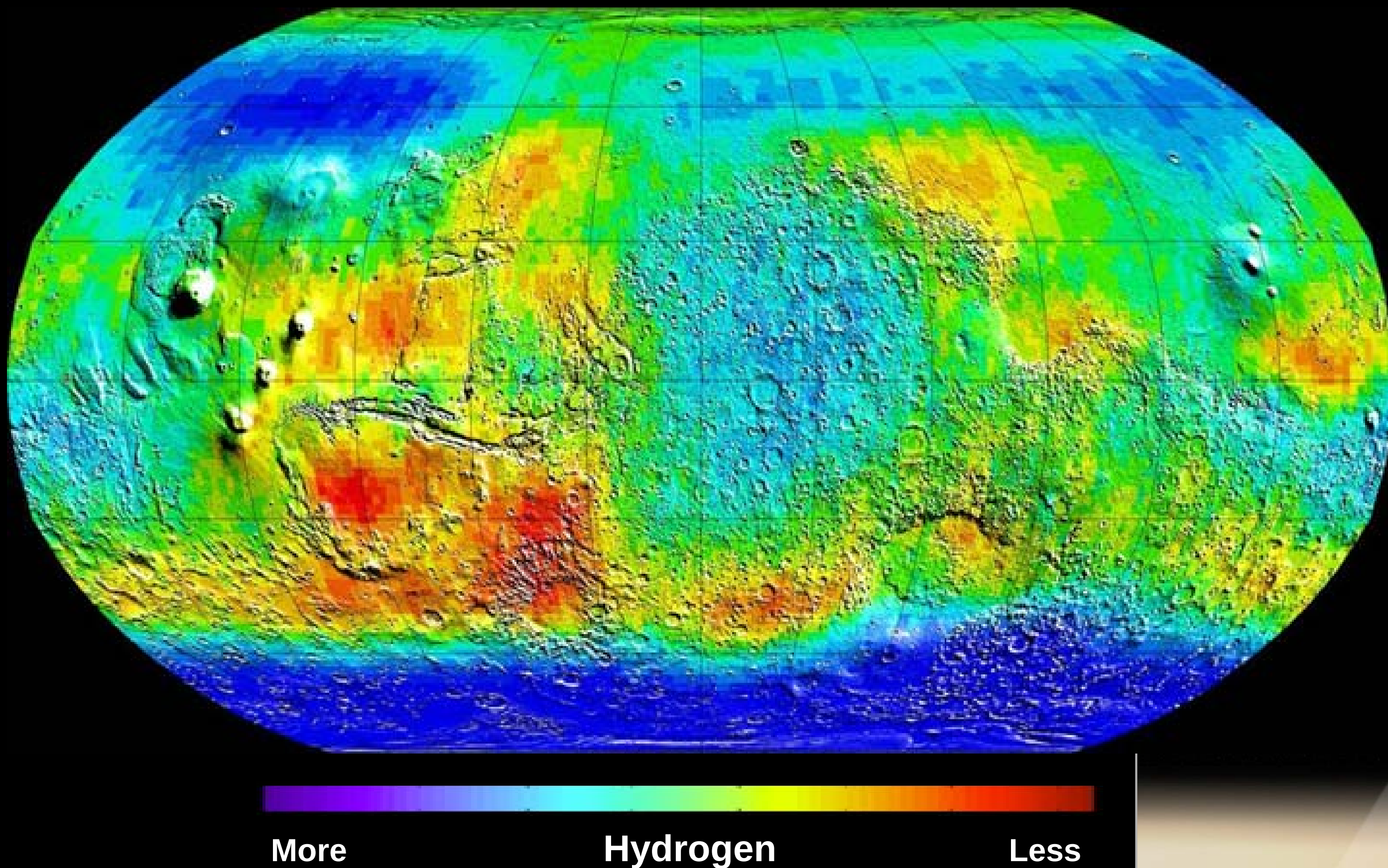
By comparison the largest volcano on Earth is Mauna Loa which is 6 miles high 75 miles across.

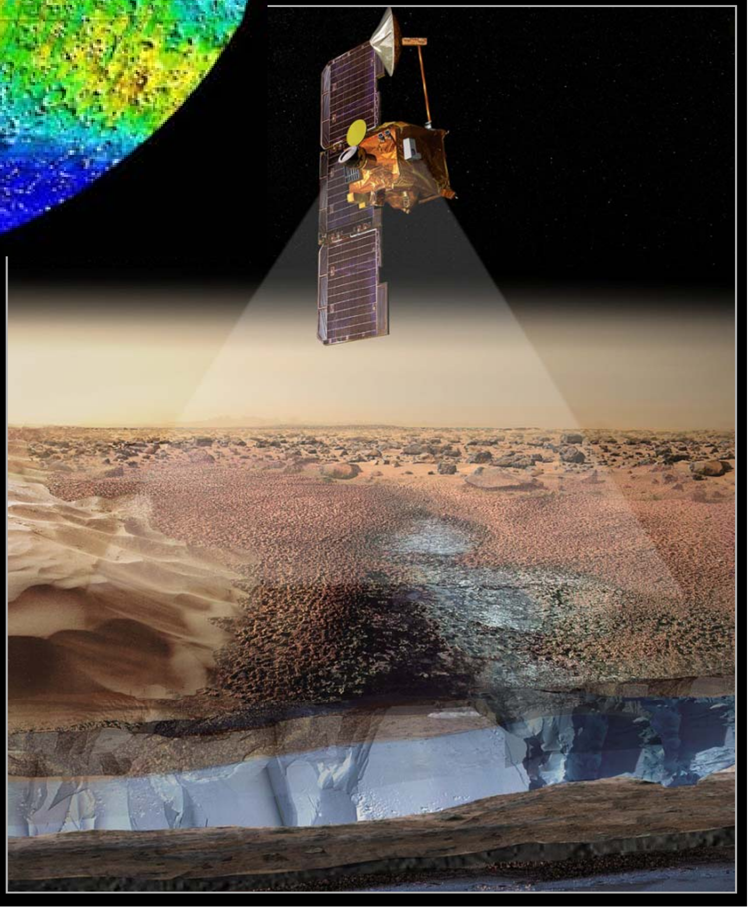




Valles Marineris

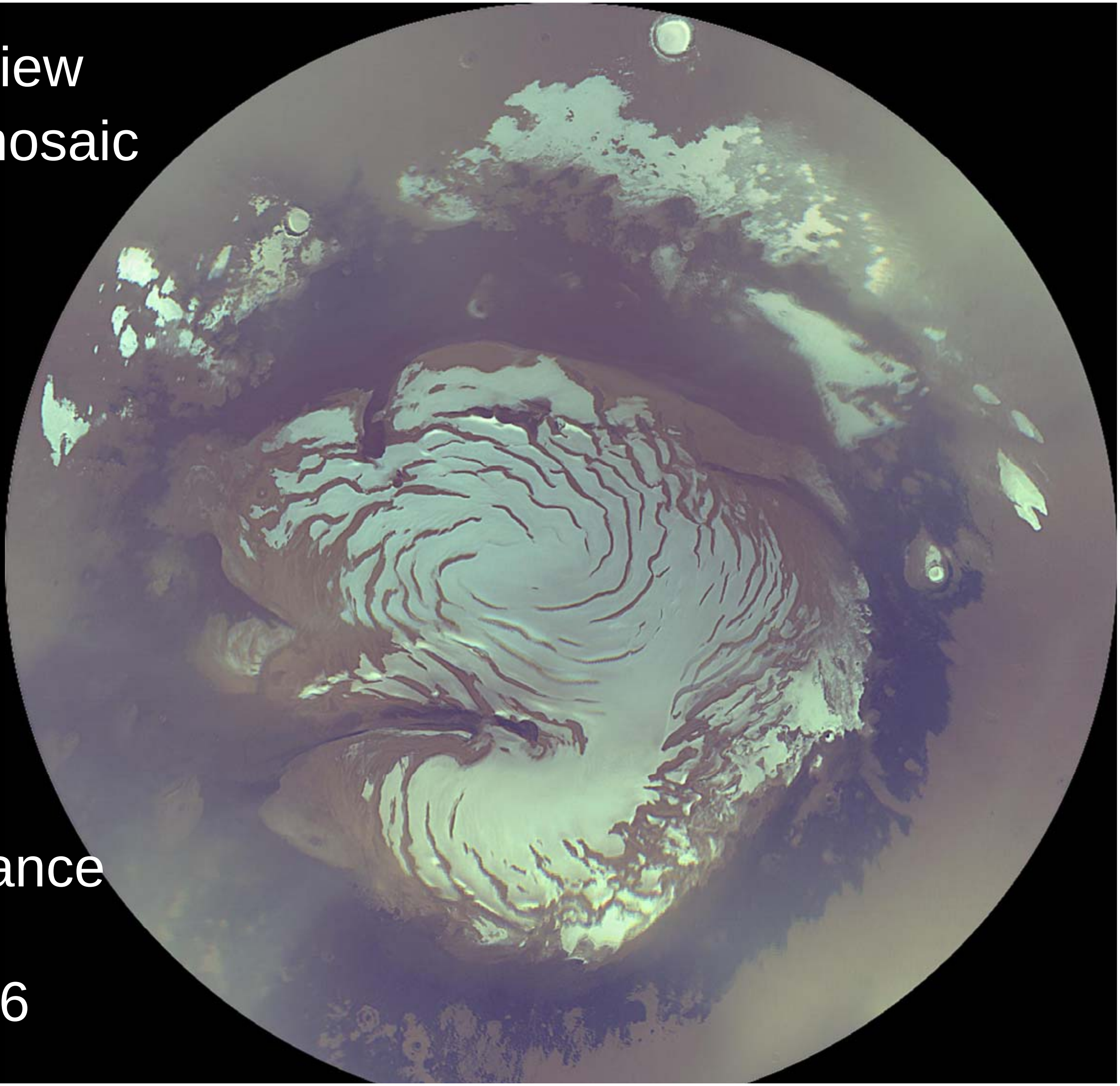
2500 miles long, 4 miles deep





2001 Mars Odyssey has revealed abundant water ice in the upper few feet at high latitudes

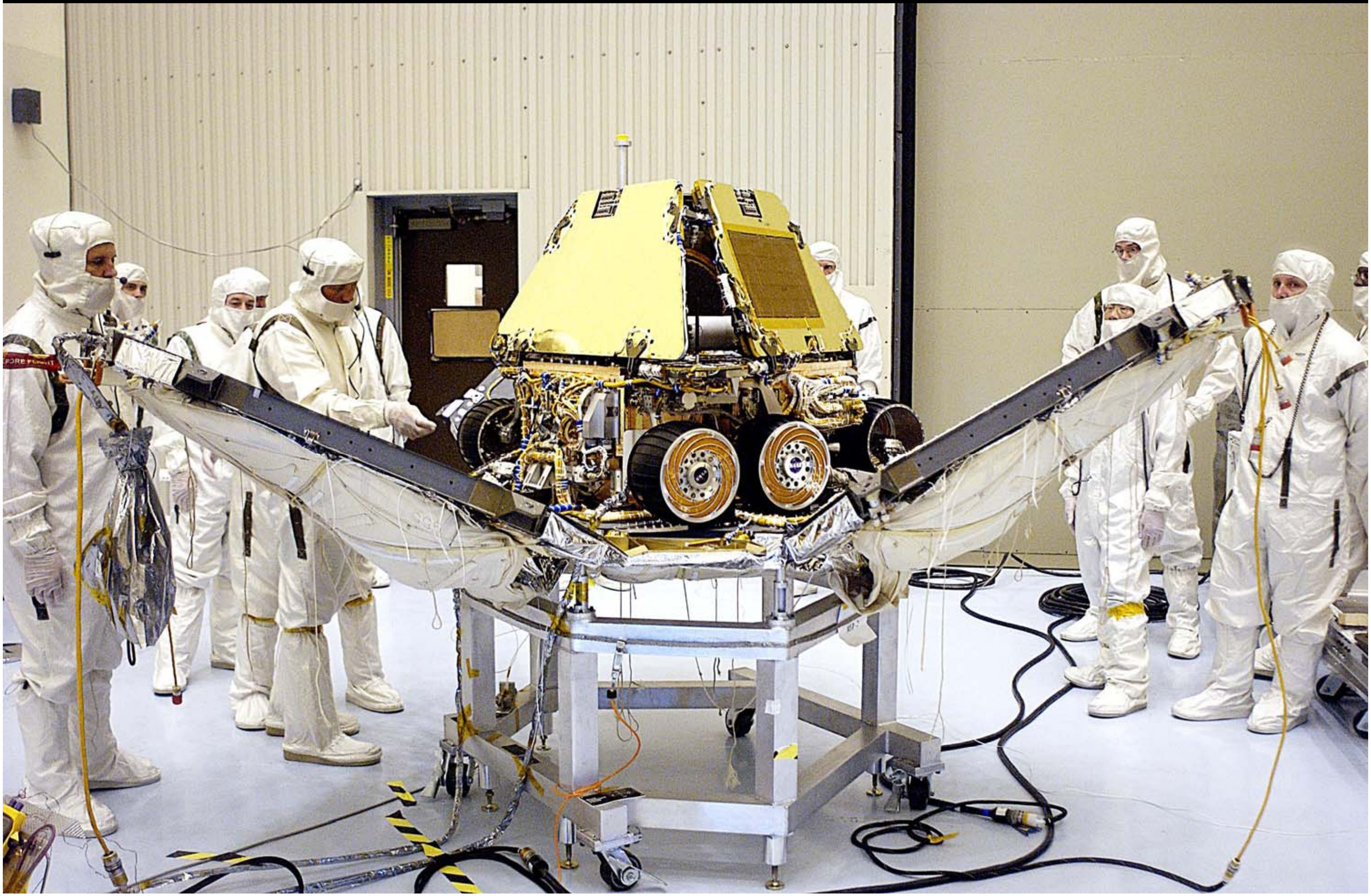
Mars polar view
composite mosaic

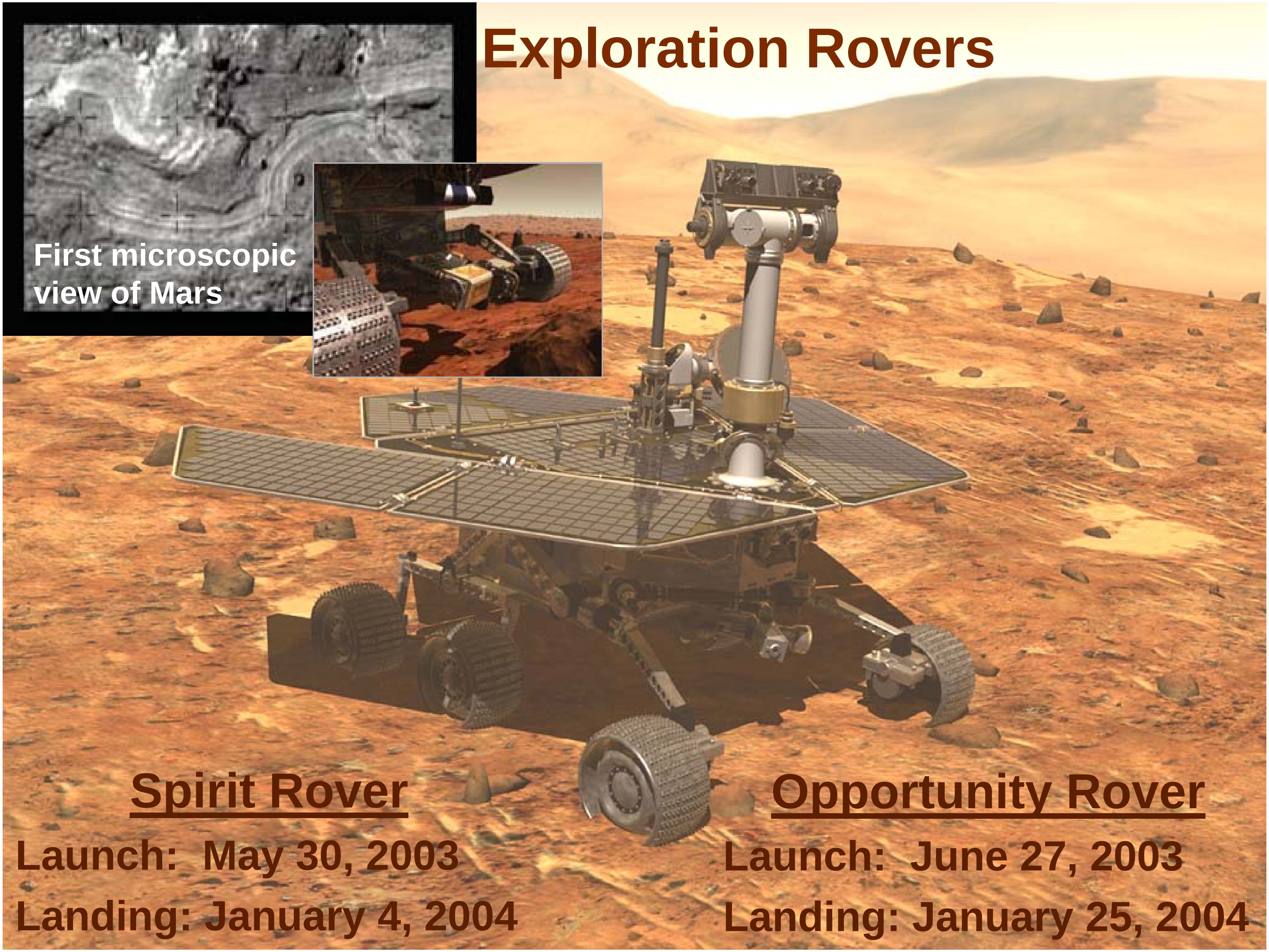


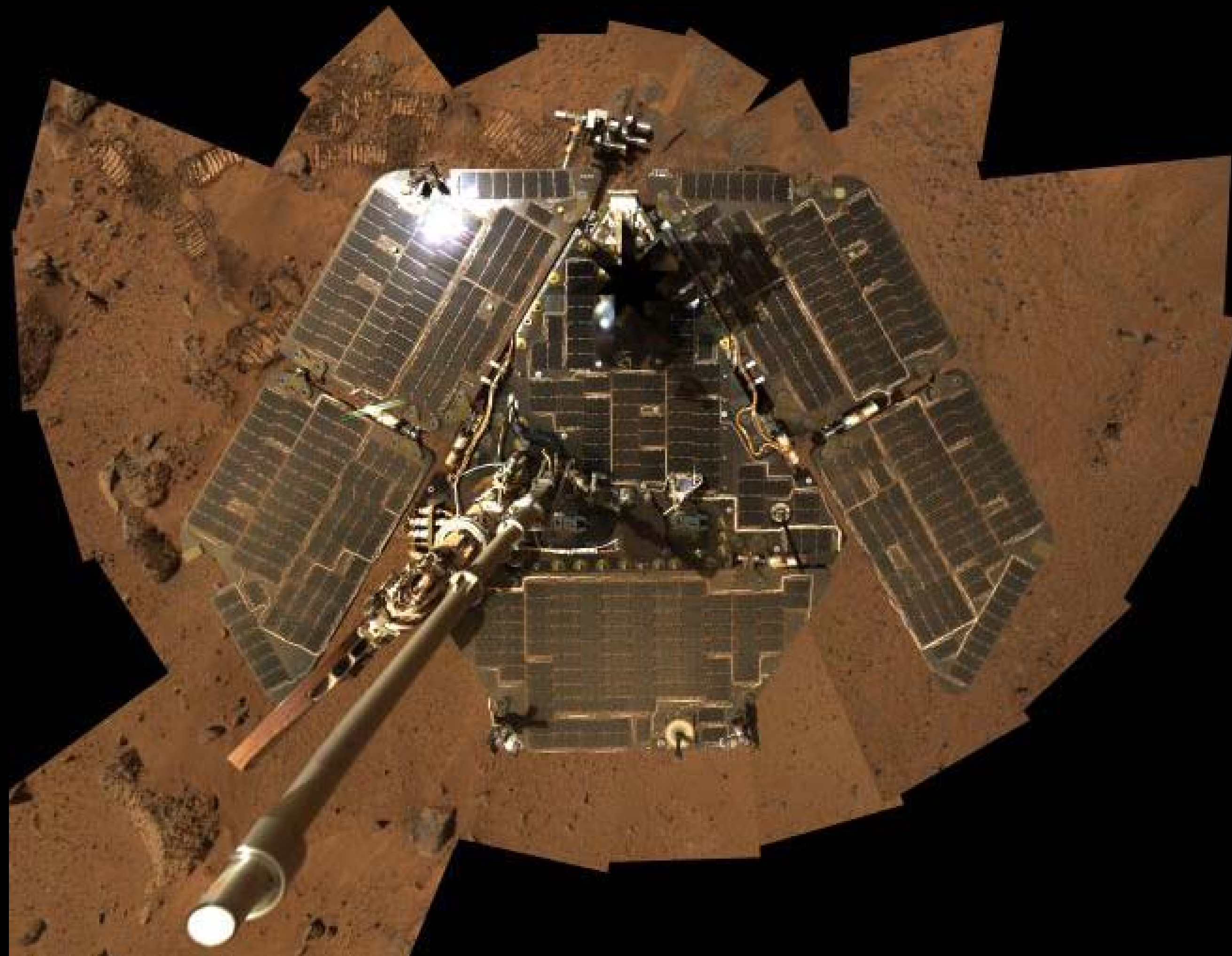
Mars
Reconnaissance
Orbiter
October 2006

Mars Exploration Rover at KSC

April 2003

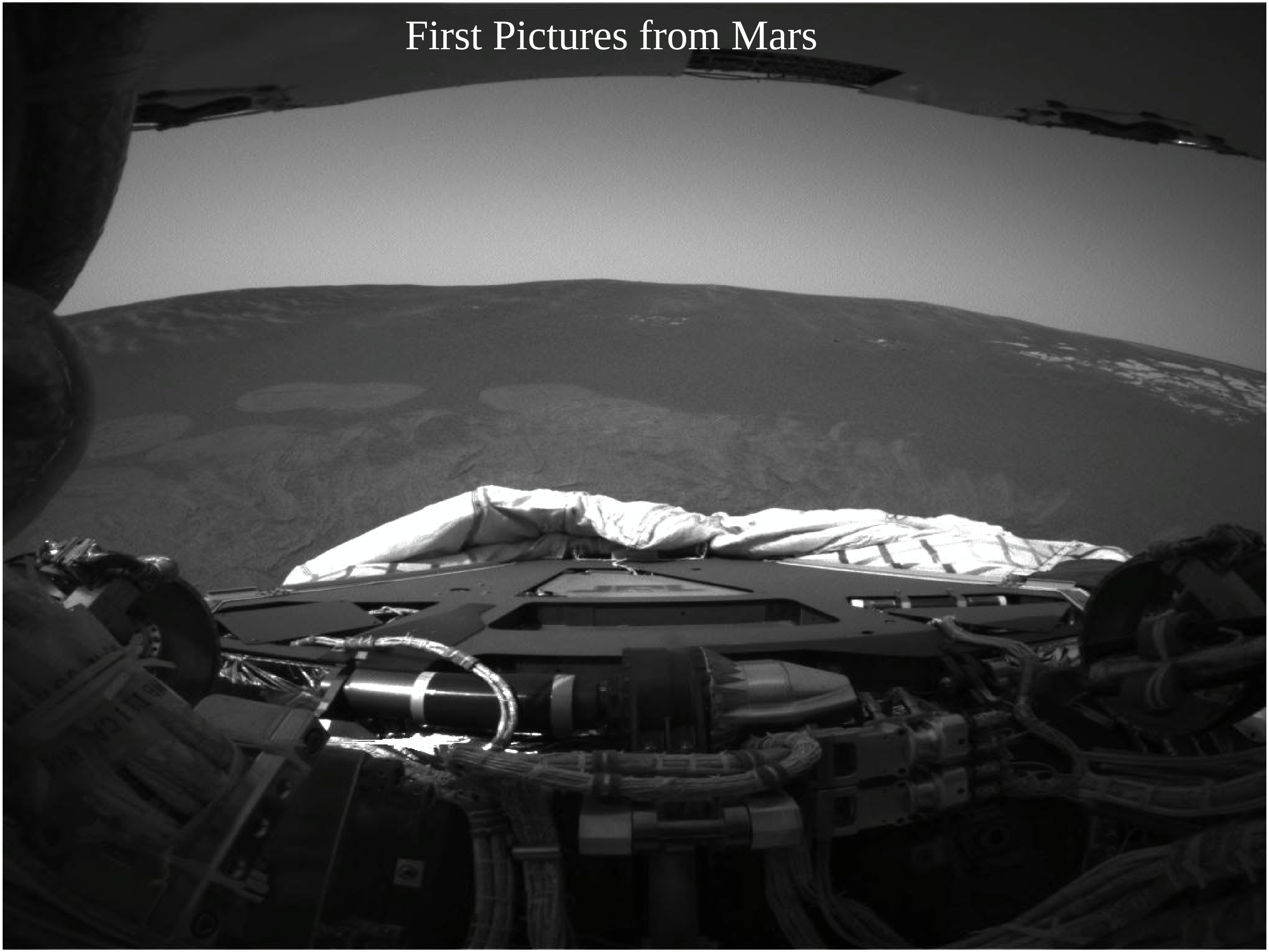



Exploration Rovers
First microscopic view of Mars
Spirit Rover
Launch: May 30, 2003
Landing: January 4, 2004
Opportunity Rover
Launch: June 27, 2003
Landing: January 25, 2004



Self-portrait of NASA's Mars Exploration Rover Spirit
August 2005

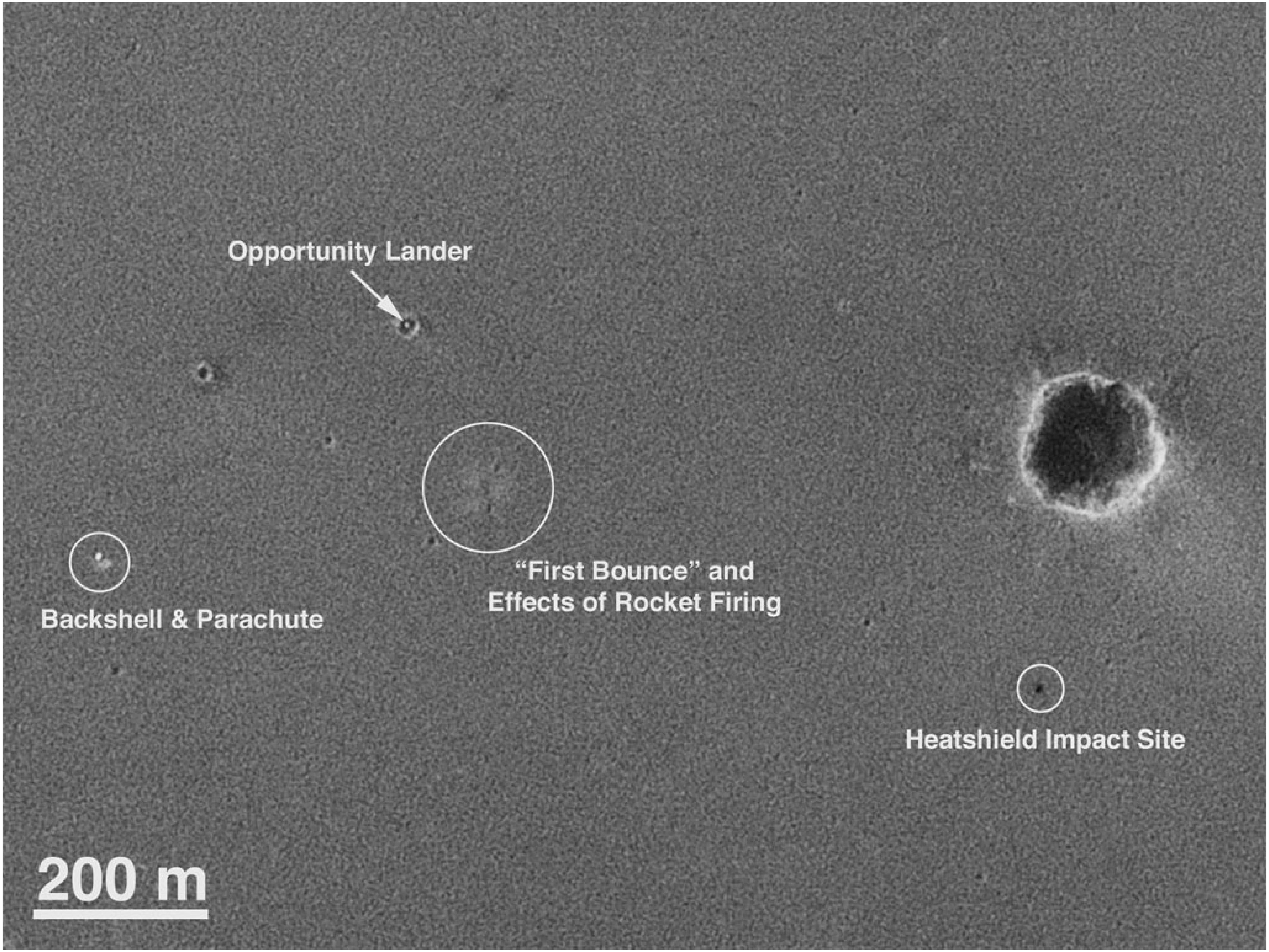
First Pictures from Mars



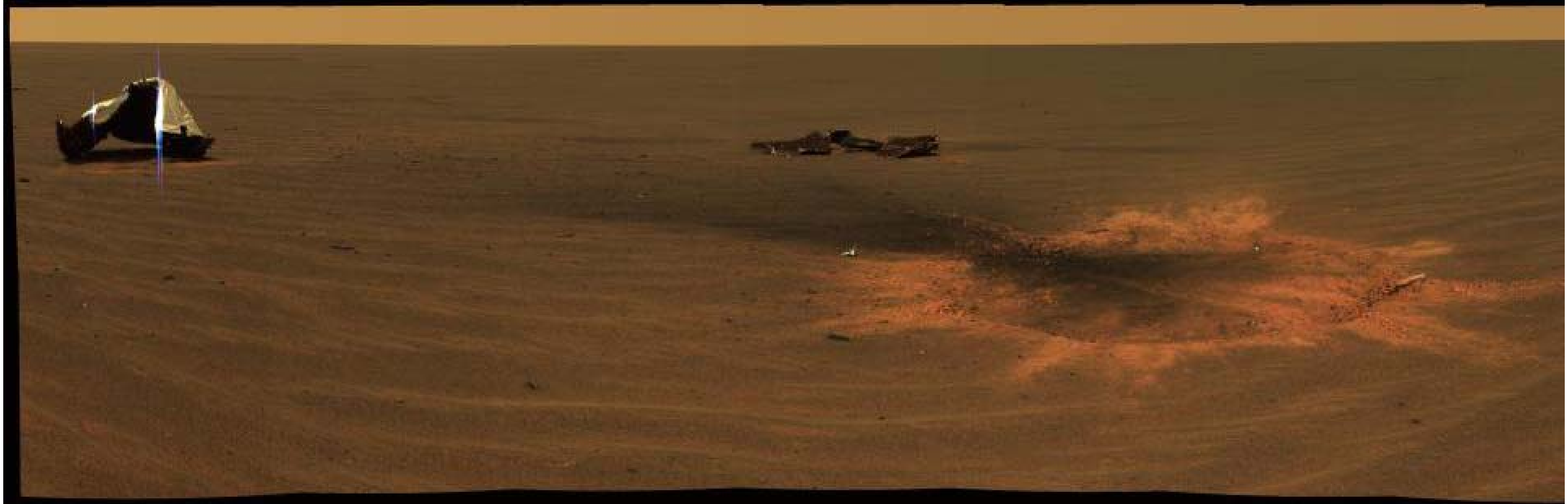
Searching for Life on Mars: *The Challenge*

Dust Devils in Gusev Crater

Dust Devils in Gusev Crater



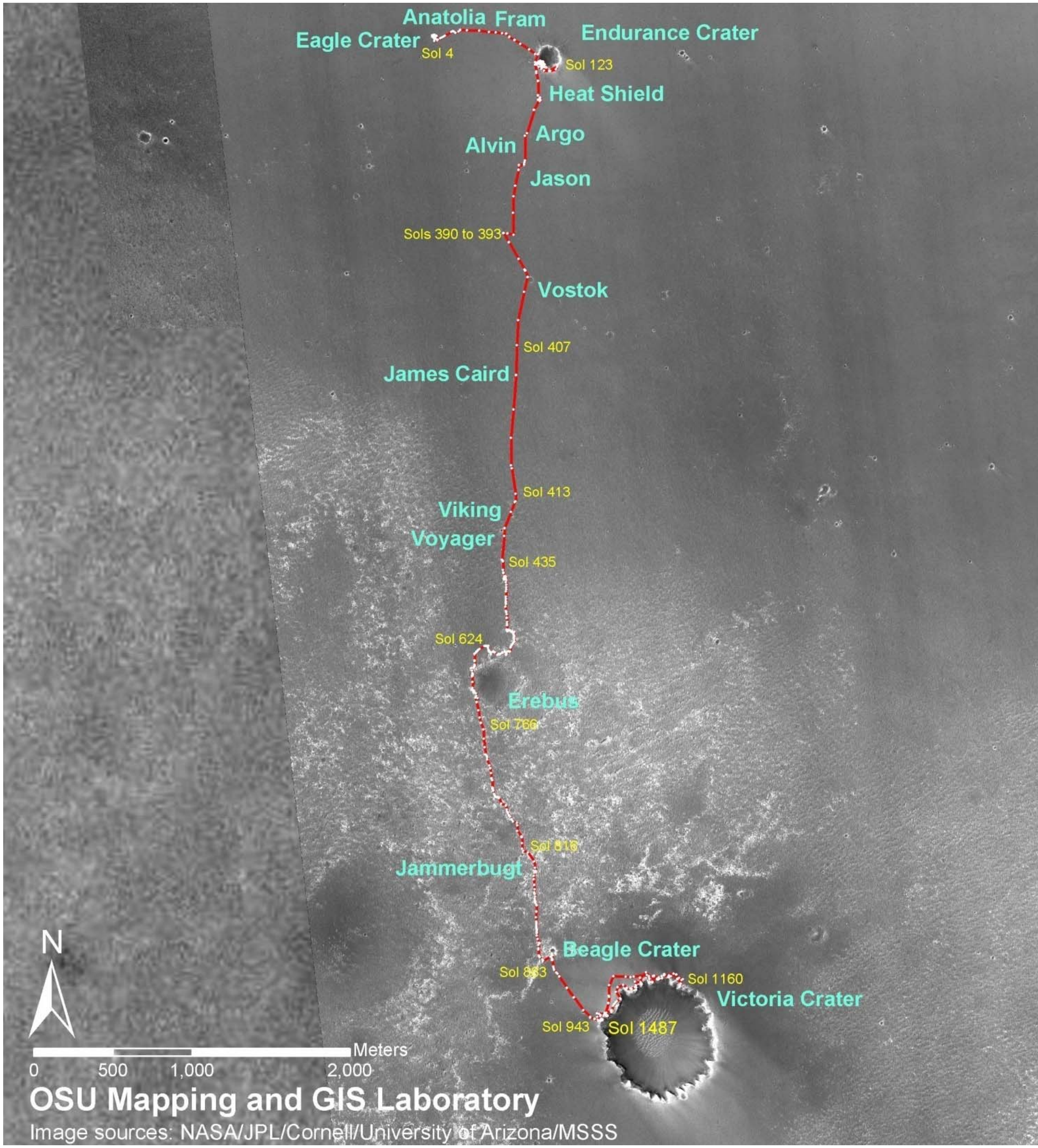
Opportunity Lander
"First Bounce" and
Effects of Rocket Firing
Backshell & Parachute
Heatshield Impact Site
200 m



Heat shield impact site of NASA's Mars Exploration Rover Opportunity.

Mosaic was acquired on Opportunity's sol 330 (Dec. 28, 2004)

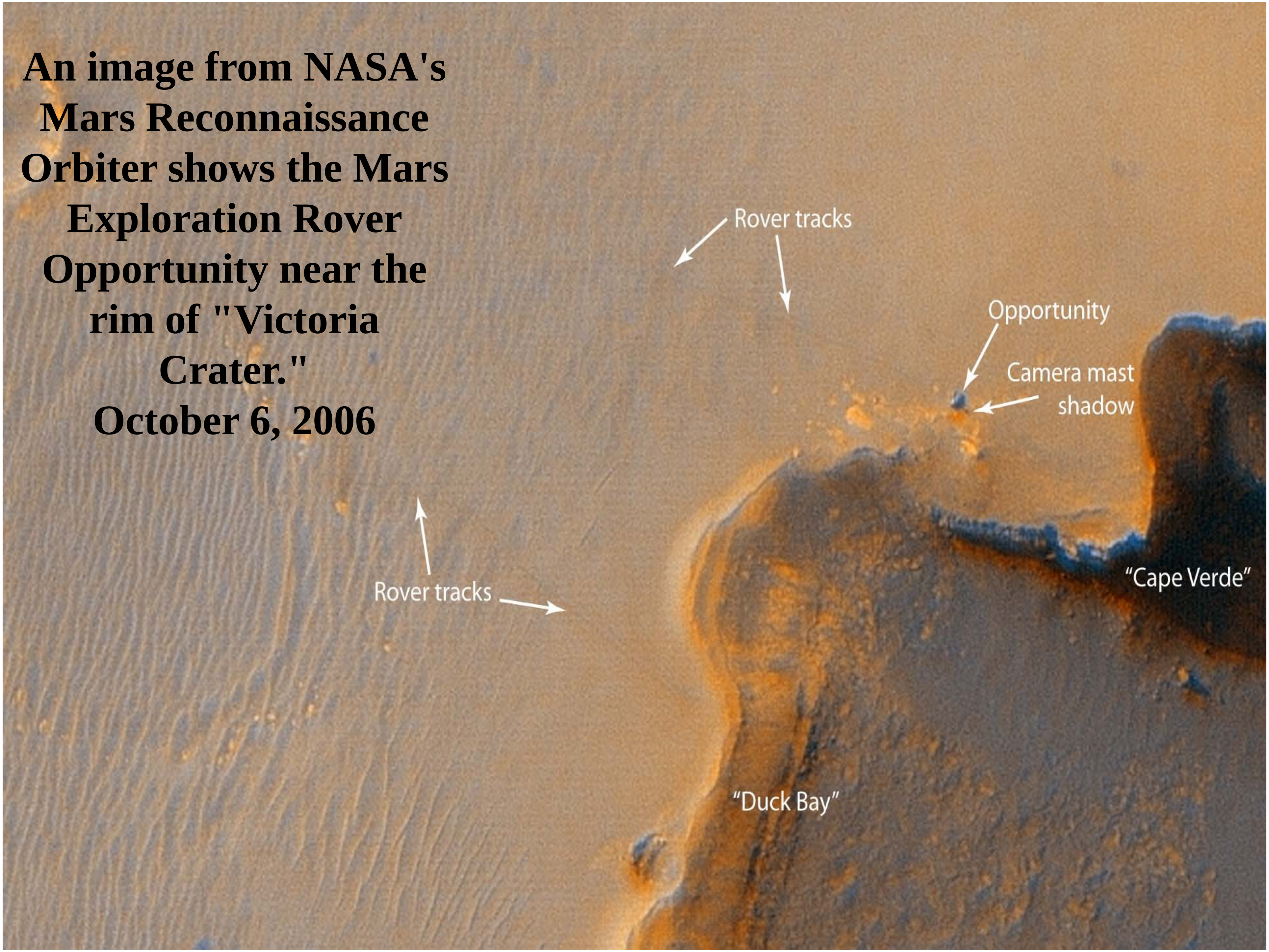
On the left, the main heat shield piece is inverted and reveals its metallic insulation layer, glinting in the sunlight. The main piece stands about 1 meter tall (about 3.3 feet) and about 13 meters (about 43 feet) from the rover.

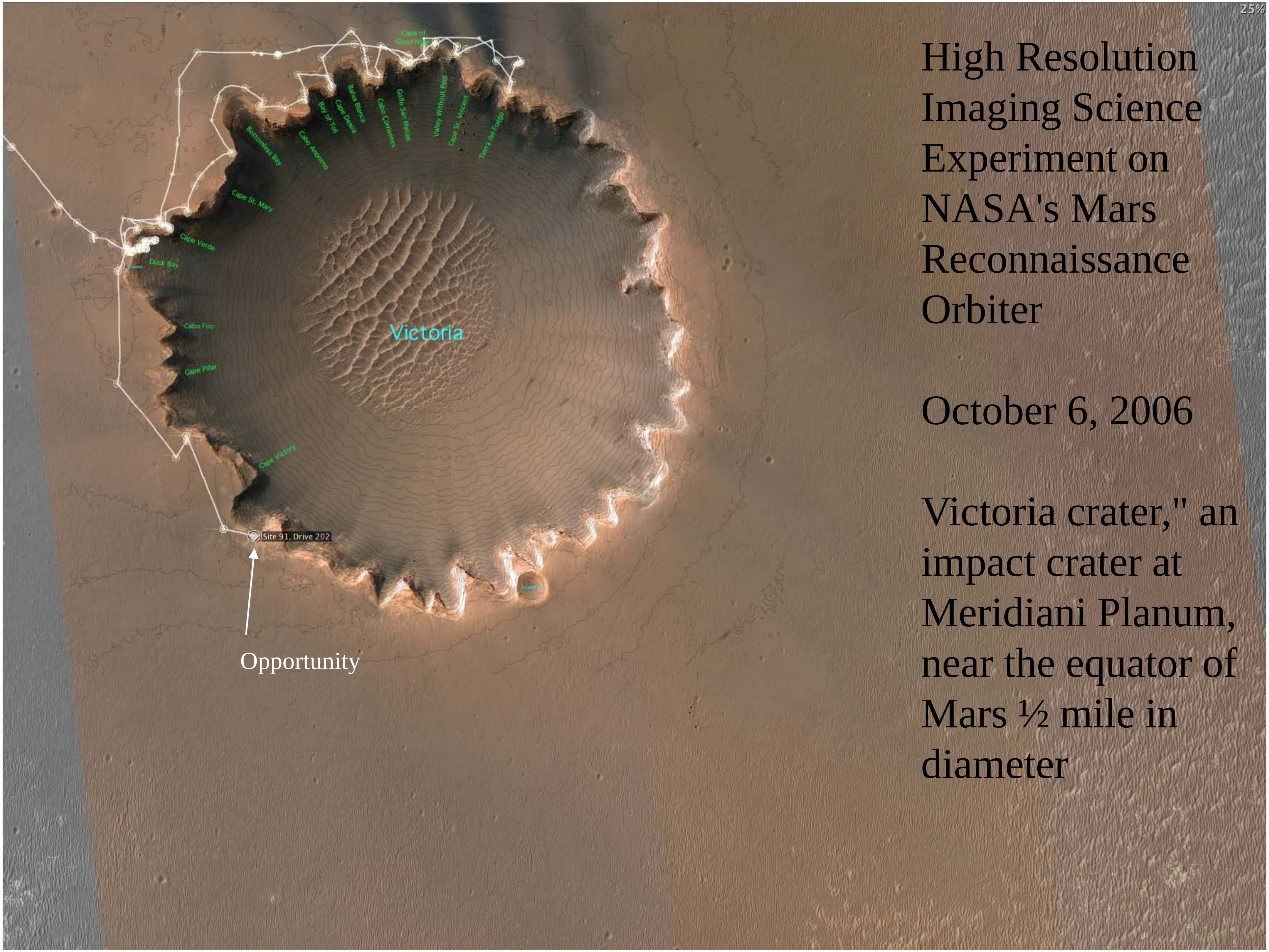


Opportunity's traverse map through Sol 1487

As of March 30 2008, Opportunity has driven more than 11.4 kilometers (7.25 miles) since leaving Endurance and exploring Victoria Crater.

An image from NASA's Mars Reconnaissance Orbiter shows the Mars Exploration Rover Opportunity near the rim of "Victoria Crater." October 6, 2006

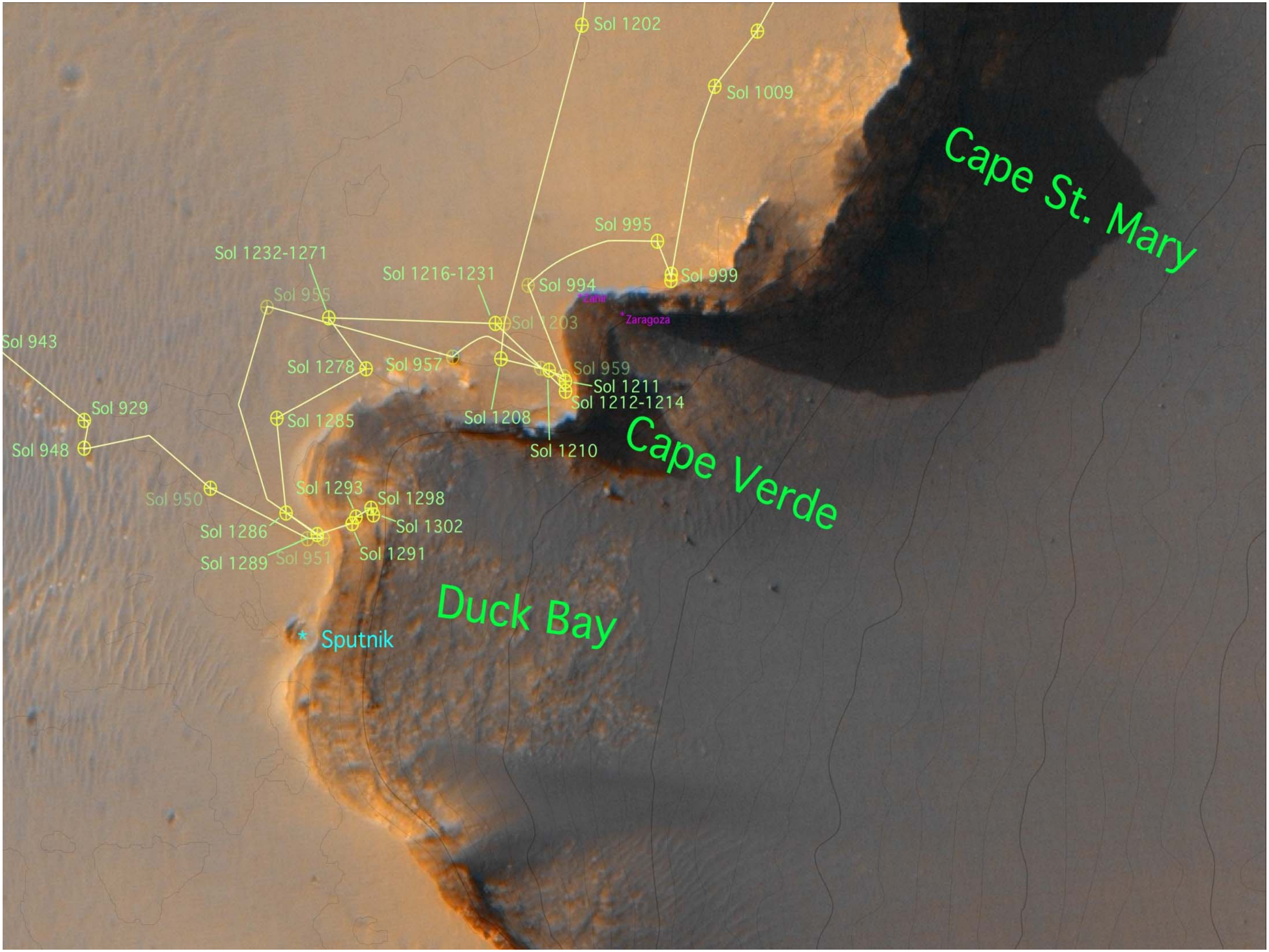




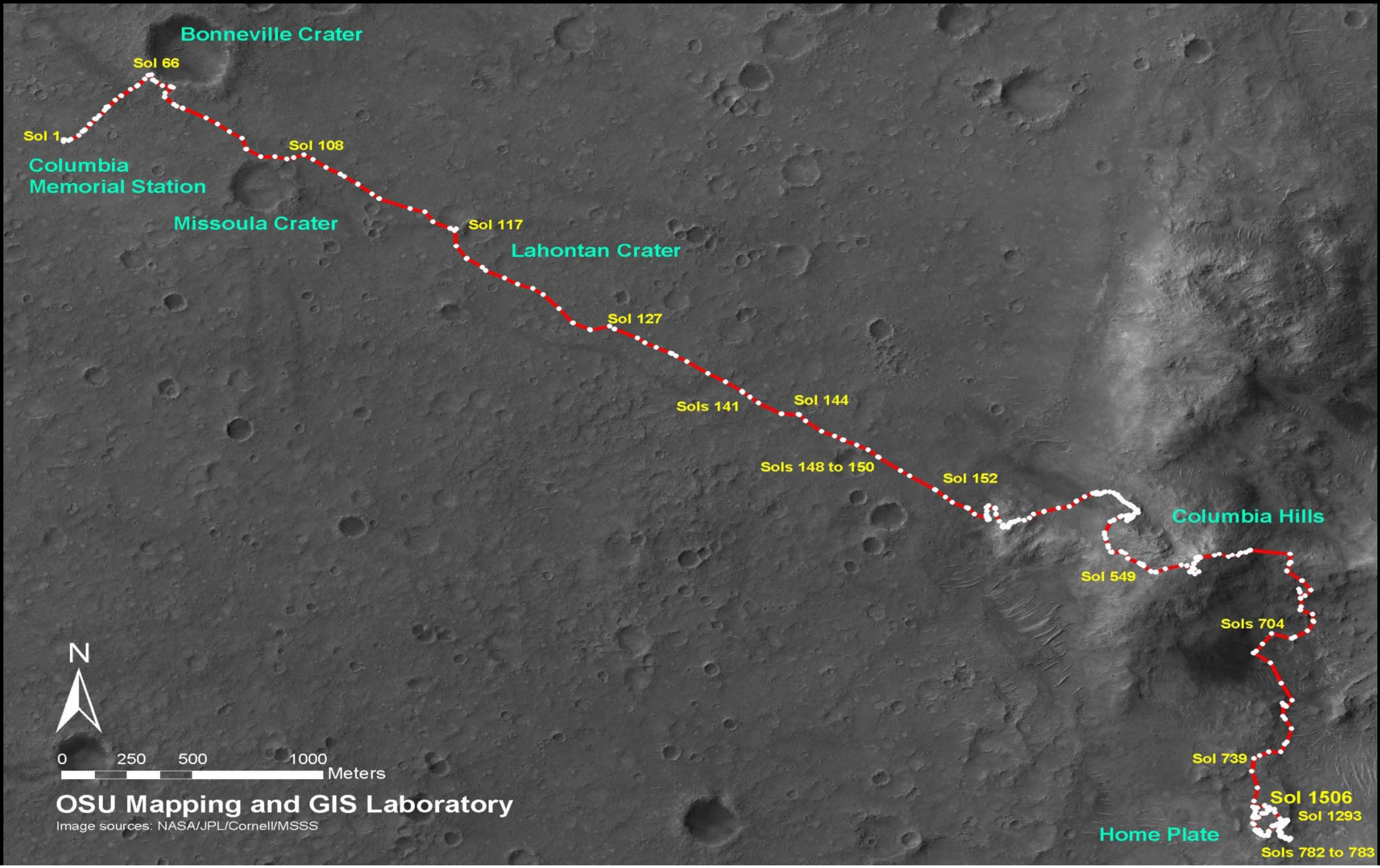
High Resolution Imaging Science Experiment on NASA's Mars Reconnaissance Orbiter

October 6, 2006

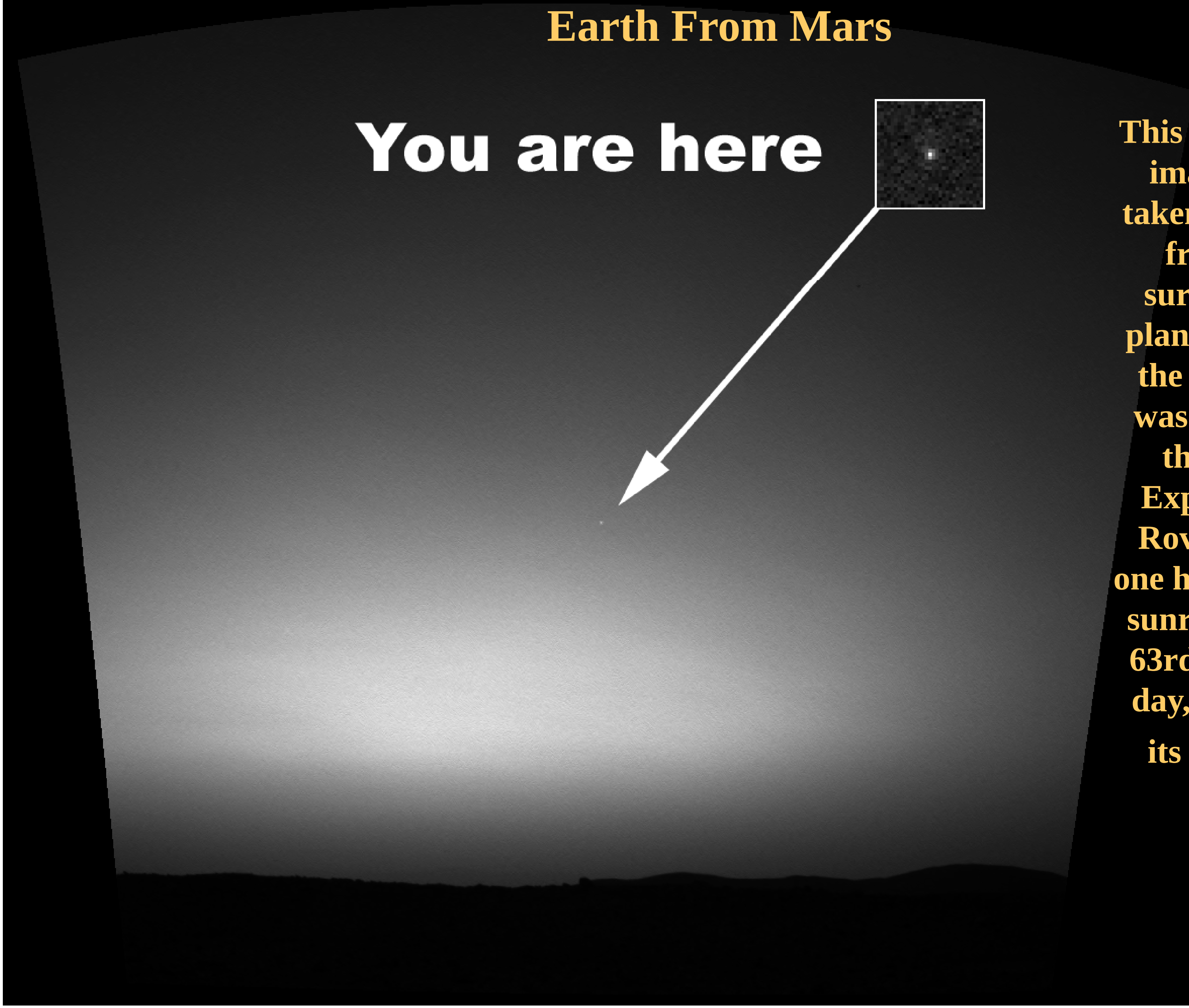
Victoria crater," an impact crater at Meridiani Planum, near the equator of Mars ½ mile in diameter


Sol 1202
Sol 1009
Cape St. Mary
Sol 995
Sol 1232-1271
Sol 1216-1231
Sol 994
Sol 999
Sol 955
*Zahir
*Zaragoza
Sol 1203
Sol 943
Sol 1278
Sol 957
Sol 959
Sol 1211
Sol 1212-1214
Sol 929
Sol 1285
Sol 1208
Sol 948
Sol 1210
Cape Verde
Sol 1293
Sol 1298
Sol 950
Sol 1302
Sol 1286
Sol 1291
Sol 1289
Sol 951
Duck Bay
* Sputnik

Spirit's traverse map through Sol 1506
As of sol 1506 (March 28, 2008), Spirit's total odometry was about4.7 miles



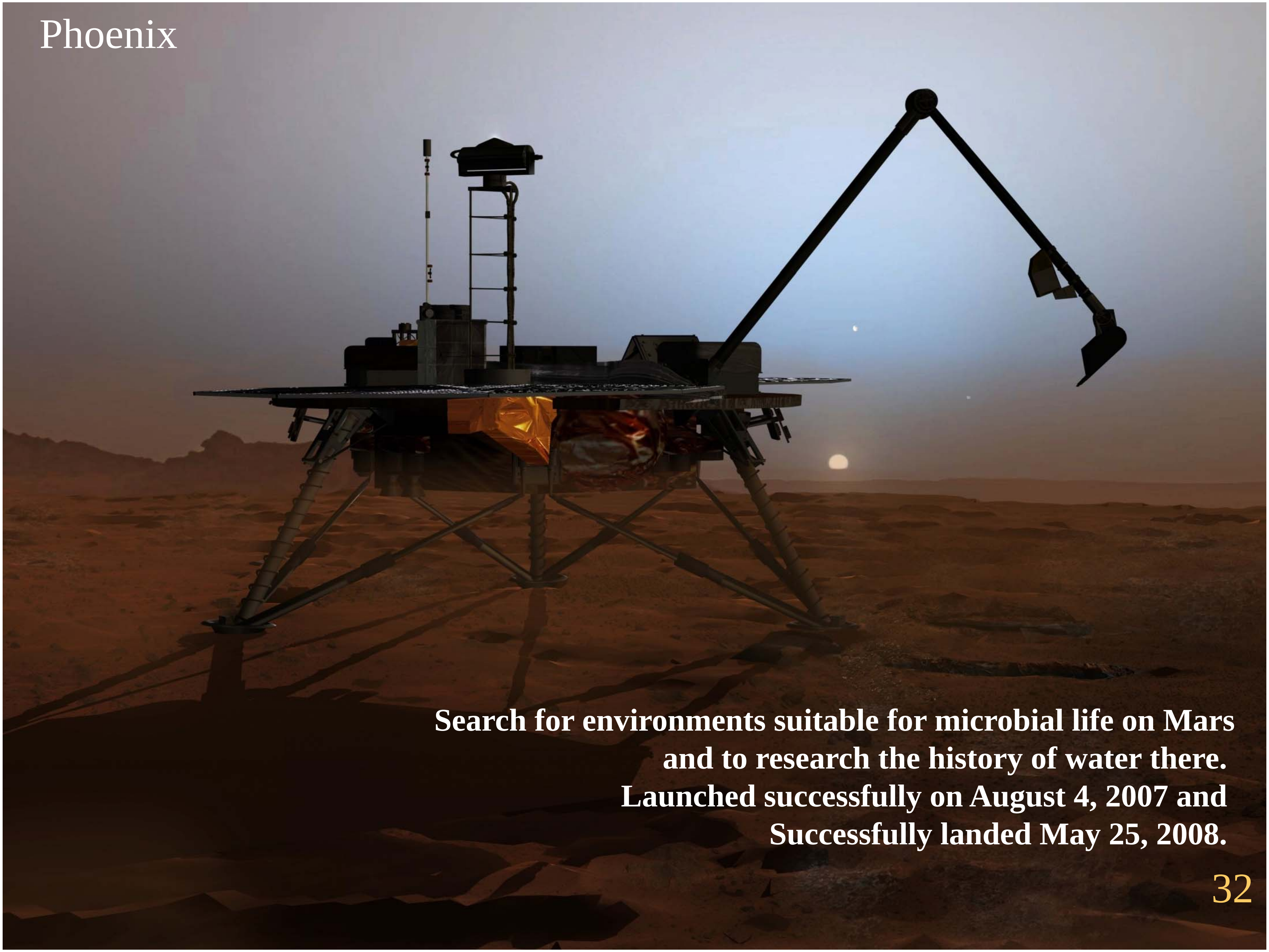
Earth From Mars



This is the first image ever taken of Earth from the surface of a planet beyond the Moon. It was taken by the Mars Exploration Rover Spirit one hour before sunrise on the 63rd Martian day, or sol, of its mission.


Life ???

Phoenix



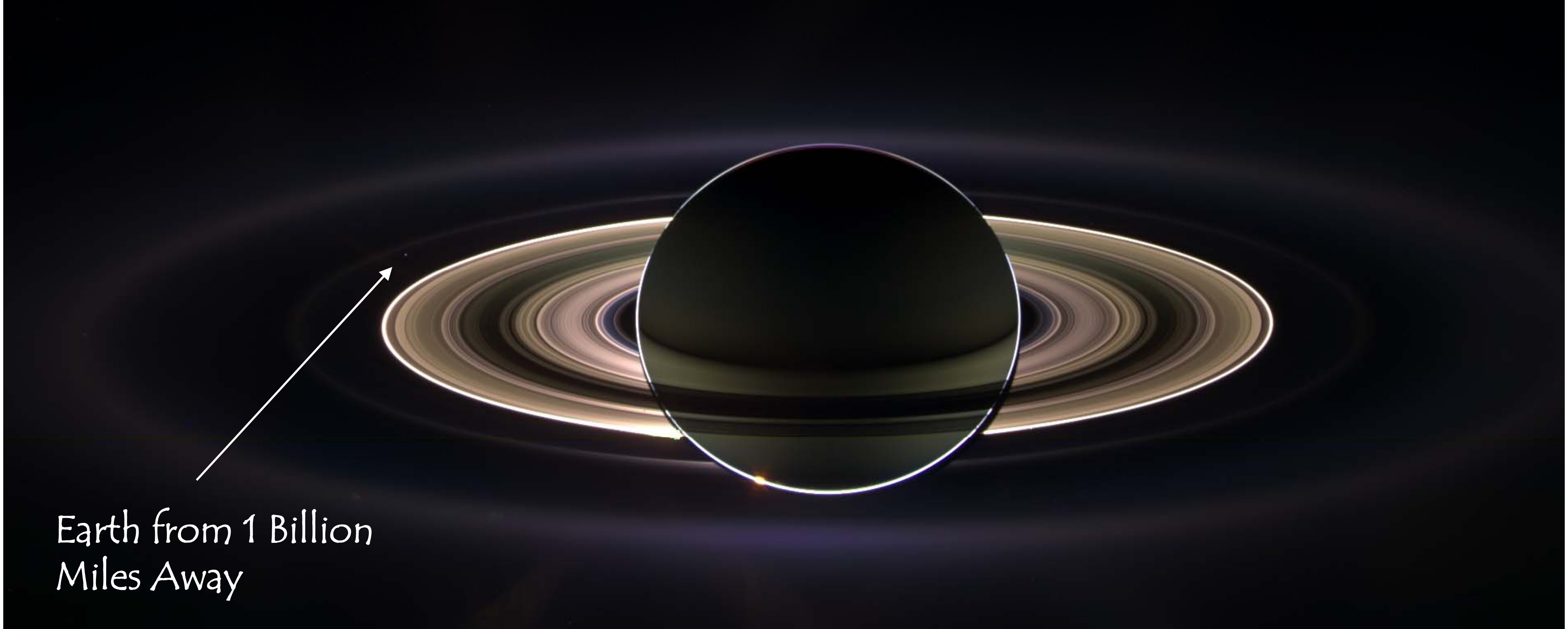
Search for environments suitable for microbial life on Mars and to research the history of water there.
Launched successfully on August 4, 2007 and Successfully landed May 25, 2008.

Mars Science Laboratory

Scheduled for Launch mid 2011

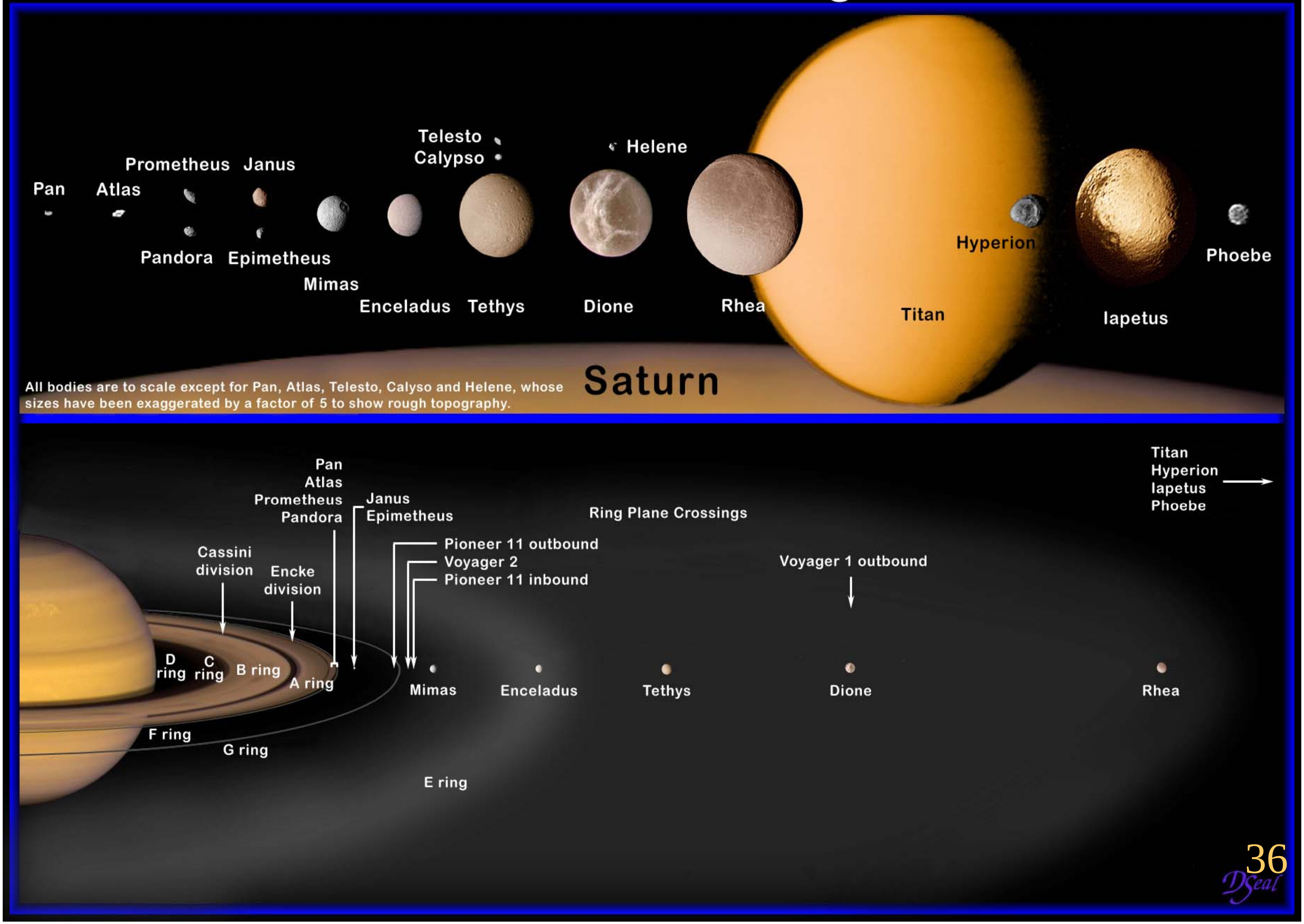
A rover that will assess whether Mars ever was, or is still today, an environment able to support microbial life. In other words, its mission is to determine the planet's "habitability."

In The Shadow of Saturn

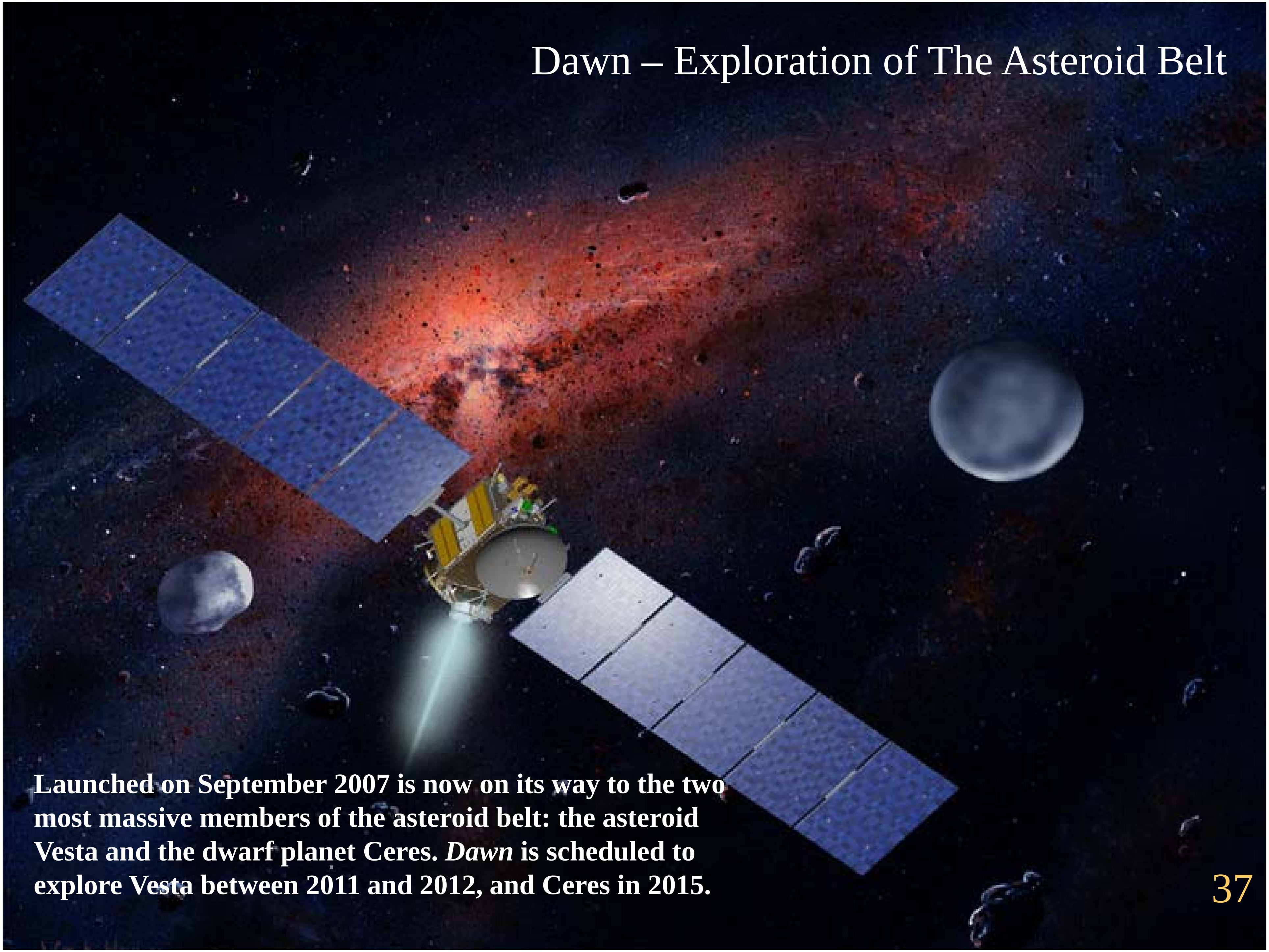


Cassini–Huygens **studying the planet Saturn and its moons launched October 15, 1997 and entered into orbit around Saturn on July 1 , 2004**

Saturn's Satellites and Ring Structure



Dawn – Exploration of The Asteroid Belt



Launched on September 2007 is now on its way to the two most massive members of the asteroid belt: the asteroid Vesta and the dwarf planet Ceres. *Dawn* is scheduled to explore Vesta between 2011 and 2012, and Ceres in 2015.

Lunar Reconnaissance

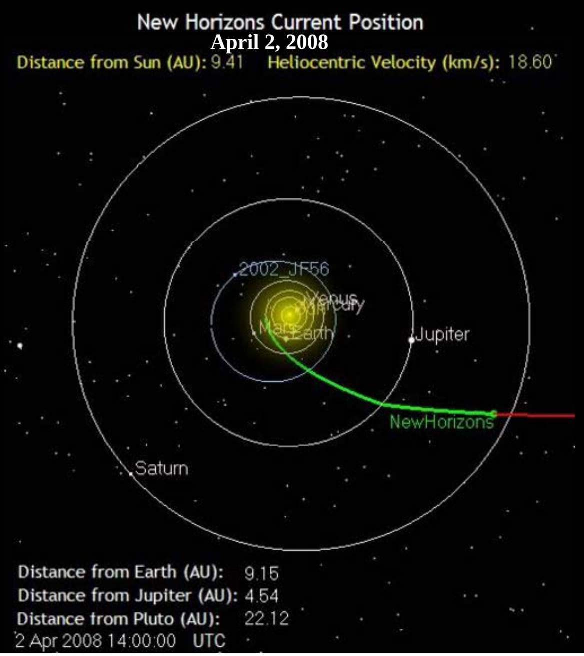
The Lunar Reconnaissance Orbiter (LRO)

- Robotic spacecraft that will be placed in lunar polar orbit to build a detailed atlas/map of the Moon's surface features and resources
- Emphasis on polar regions where possibility of water is favorable

The Lunar Crater Observation and Shepherding Spacecraft (LCROSS)

- Search for water near the Moon's poles for future human lunar outposts.
- Guide the empty Centaur upper stage (5000 lb) to impact a permanently shadowed crater
- impact expected to excavate about 200 tons of lunar surface material

Pluto New Horizons



Pluto New Horizons will be the first spacecraft to fly by and study the dwarf planet Pluto and its moons, Charon, Nix, and Hydra. Launched on January 19, 2006 and a flyby of Jupiter on February 28, 2007, it will arrive at Pluto on July 14, 2015


PLUTO IS PRICELESS
WHAT WOULD WALT DO?
HE'D BUY PLUTO!
ALL WE ARE SAYING IS GIVE PLUTO A CHANCE
Worth1000.com


start calling pluto
an asteroid.....
and it starts acting
like one.
paid for by the friends of pluto
ahom.ru

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- Complete the International Space Station
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- Return to the moon no later than 2020
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- Implement a sustained and affordable human and robotic program
- **Extend human presence across the solar system and beyond**

How Big is this challenge?

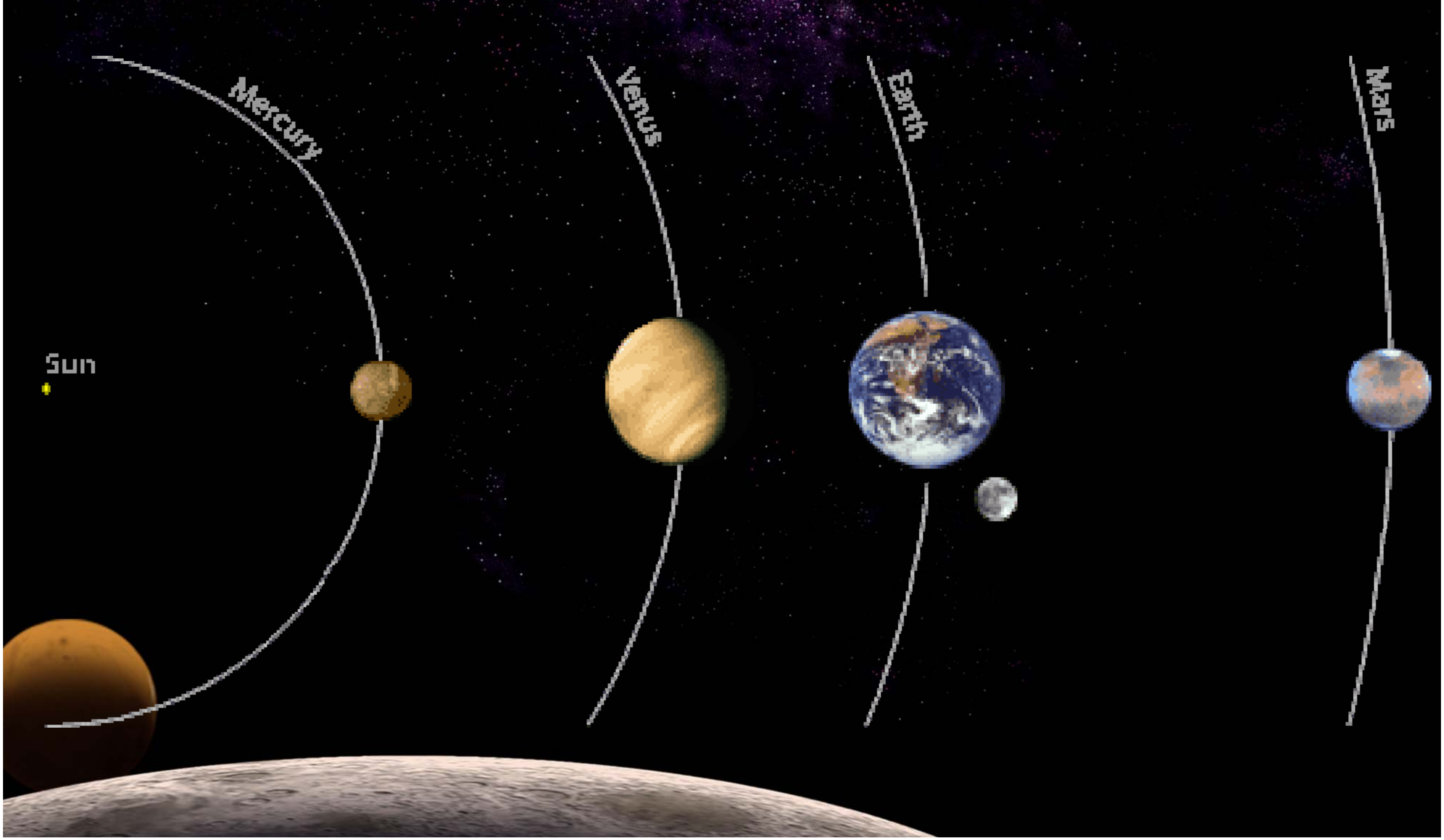
How Big is this challenge?

- **How Big is the Universe?**
- **Let's say an average grain of sand is .1 MM which is equal to 0.0039 inches.**
- **The diameter of the earth at the equator is 7,926 miles.**
- **So let's say 1 grain of sand is the size of the Earth**
- **.1 MM = 7,926 miles . . . .**

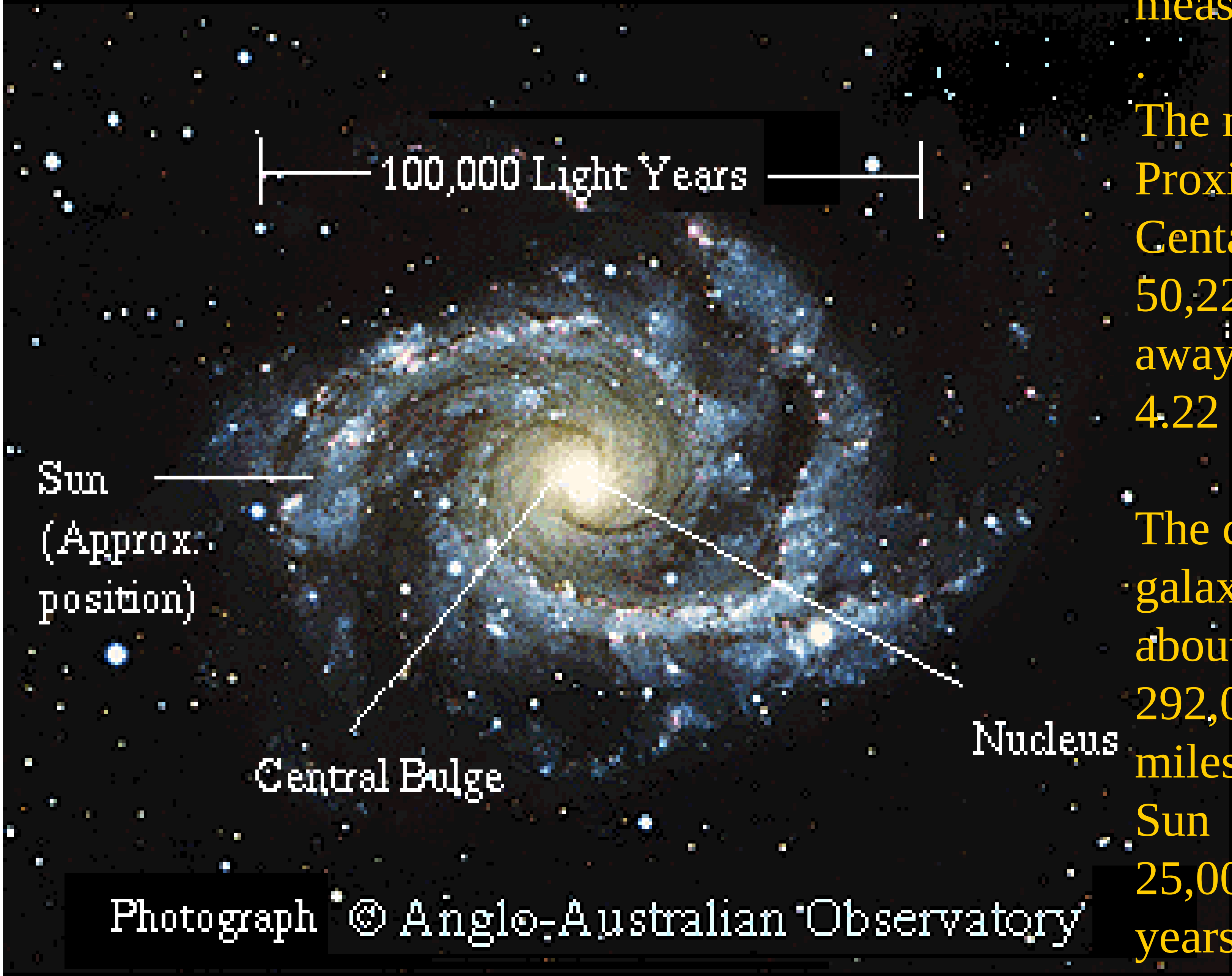
Distance to the moon = 1/8 th inch - 30.28 grains of sand (actually 240,000 miles)

Distance to Mars = 16.7 inches (actually 34,000,000 miles)

Distance to the sun = 45.7 inches (actually 92,955,820 miles)



Milky Way Galaxy - Our Home

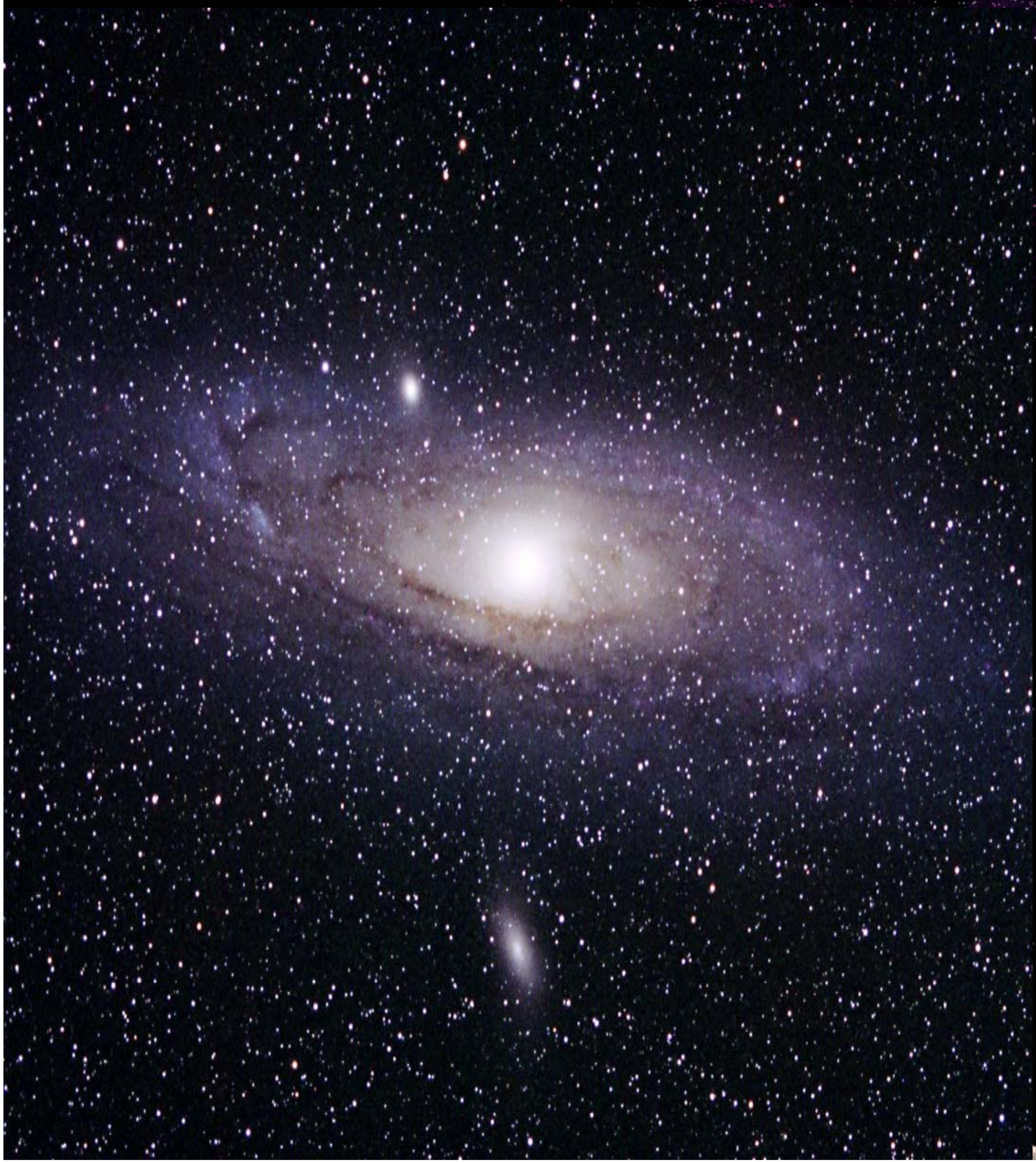


In grains of sand measurements….

The nearest star, Proxima Centauri, is 50,225 miles away (actually 4.22 light-years)

The center of our galaxy would be about 292,005,024 miles from the Sun (actually 25,000 light-years)

The Great Andromeda Galaxy Our Sister Galaxy

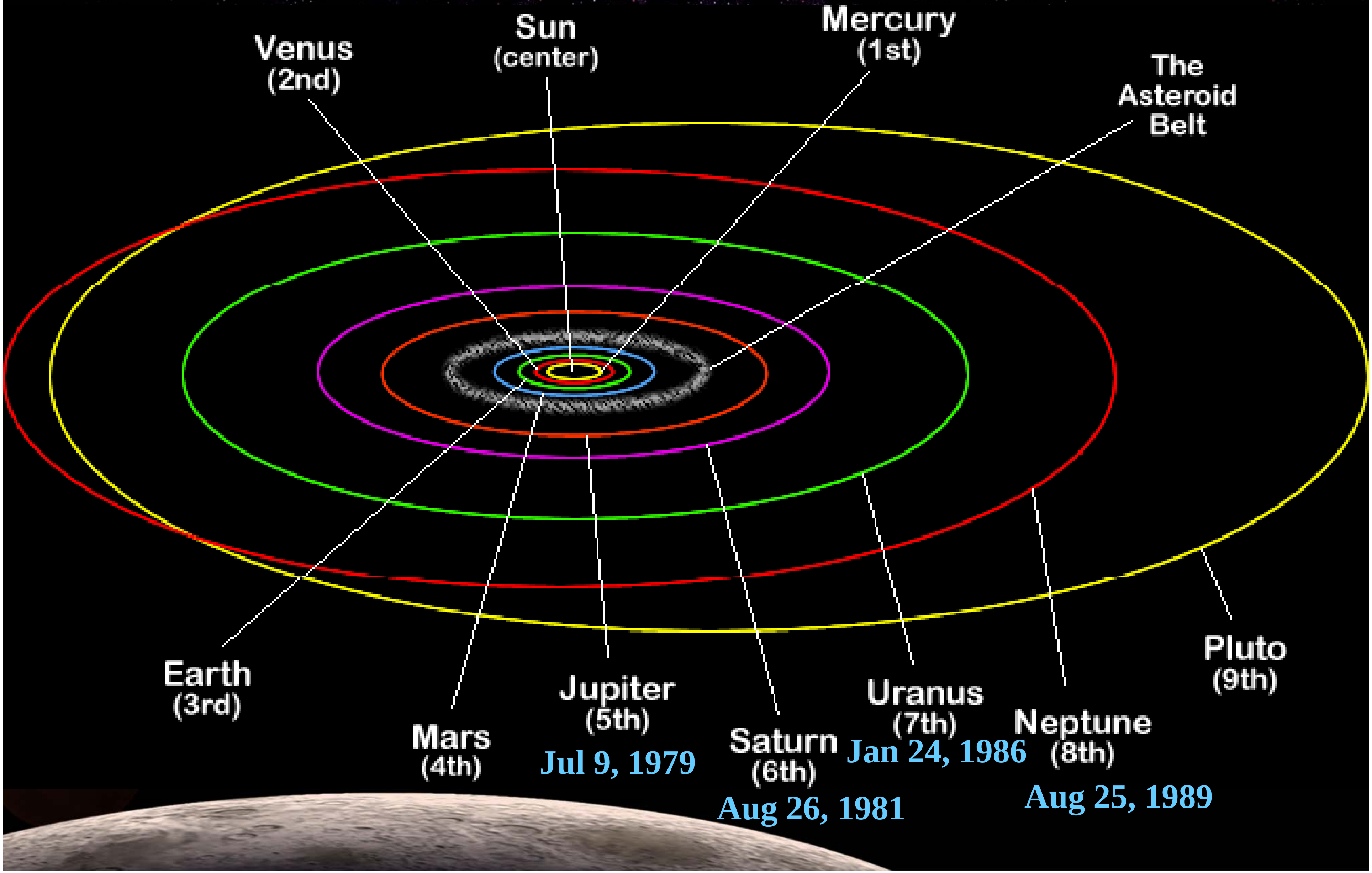


In grains of sand measurements…..

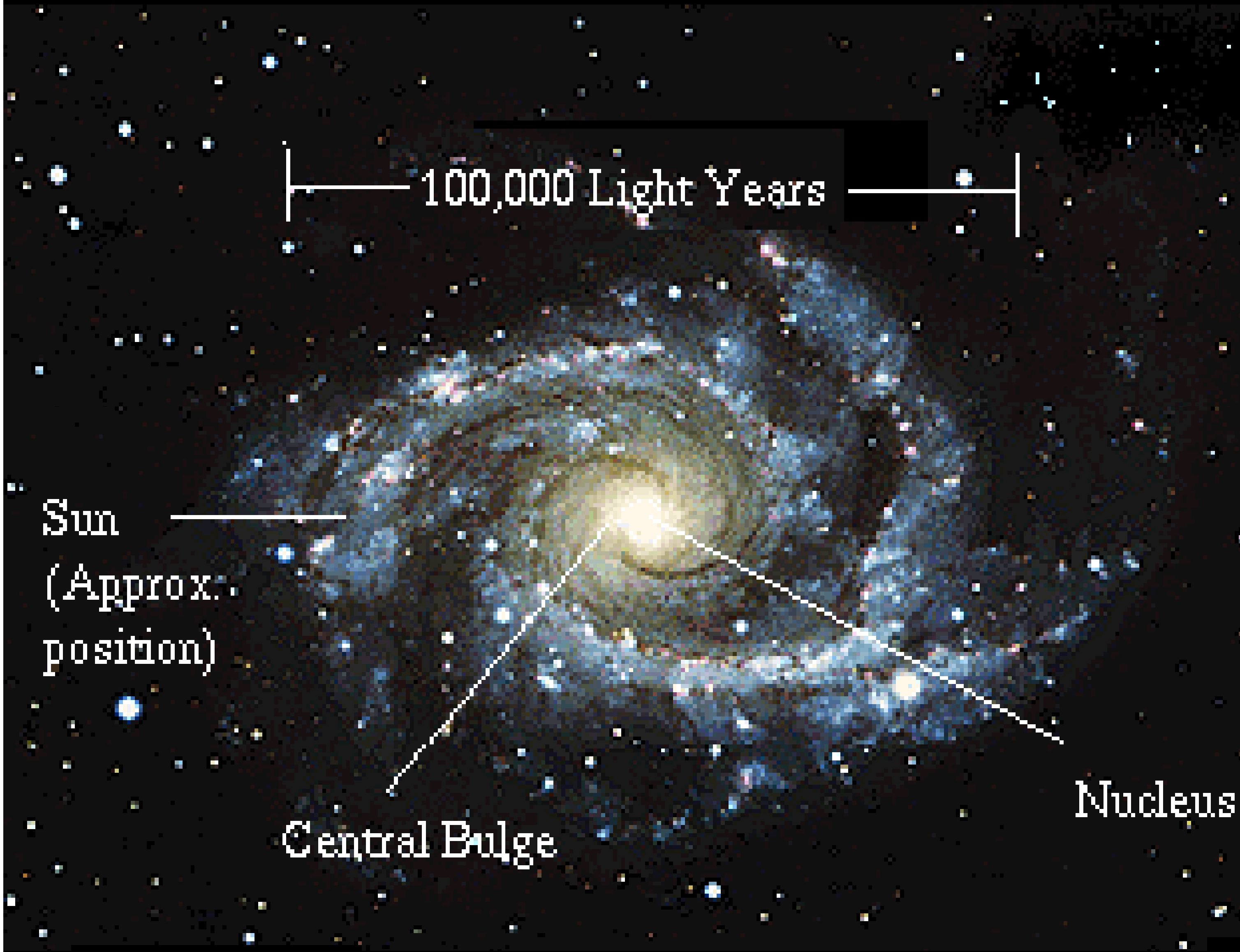
The Andromeda galaxy would be about 33,872,582,754 miles Away (actually 2.9 million light years)

The most distant known objects in the universe would be 151,842,000,000,000 miles away (actually13 billion light-years from Earth.)

Voyager 2 - Launch Aug 20 1977



Milky Way Galaxy - Our Home



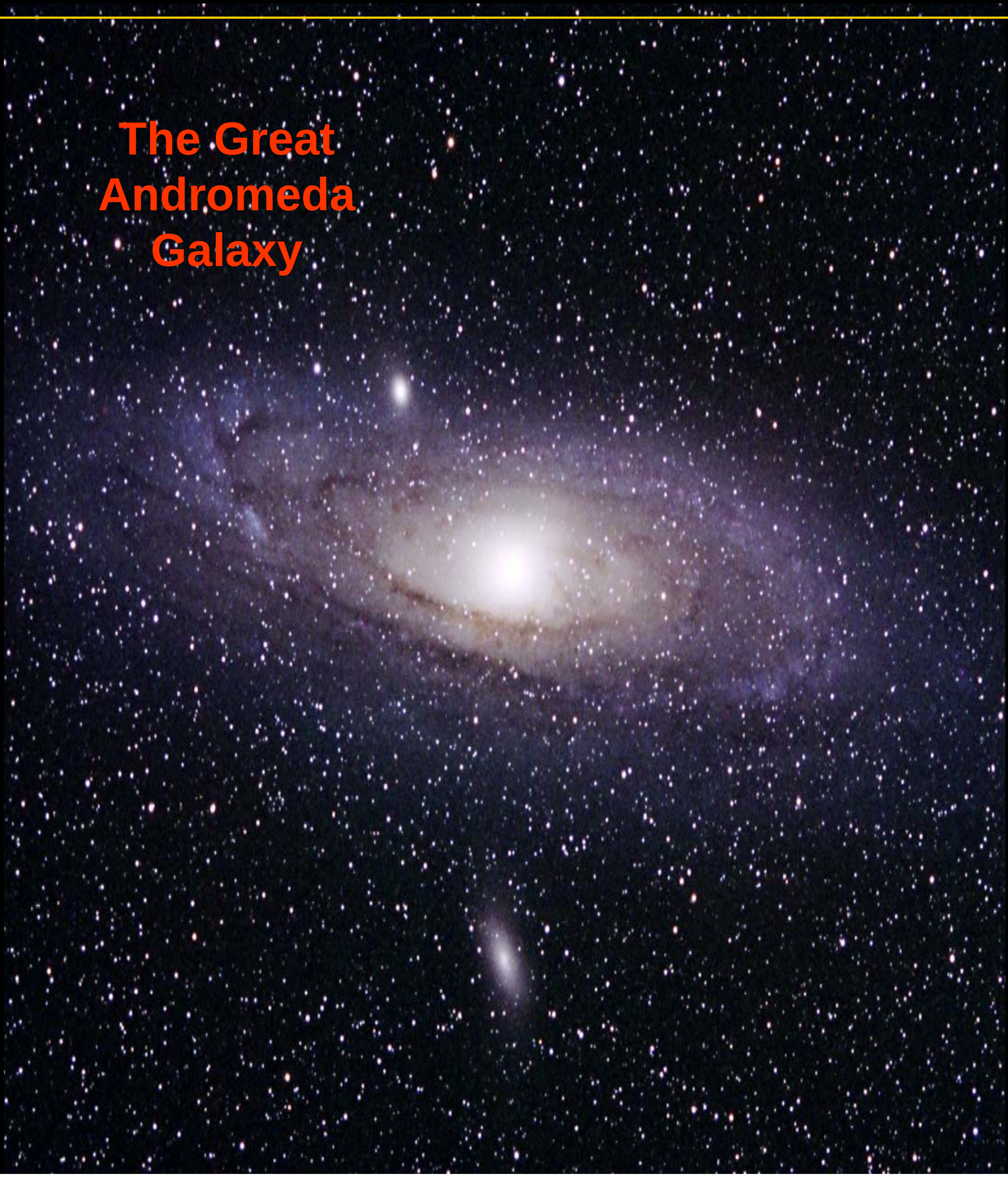
One of the fastest objects ever made by Humans are the Voyager Spacecrafts

Launched in 1977 these small spacecrafts are now traveling at over 35,000 mph - this is about 10 miles per second

Even at those speeds it will take nearly 80,000 years for the Voyager to reach Proxima Centauri, the nearest star.

It would take 1, 895,730,000 years to travel 100,000 light years across the Milky Way Galaxy

Voyager 2 - Launch Aug 20 1977



It would take 47,393,360,000 years to reach our closest sister Galaxy – The Great Andromeda Galaxy

To Exploring the Far Reaches of the Universe with the Hubble Space Telescope
A Window on the Universe

The Hubble Space Telescope uses mirrors to collect science data. Hubble's main mirror is about eight feet in diameter. These powerful instruments analyze the incoming light stream and translate it into information and images for scientists back on Earth.

After Hubble's launch in 1990, NASA discovered a flaw in the large, main mirror. The flaw was tiny — about 1/50th the thickness of a piece of paper — but significant enough to distort Hubble's vision. During the First Servicing Mission, astronauts added corrective optics to compensate for the flaw. The optics acted like eyeglasses to correct Hubble's vision.

S109E5660

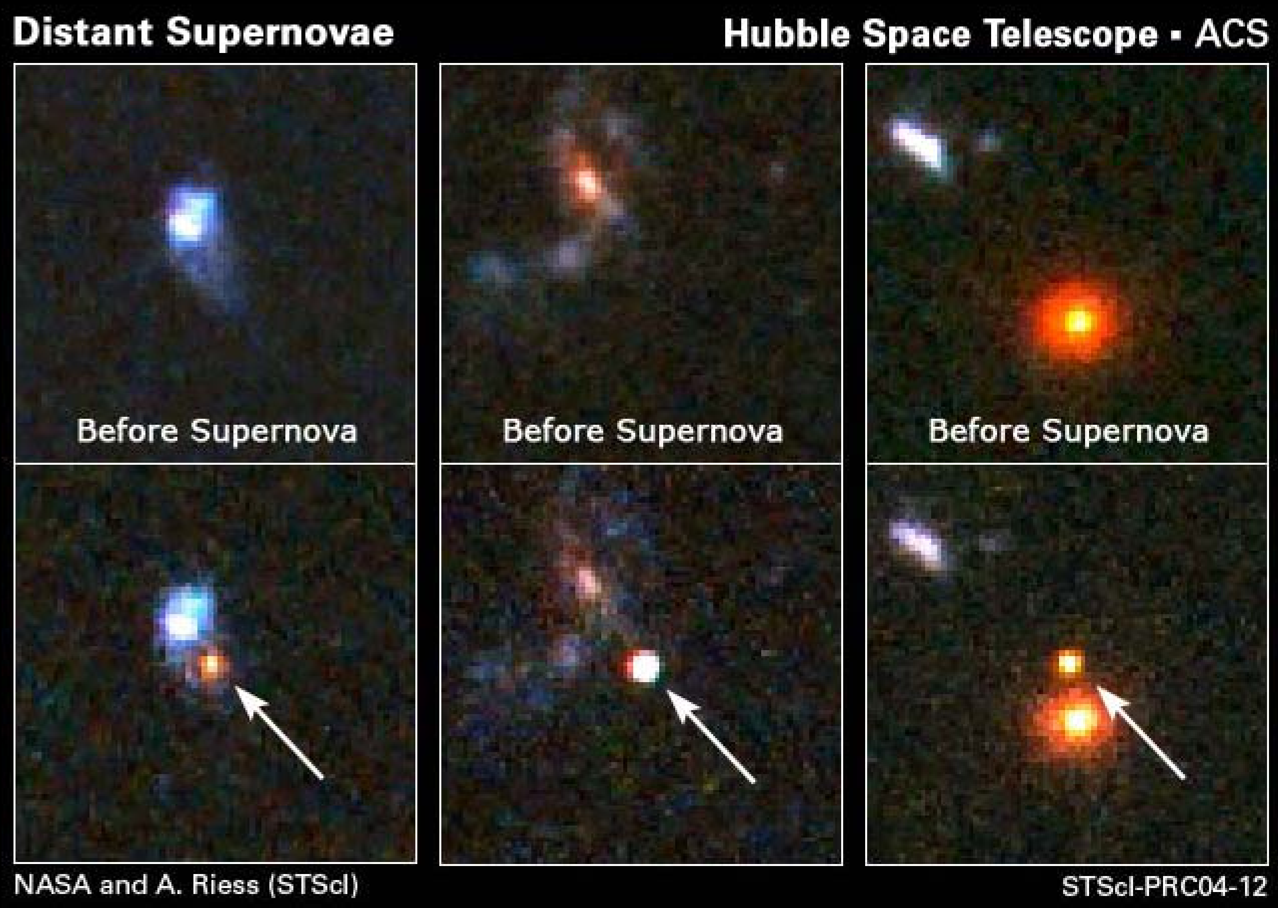
M100 Galactic Nucleus

Fixing the Hubble Primary Mirror – Before and After

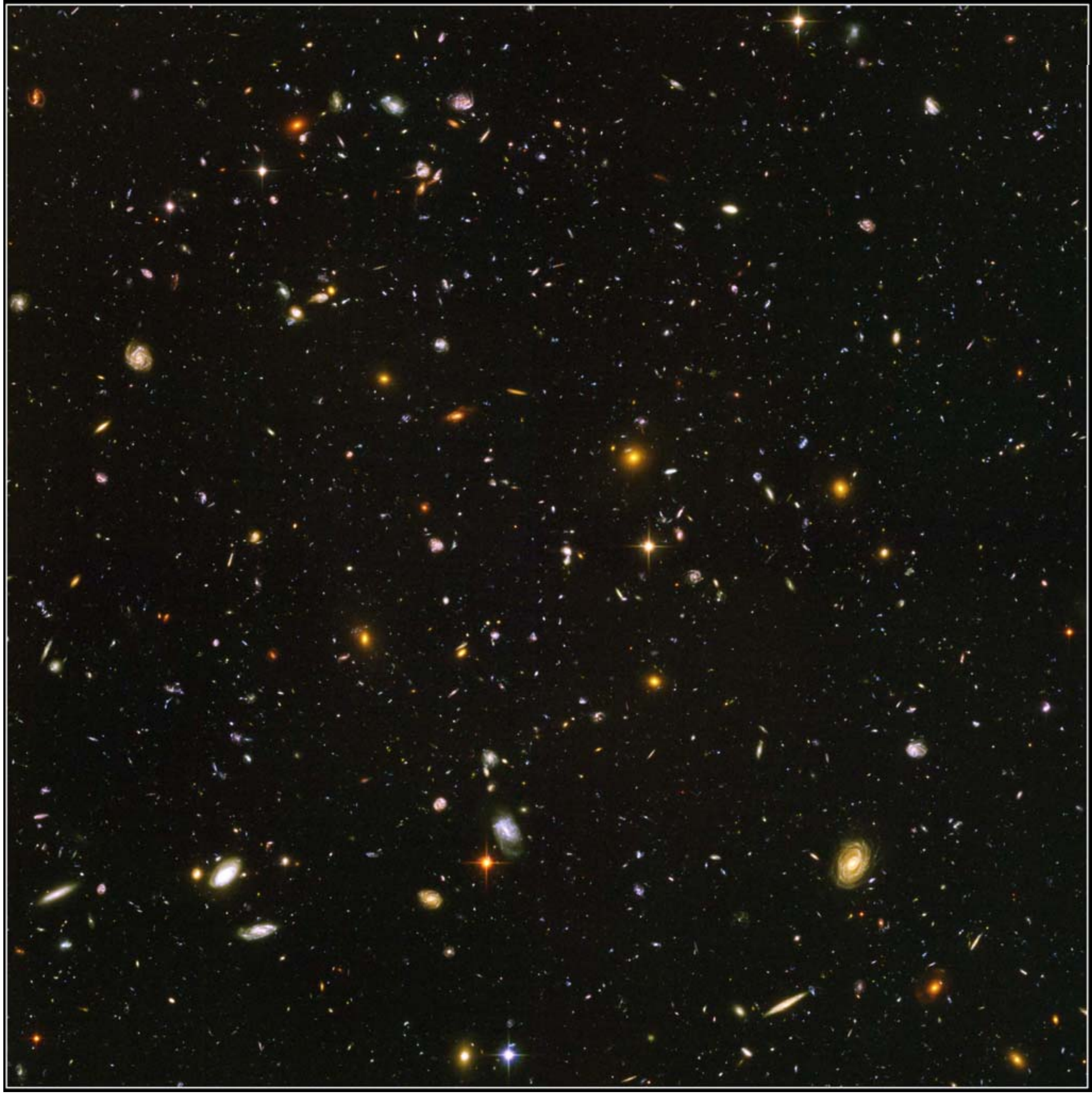
Hubble Space Telescope

Wide Field Planetary Camera 2

The Accelerating Universe



Hubble Space Telescope
Deepest Views of the Early Universe



This view of nearly 10,000 galaxies is the deepest visible-light image of the cosmos.

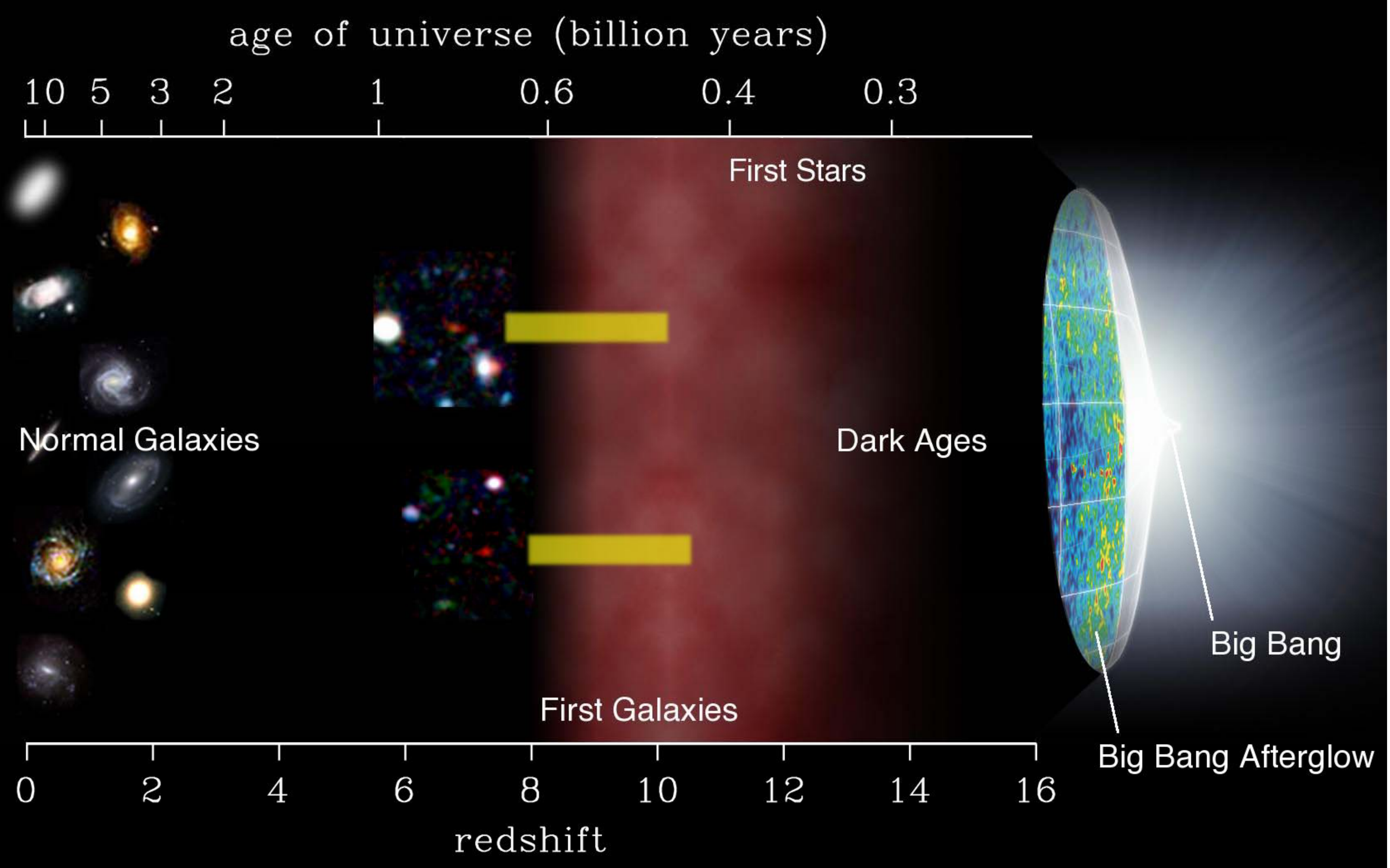
The smallest, reddest galaxies, about 100, may be among the most distant known, existing when the universe was just 800 million years old.

The nearest galaxies - the larger, brighter, well-defined spirals and ellipticals - thrived about 1 billion years ago, when the cosmos was 13 billion years old.

Peering into the Ultra Deep Field is like looking through an eight-foot-long soda straw.

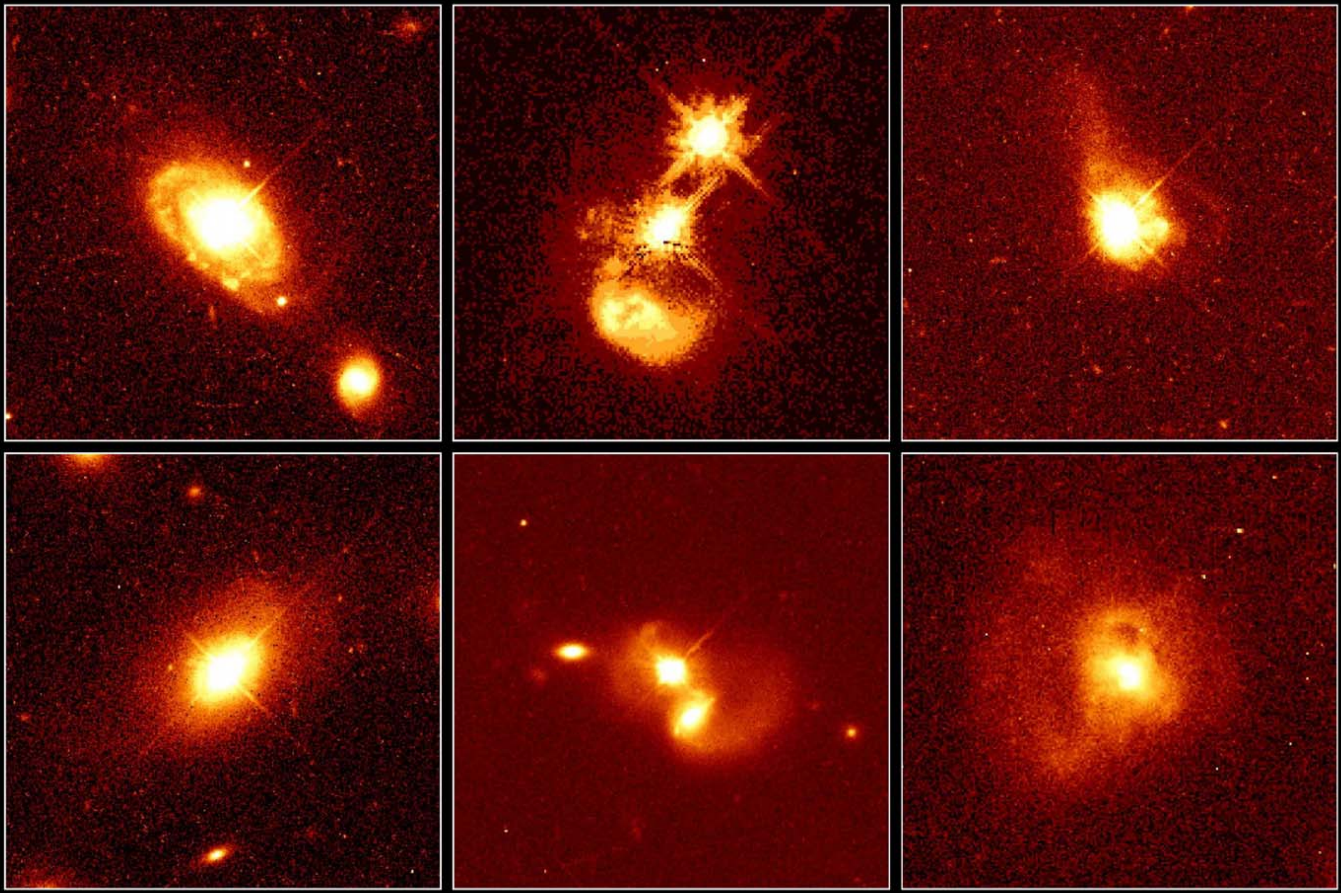
The image required 800 exposures taken over the course of 400 Hubble orbits around Earth.

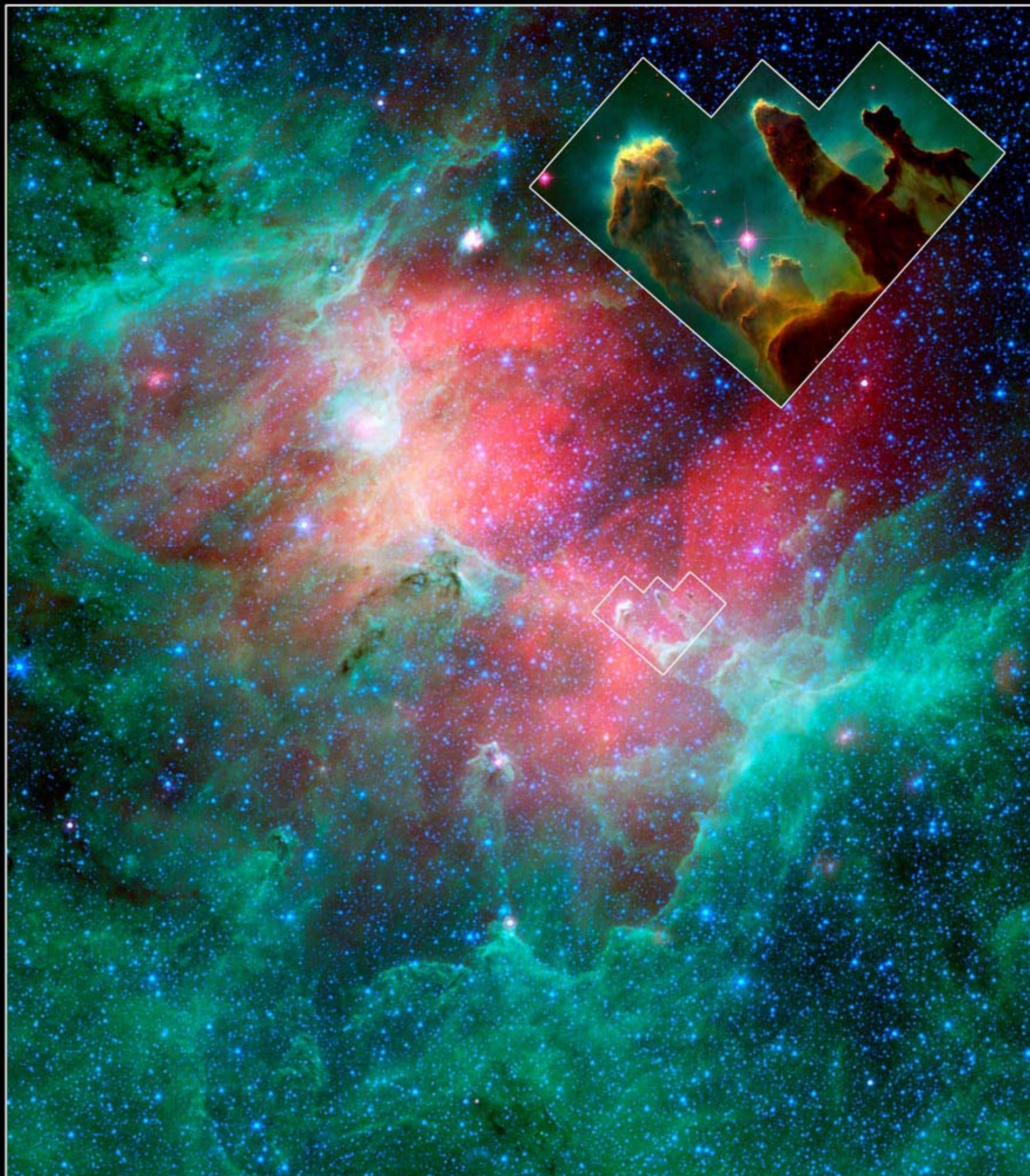
Age of the Universe ~ 13.7 Billion Years Old



Monster Black Holes are Everywhere

Quasars - Massive Black Holes in the Center of Distant Galaxies

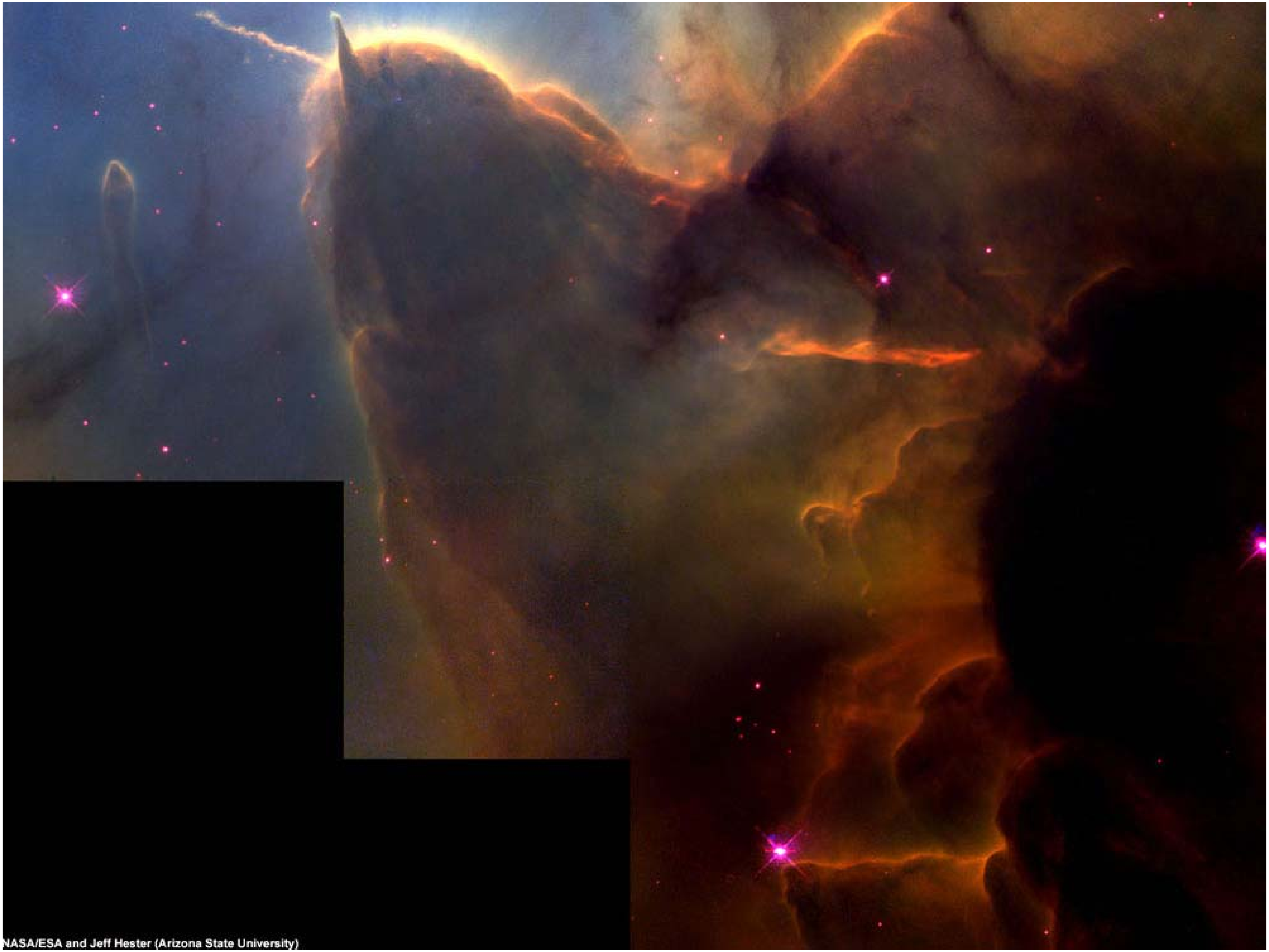




Infrared Eagle Nebula and the "Pillars of Creation"

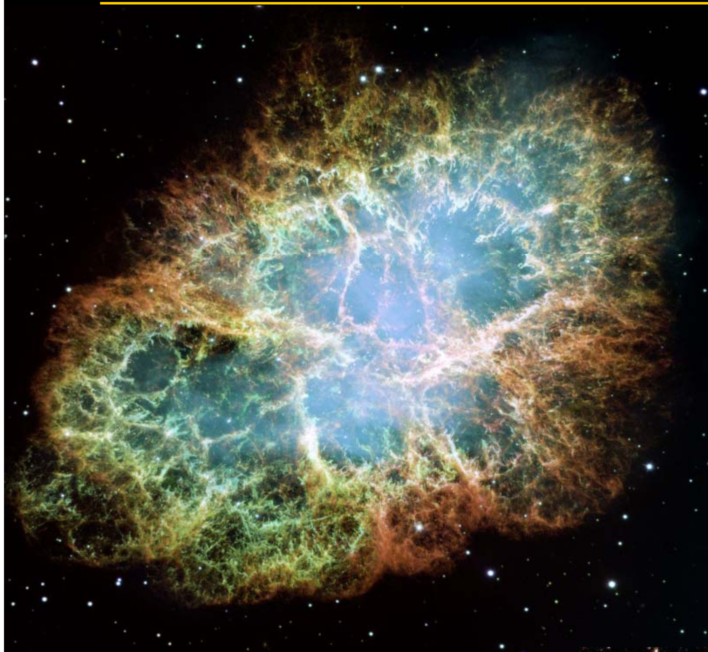
Spitzer Space Telescope • IRAC • MIPS
Hubble Space Telescope (inset)

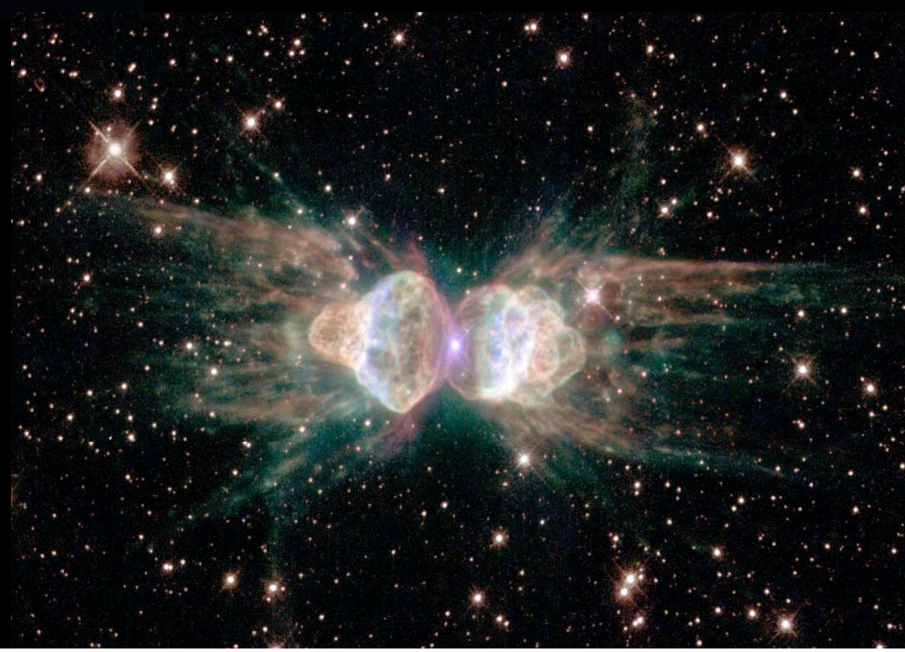
Birthplaces of New Planetary Systems

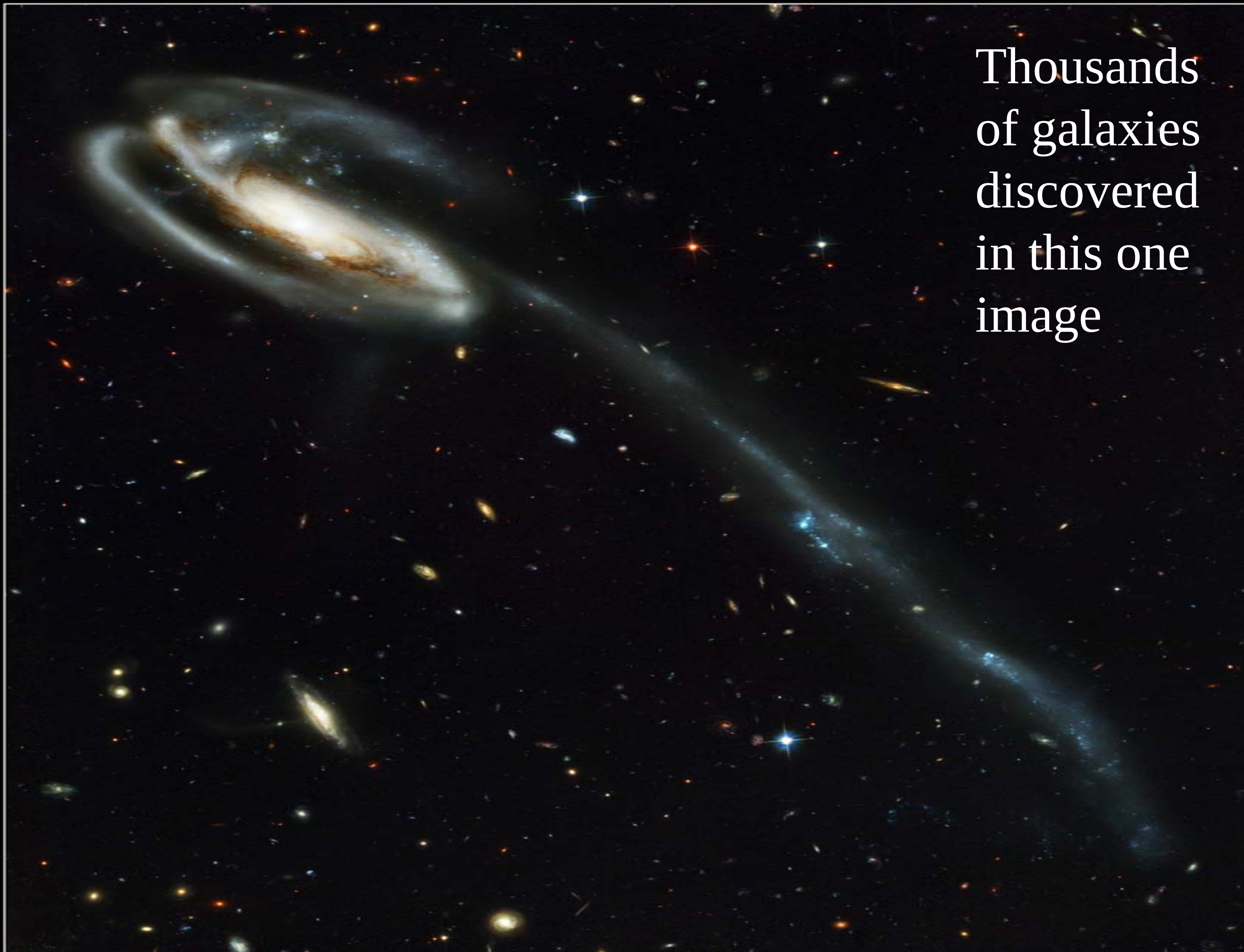


NASA/ESA and Jeff Hester (Arizona State University)

Unprecedented Details of Stars Death



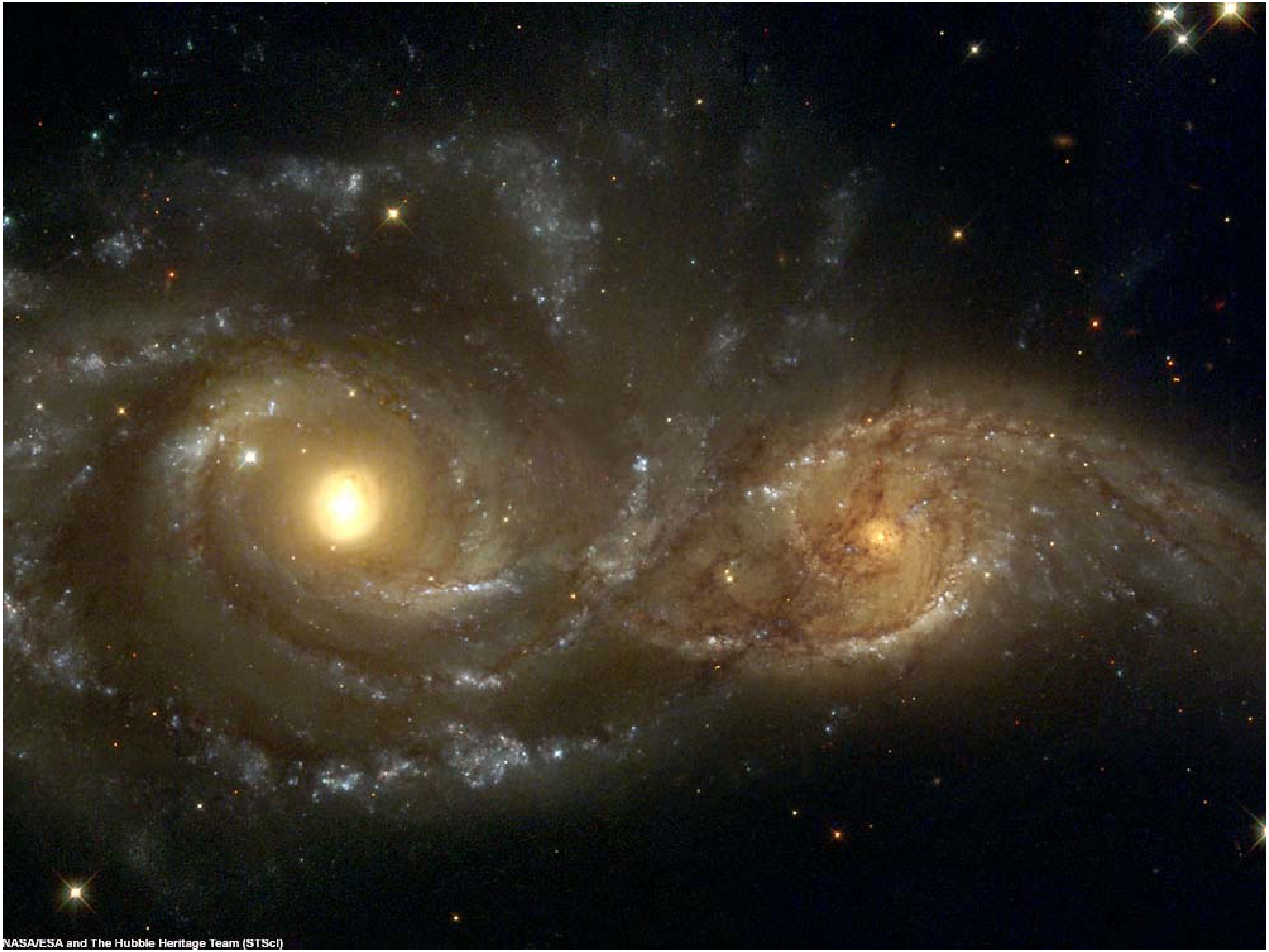




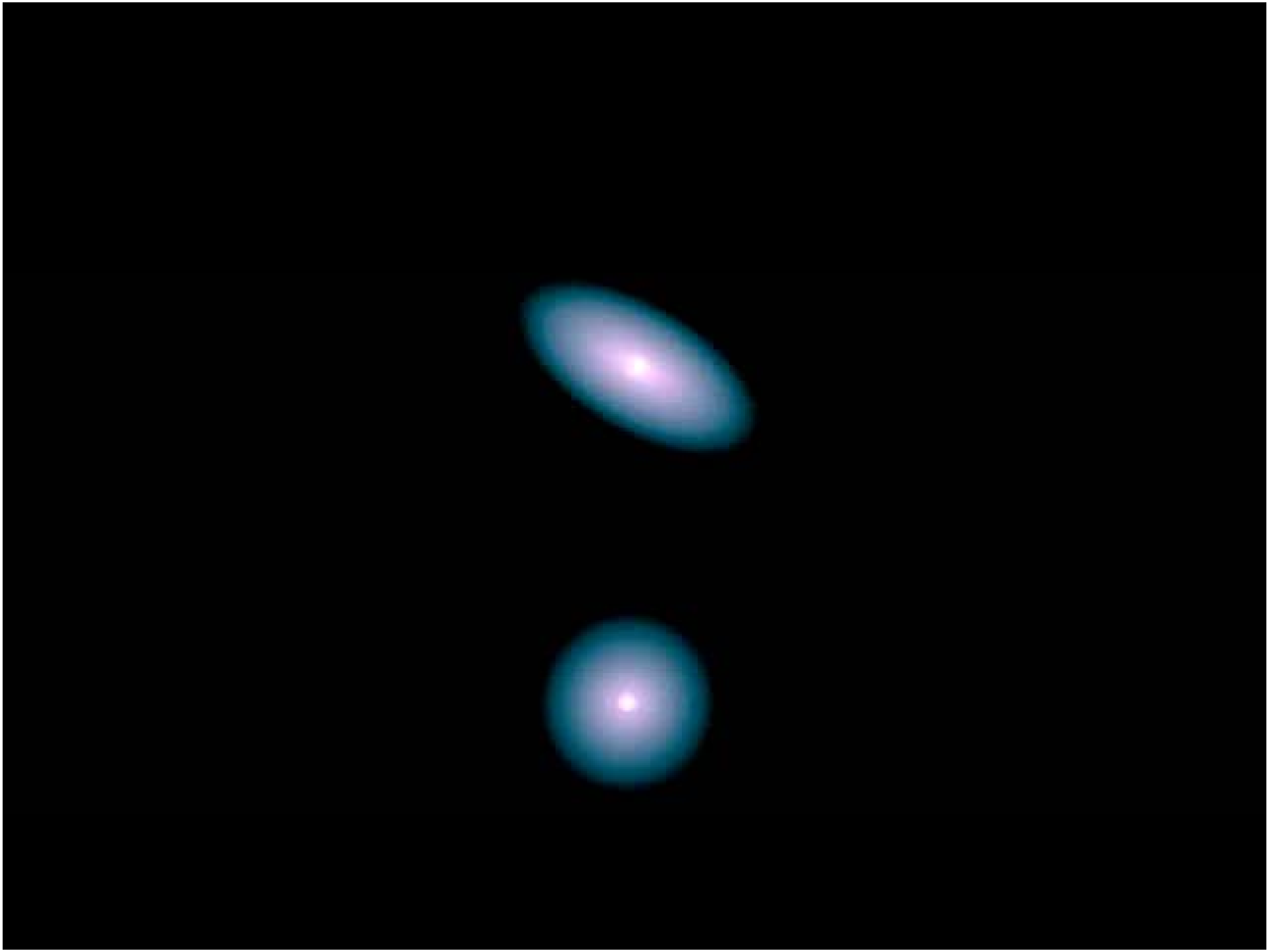
Tadpole Galaxy • UGC 10214

Hubble Space Telescope • Advanced Camera for Surveys

NASA, H. Ford (JHU), G. Illingworth (UCSC/LO), M. Clampin (STScI), G. Hartig (STScI) and the ACS Science Team • STScI-PRC02-11a



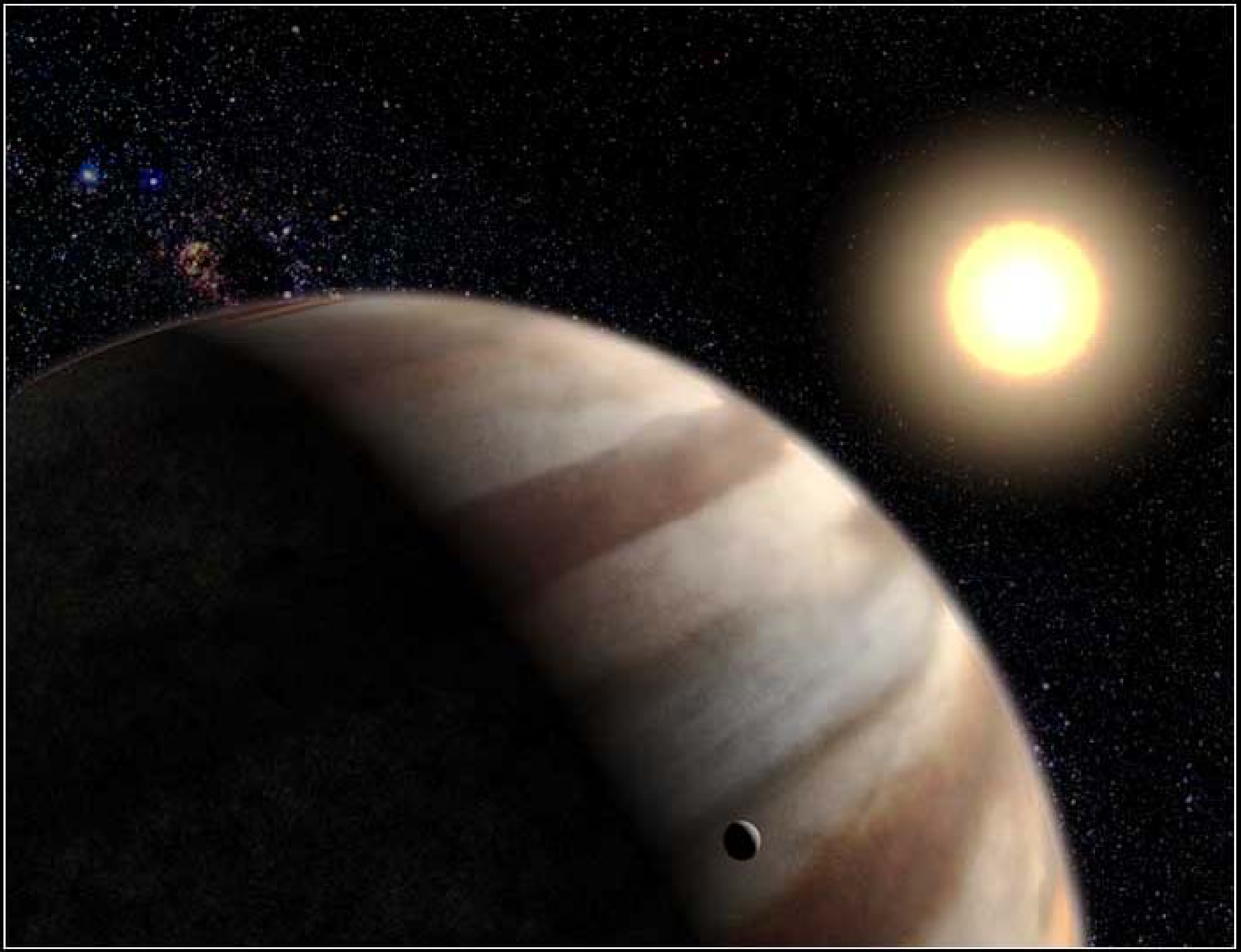
NASA/ESA and The Hubble Heritage Team (STScI)




NASA/ESA and The Hubble Heritage Team (STScI/AURA)


Stars in our Galactic Center

Planets Outside Our Solar System



Artist's View of Planet around the Star HD 209458

NASA and G. Bacon (STScI) • STScI-PRC01-38

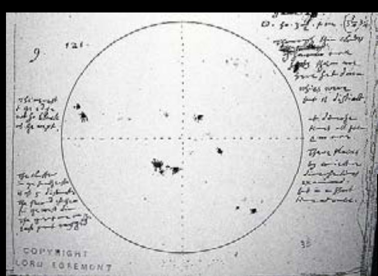
"The survival of the human race depends on its ability to find new homes elsewhere in the universe … It is important for the human race to spread out into space for the survival of the species "

Stephen Hawking
June 13, 2006


Stonehenge

"And yet it does move."

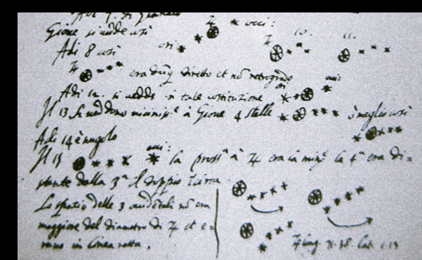
Galileo



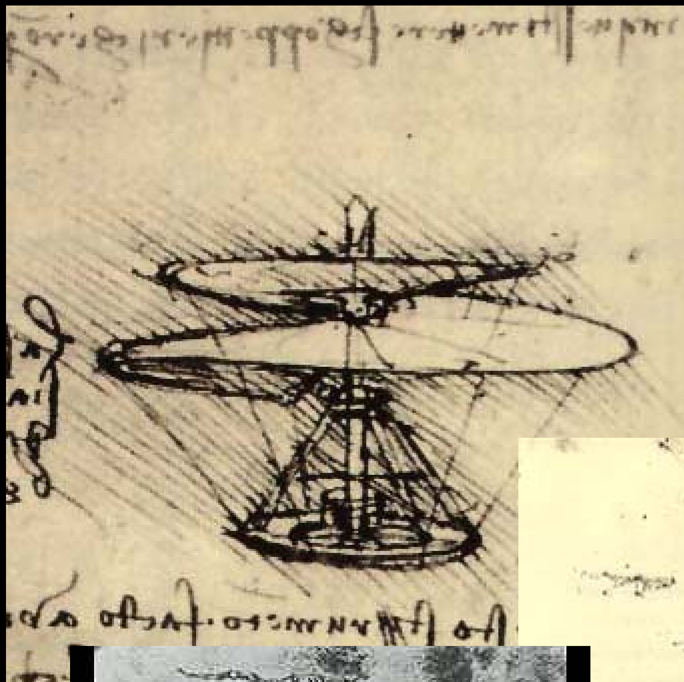
Sun Spots

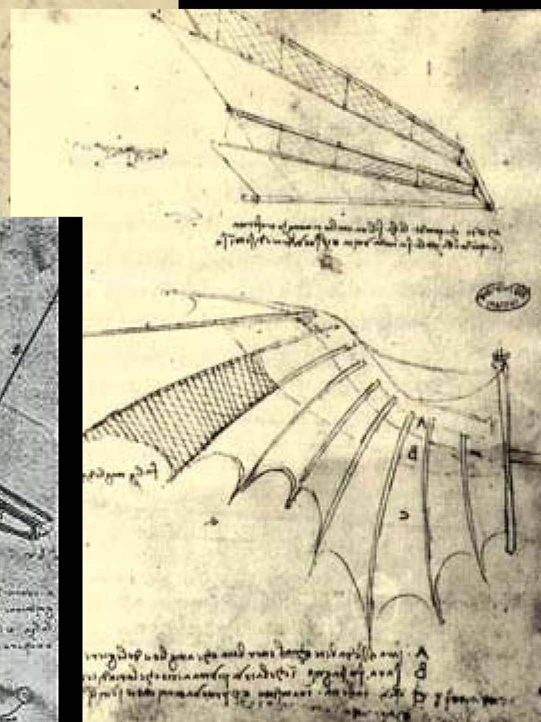
Moons around Jupiter

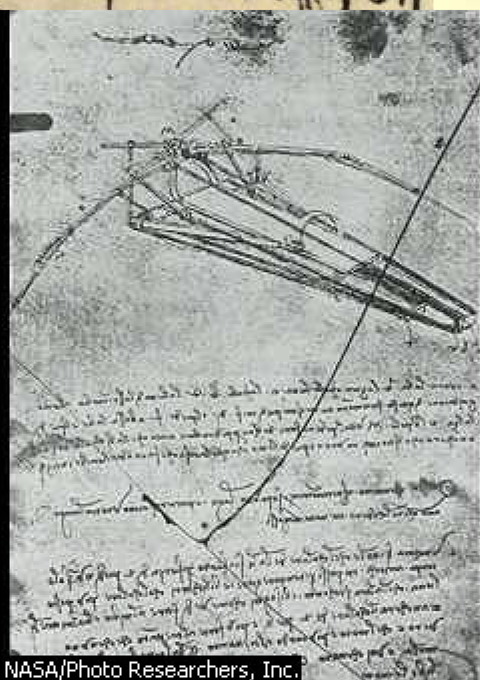
Craters on the Moon



Phases of Venus



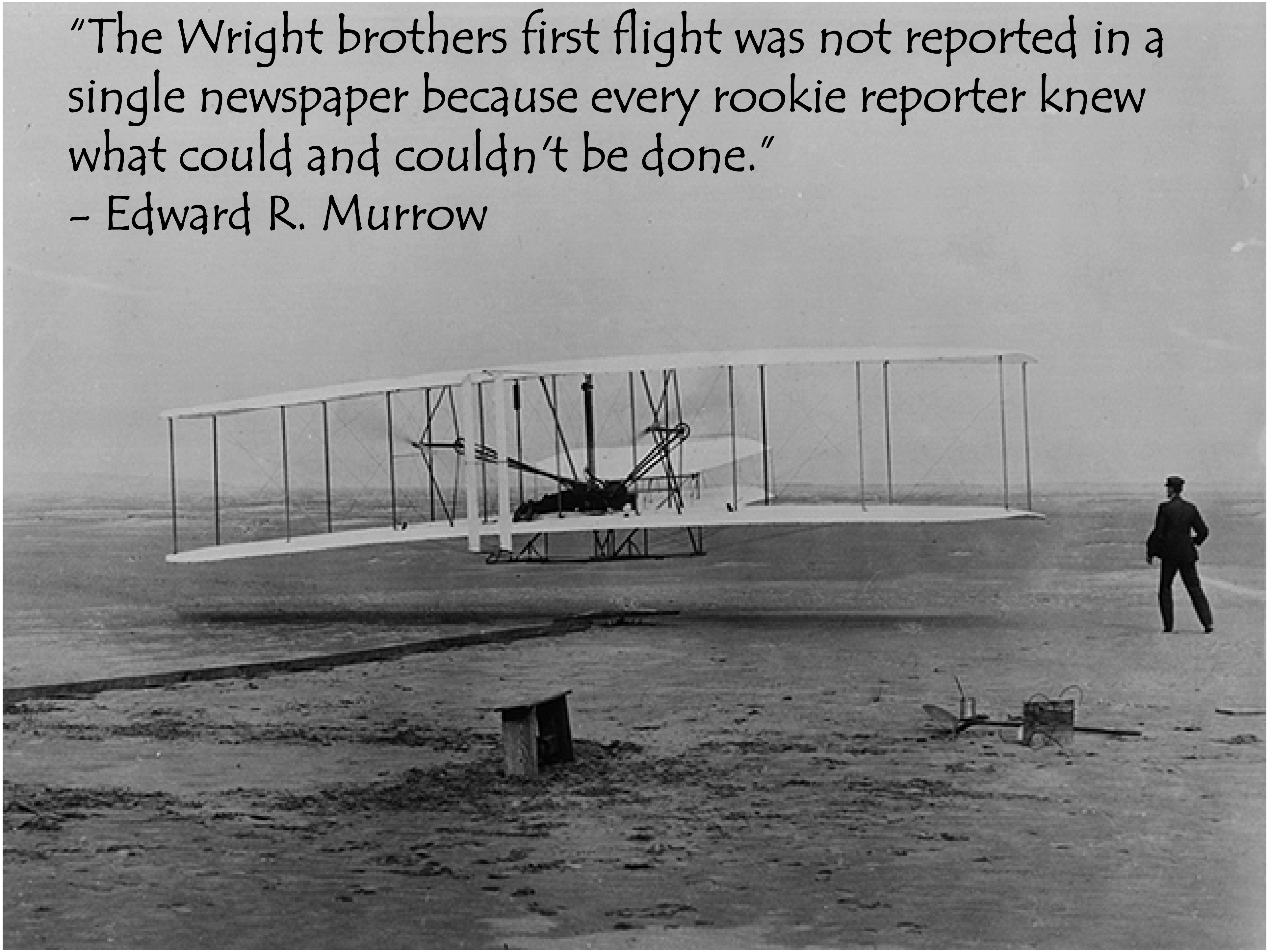




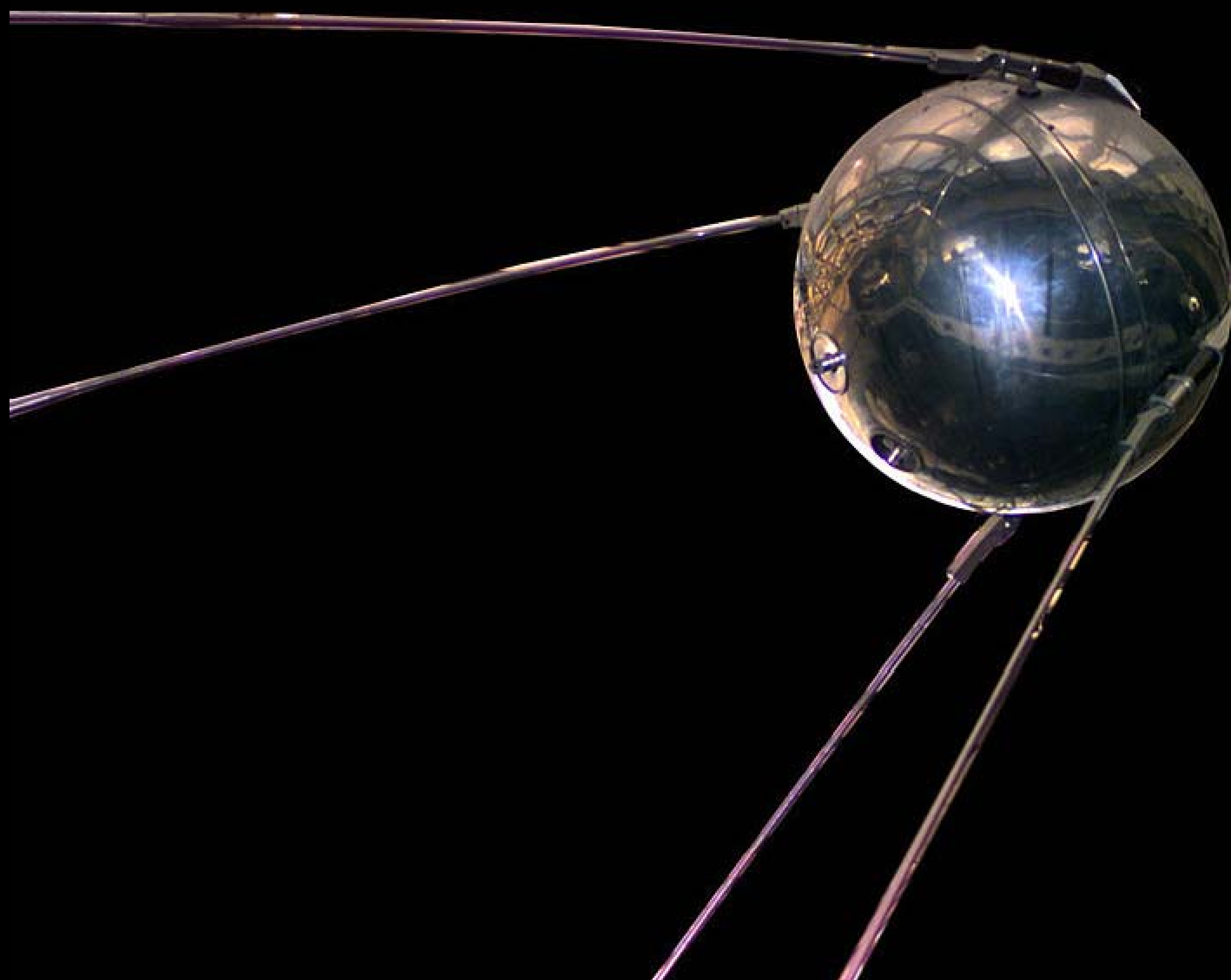
NASA/Photo Researchers, Inc.

"There shall be wings! If the accomplishment be not for me, 'tis for some other."

Leonardo da Vinci


"The Wright brothers first flight was not reported in a single newspaper because every rookie reporter knew what could and couldn't be done."
– Edward R. Murrow

Sputnik 1
October 4, 1957



“I could have gone on flying through space forever.”

Yuri A. Gagarin

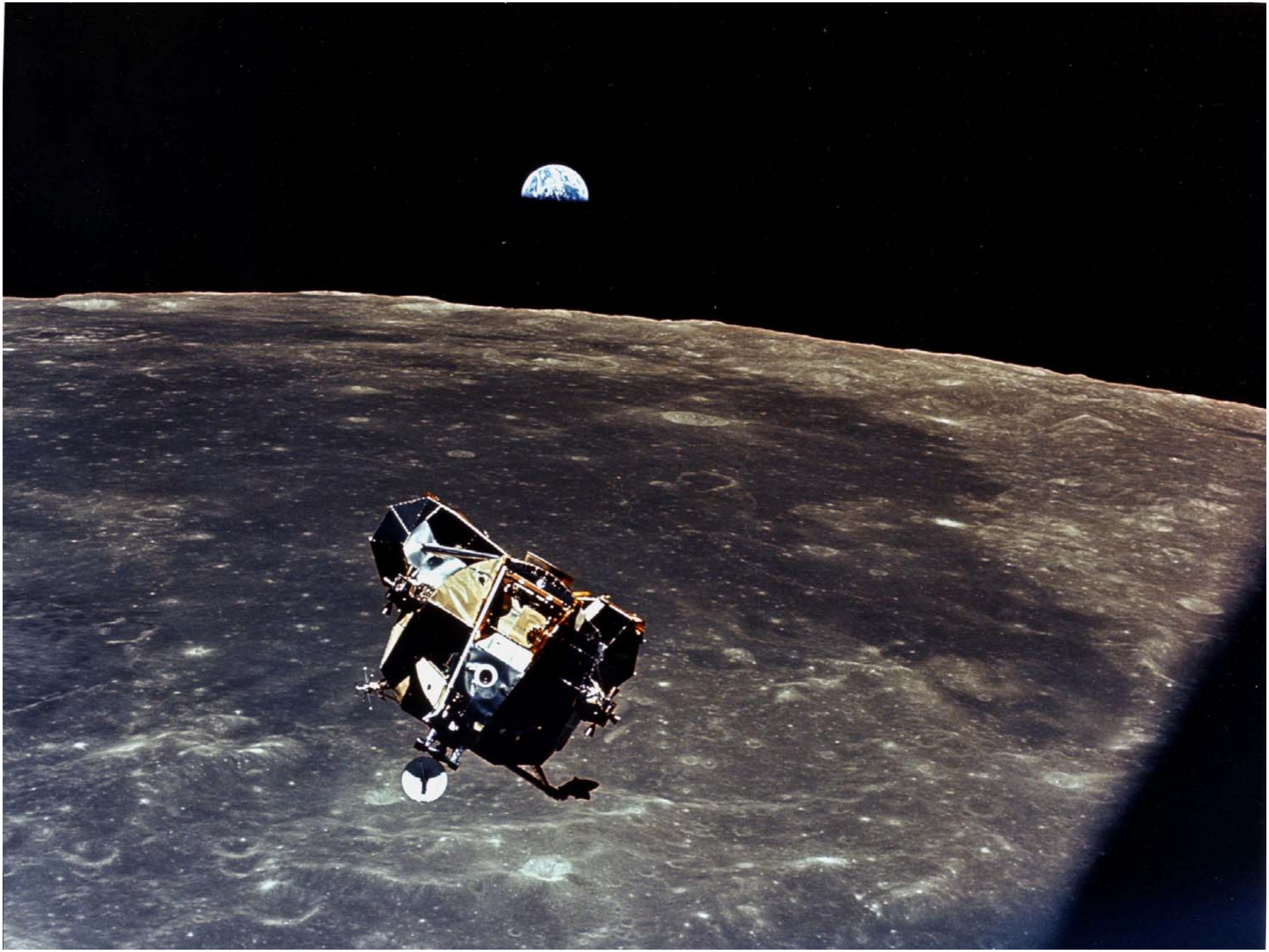
Alan Sheppard - First US Astronaut

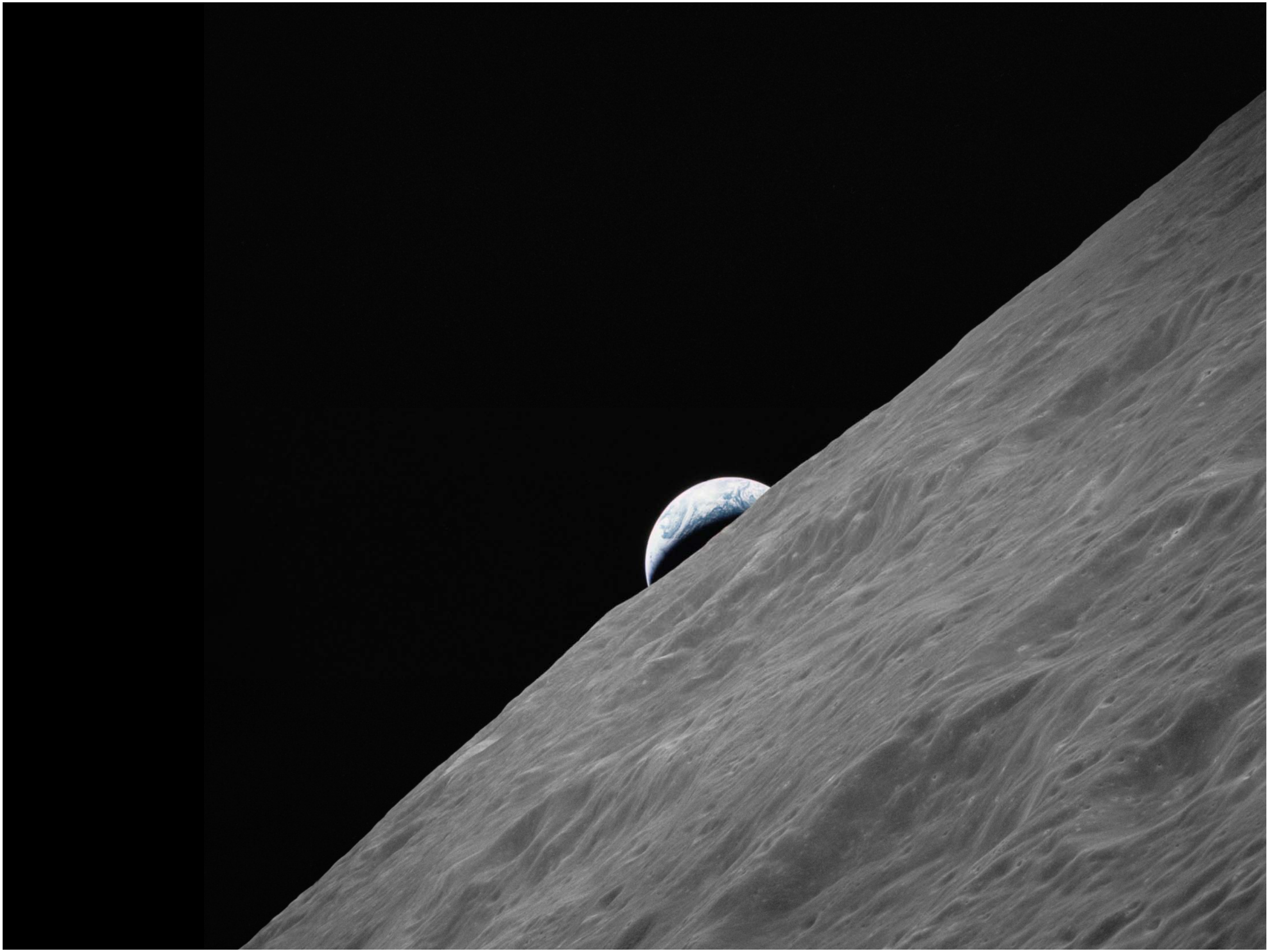
March 1, 1962, New York Ticker Tape Parade
Celebrating John Glenn's return from his first space launch,

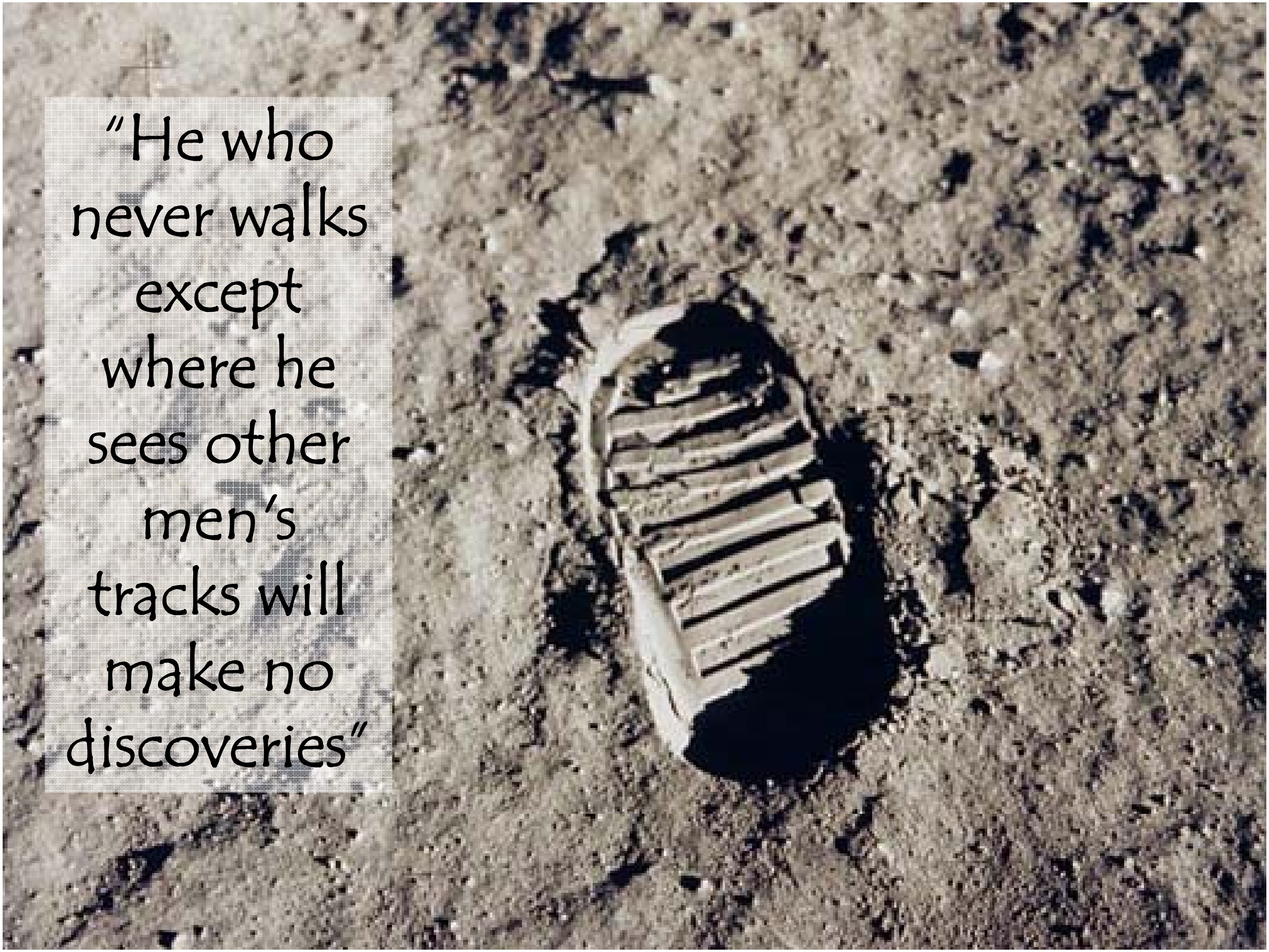

Rocket Row
Cape Canaveral– 1963

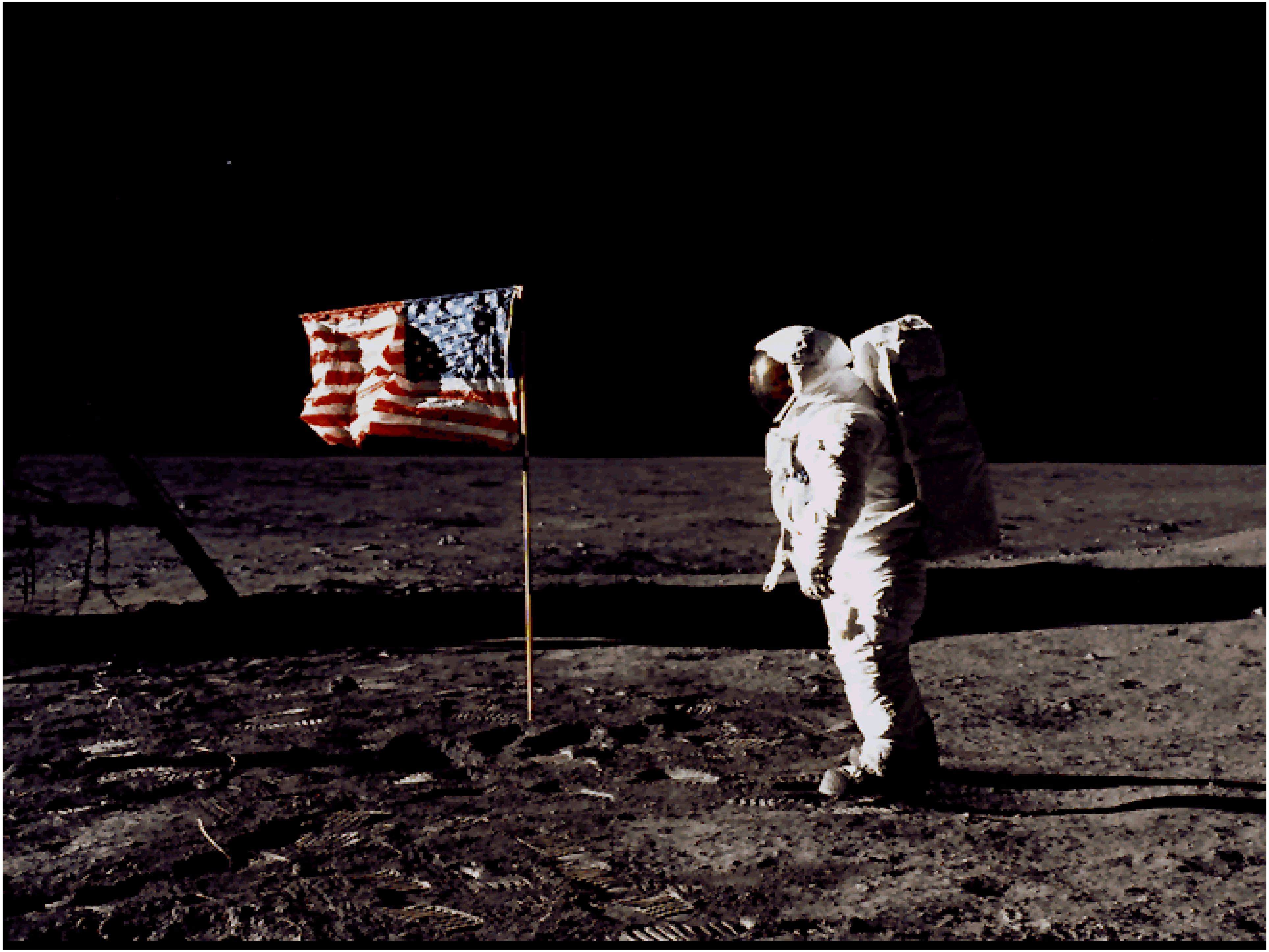
"We chose To do these things …… not because they are easy but because they are hard" John F Kennedy

Apollo 11
Moon Launch
July 1969






"He who never walks except where he sees other men's tracks will make no discoveries"



Columbia sits on the Launch Pad before its maiden flight
April 1981


Shuttle Night Launch

NASA


Sunrise on Orbit
Space Shuttle
JPL
NIMA
ASI
DLR

Aurora Australis from the Space Shuttle

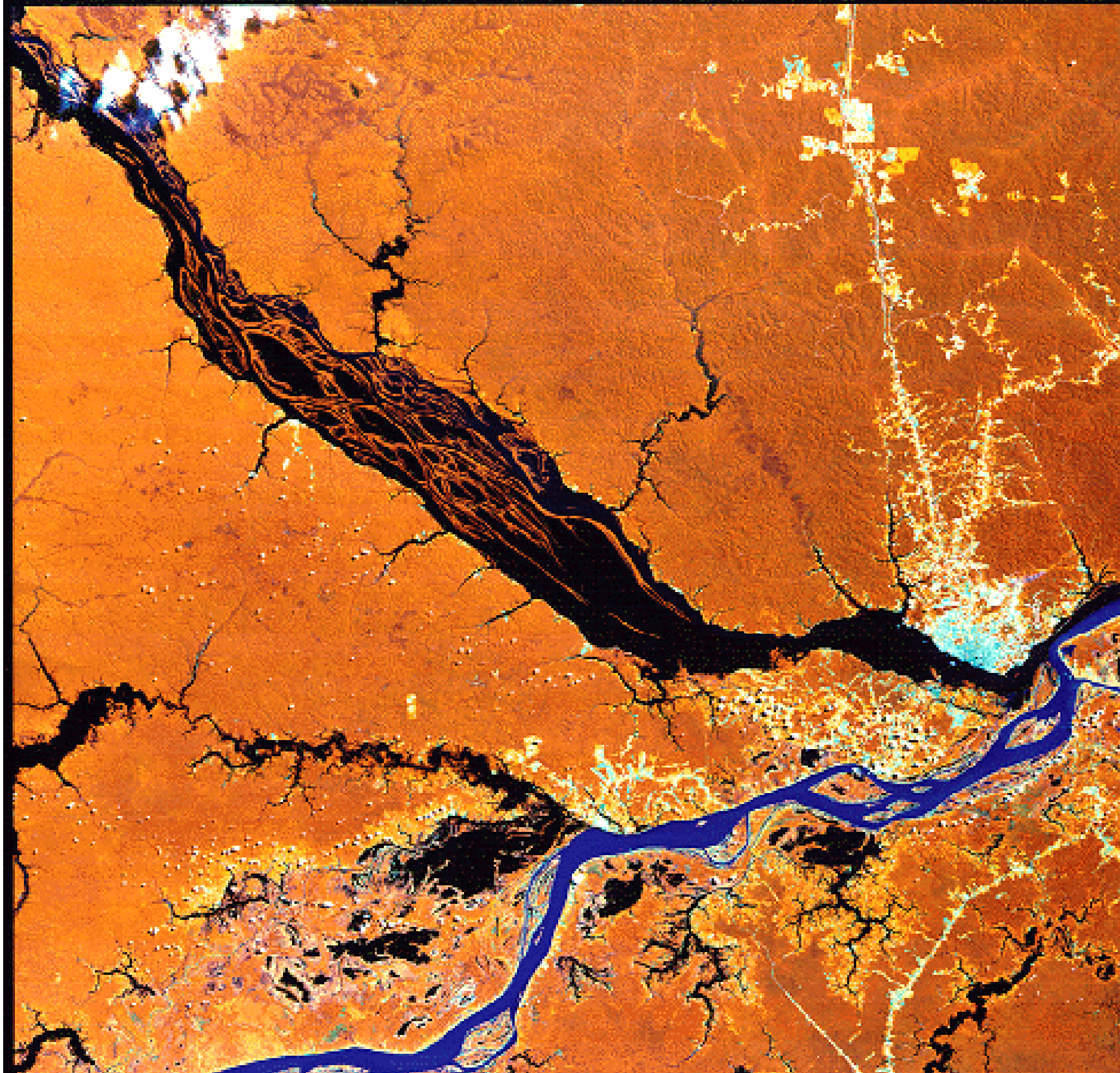

Florida Keys


Fort Jefferson Dry Tortugas National Park


Galapagos Islands

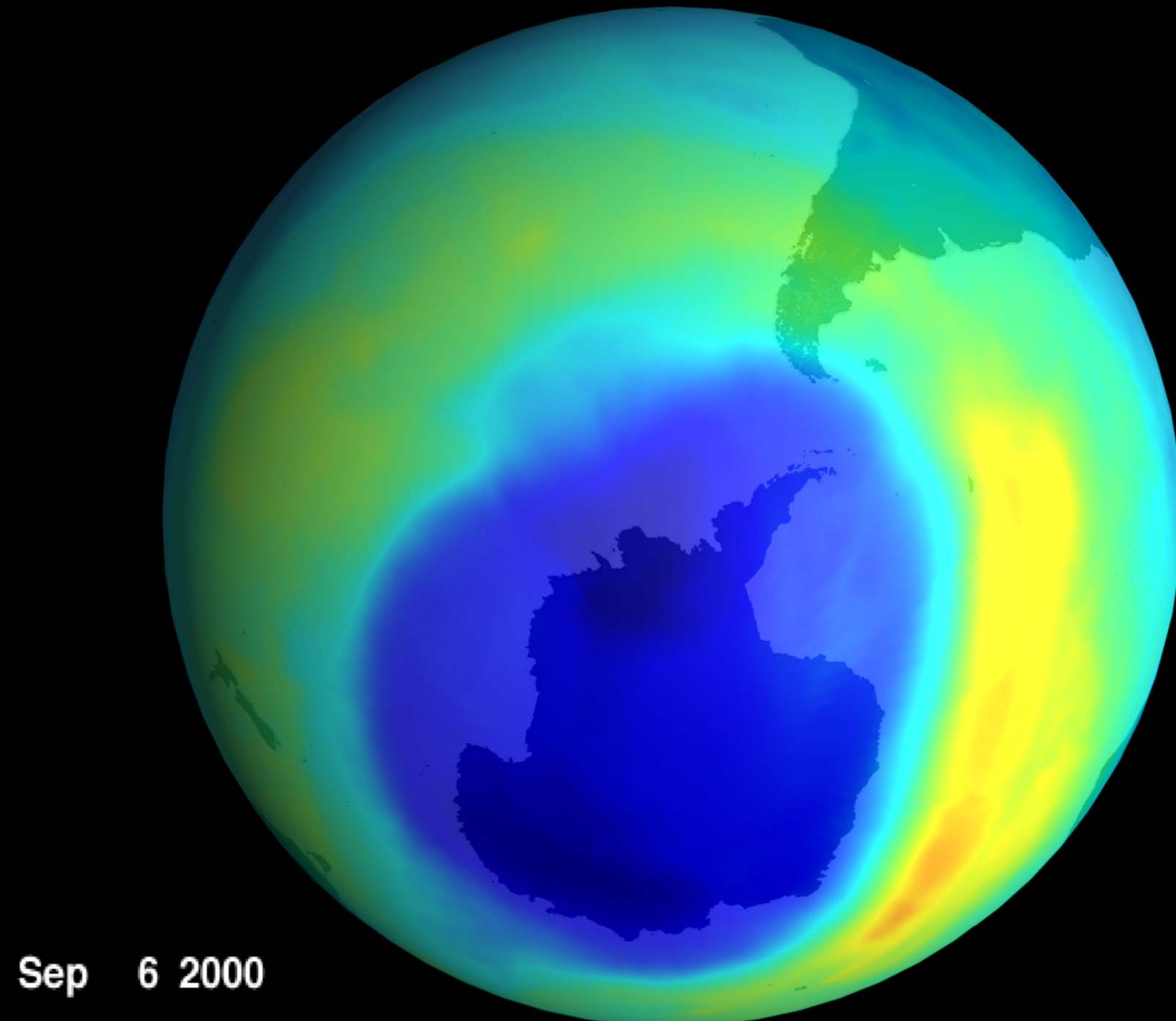

Sunset on Orbit


Dune Fields, Namibian Coastal Desert



Amazon
Deforestation

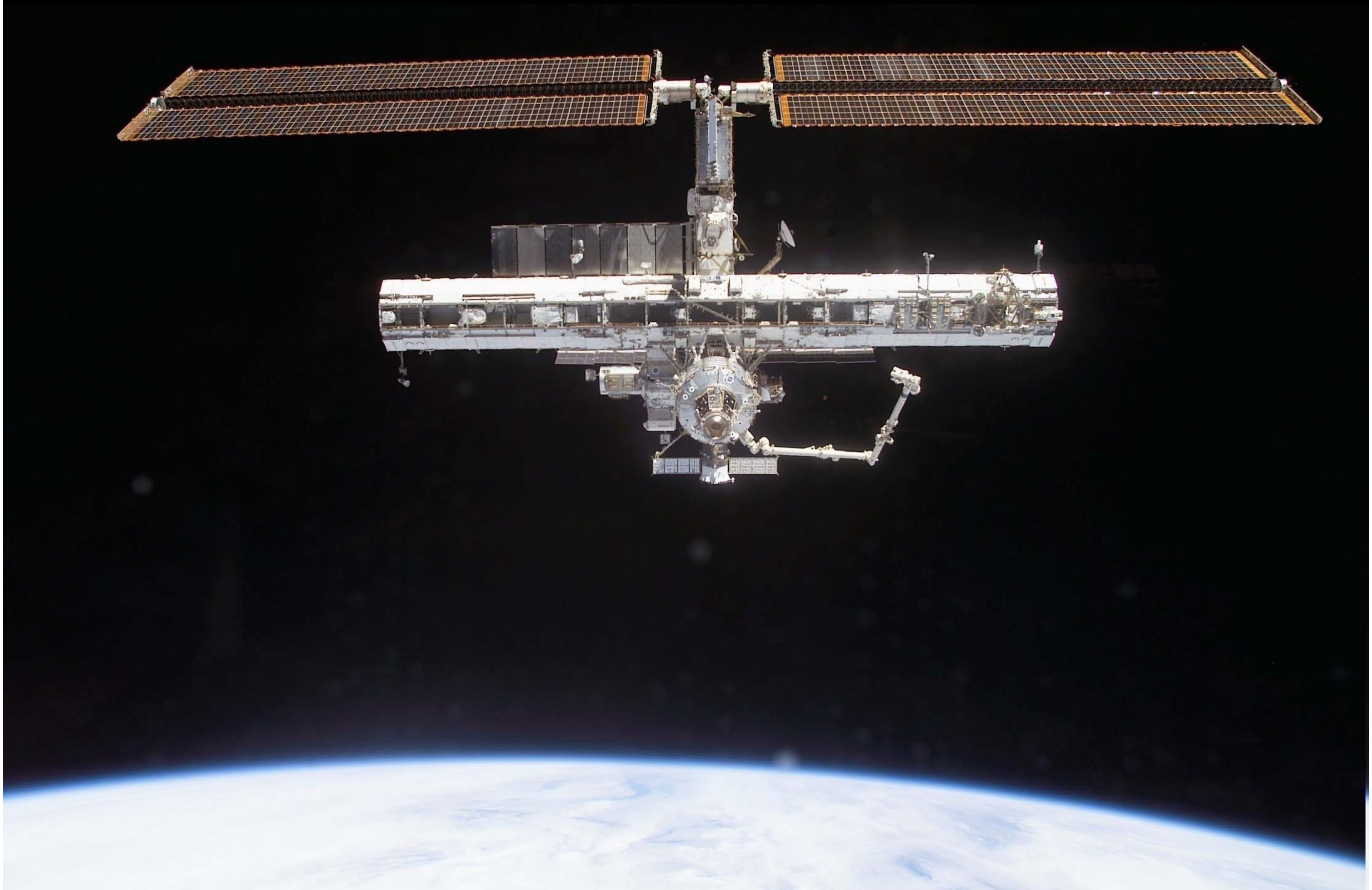
Ozone Hole Observed Over Antarctica




"Adventure Is worthwhile in itself"
Amelia Earhart

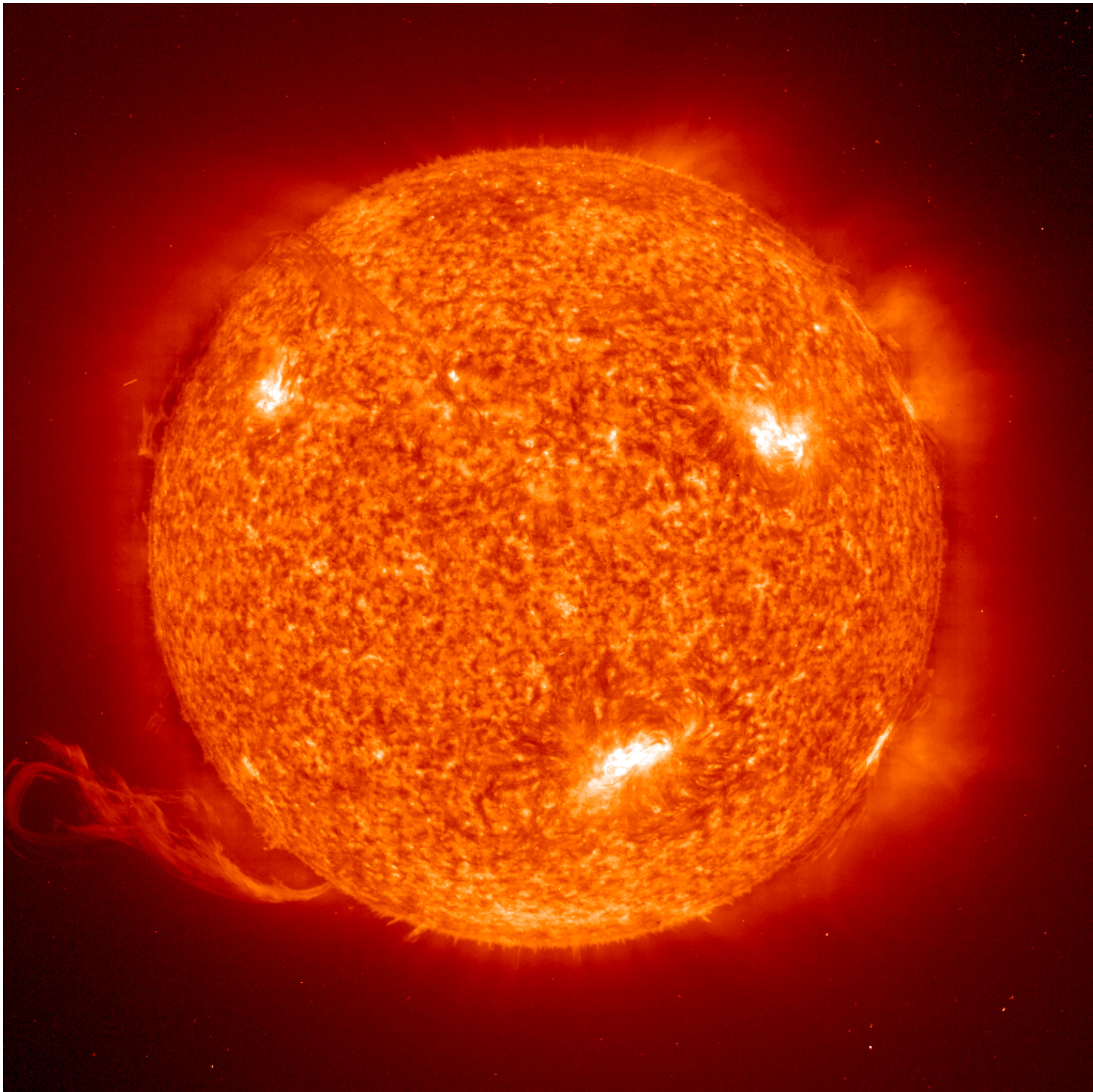

The Space Shuttle Challenger

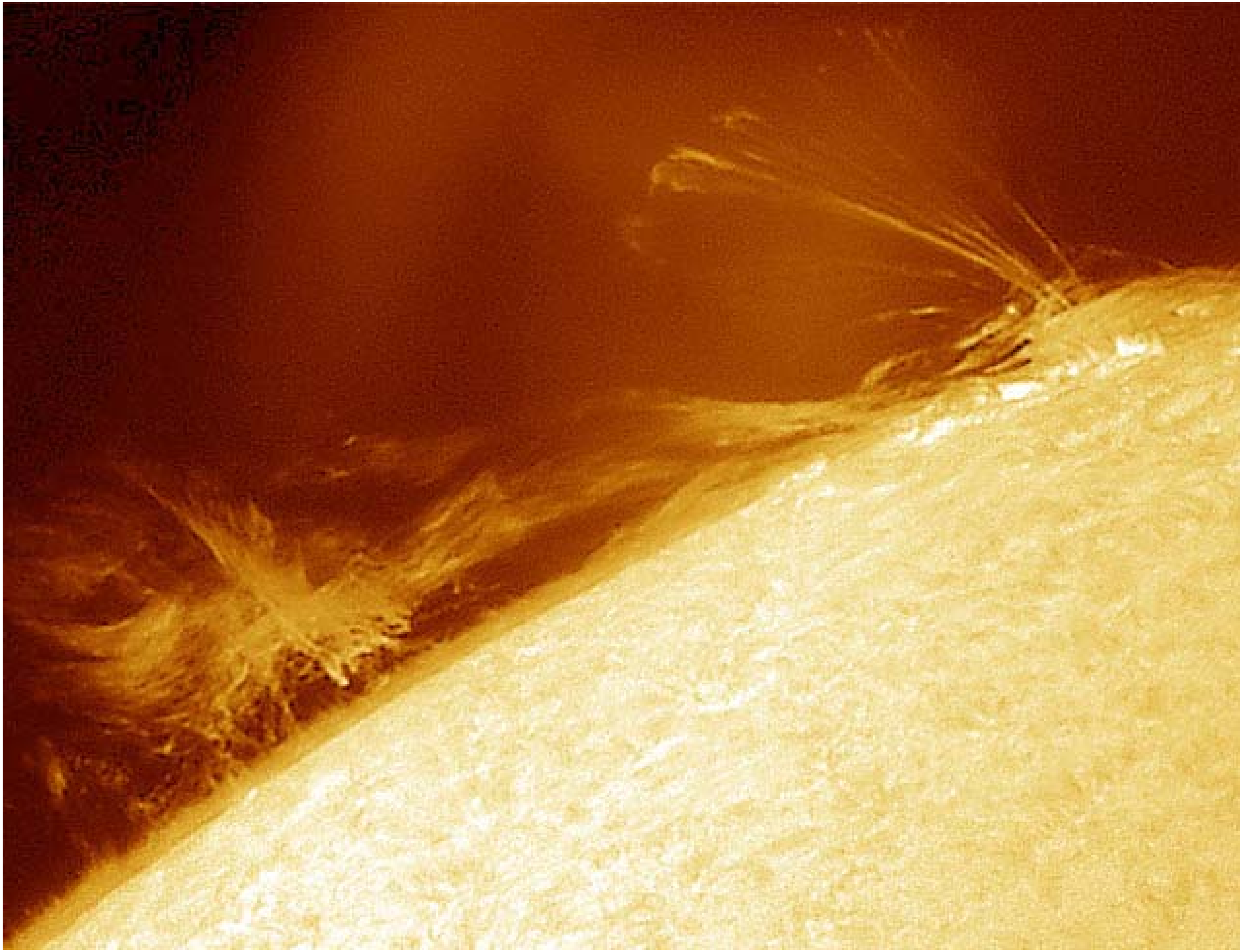
International Space Station

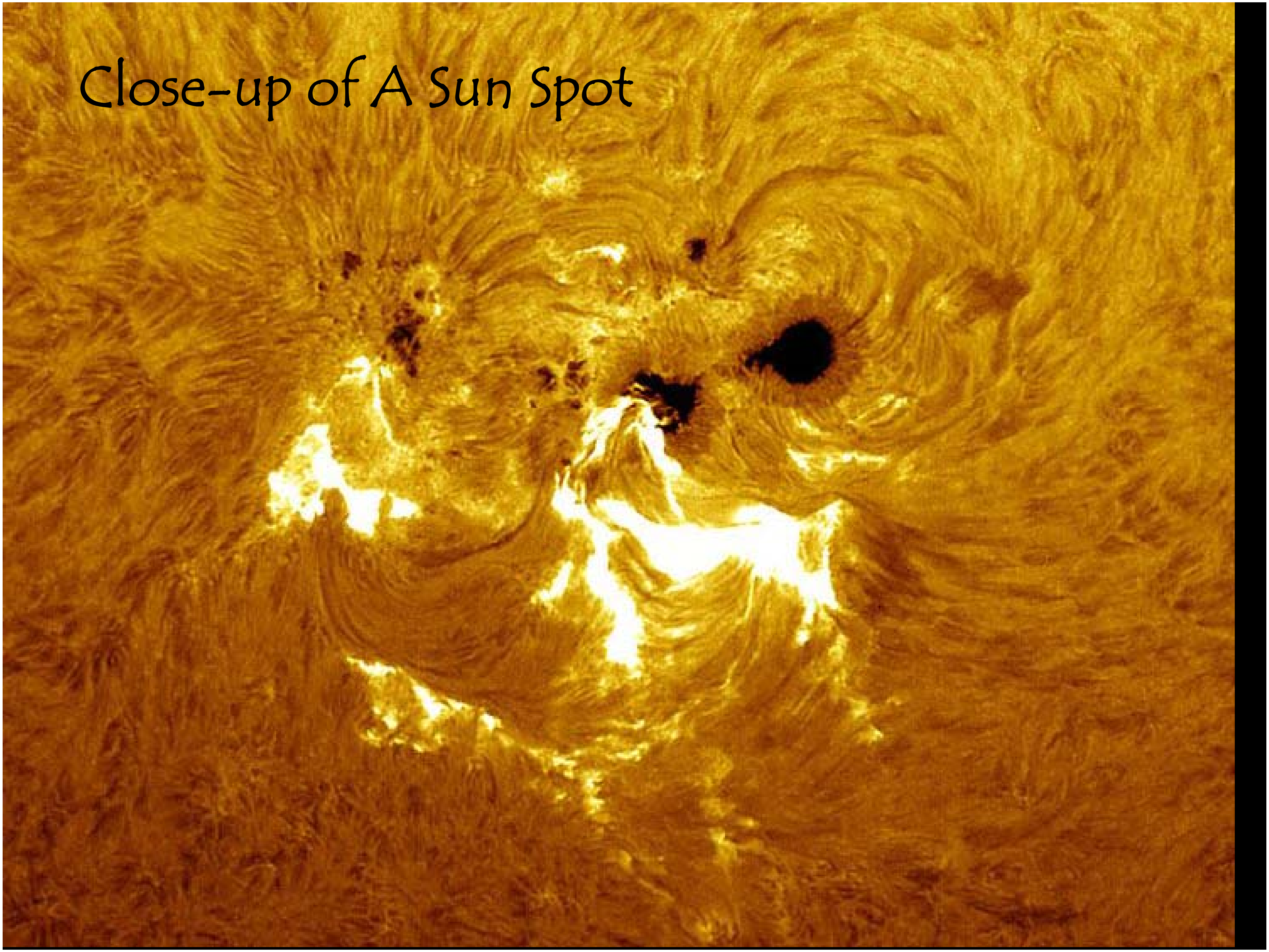


Sunset On The Space Shuttle

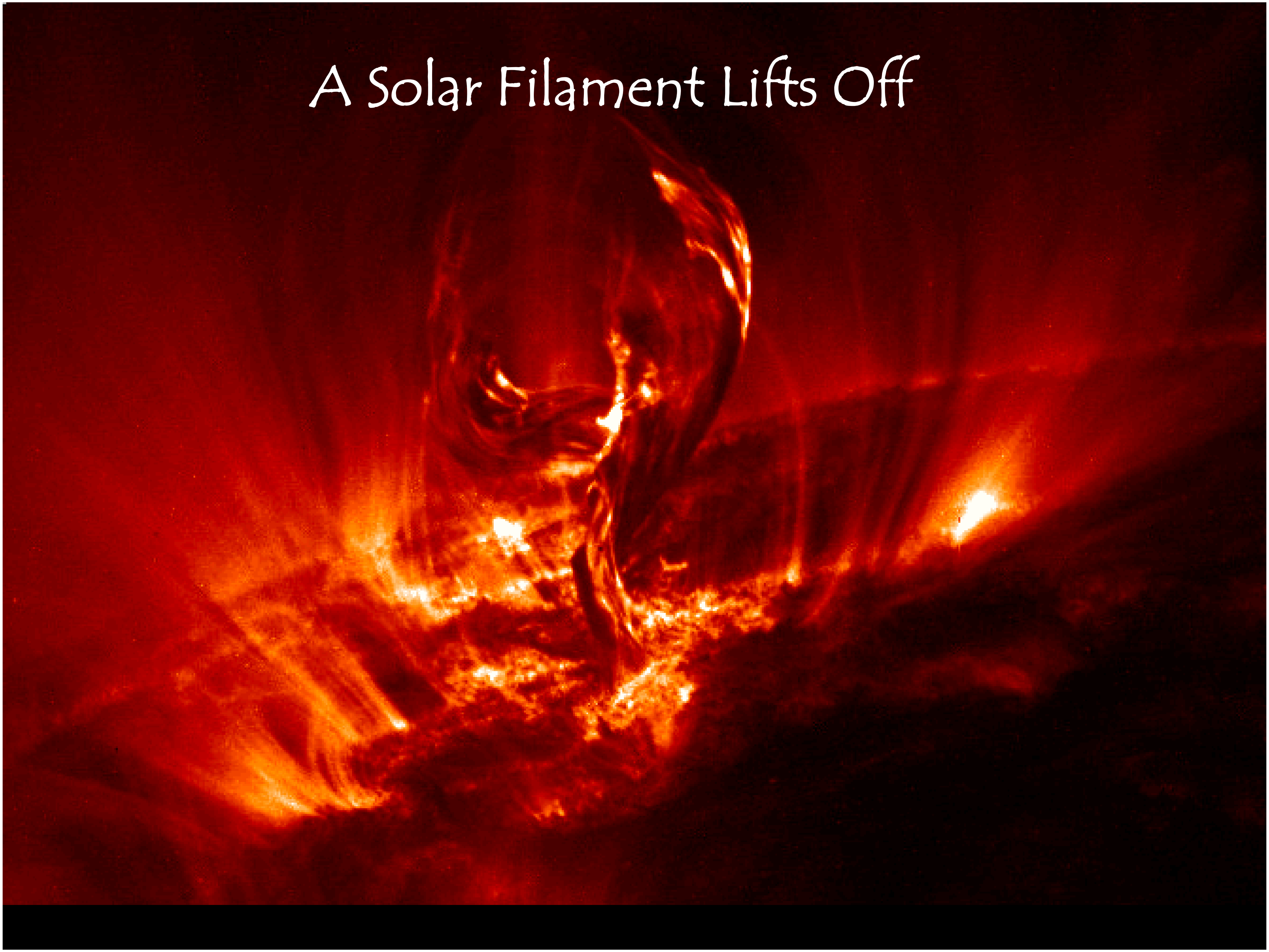
Our Sun






Close-up of A Sun Spot


Solar Flare


A Solar Filament Lifts Off

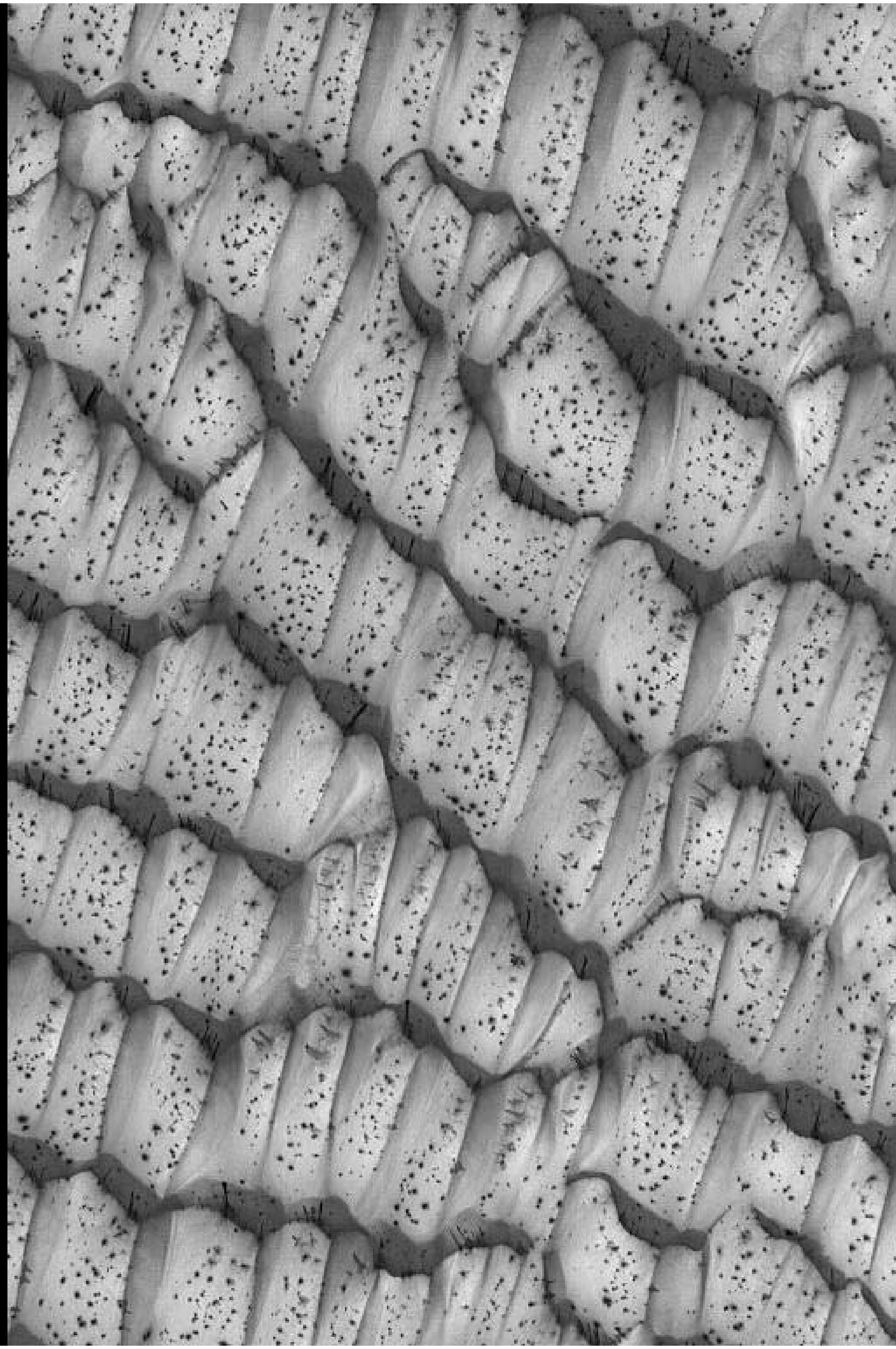
Mars

"No Pessimist
ever discovered
the secrets of the
stars ..

or sailed to an
uncharted land ..

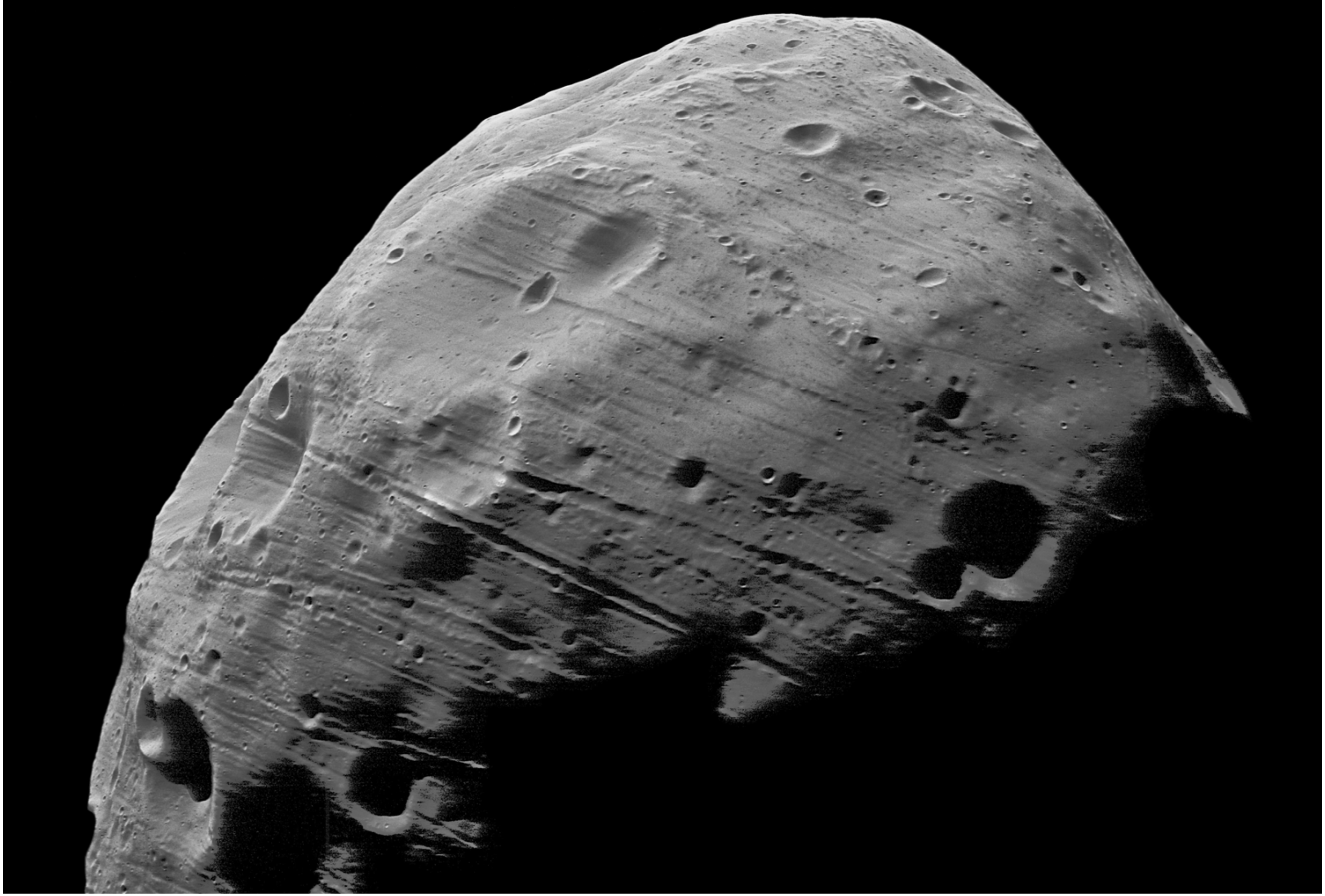
or opened a new
heaven to the
human spirit"

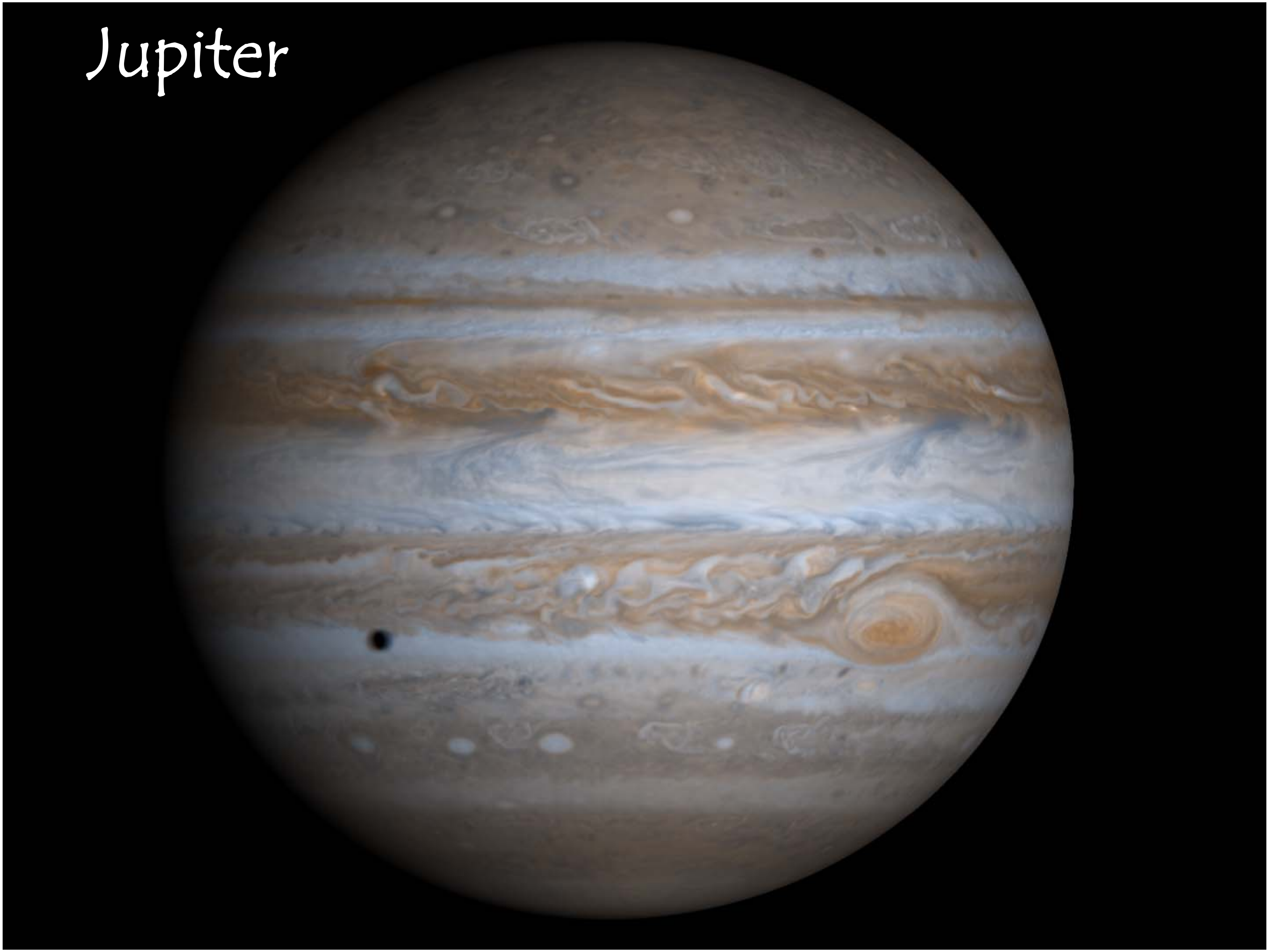
Helen Keller



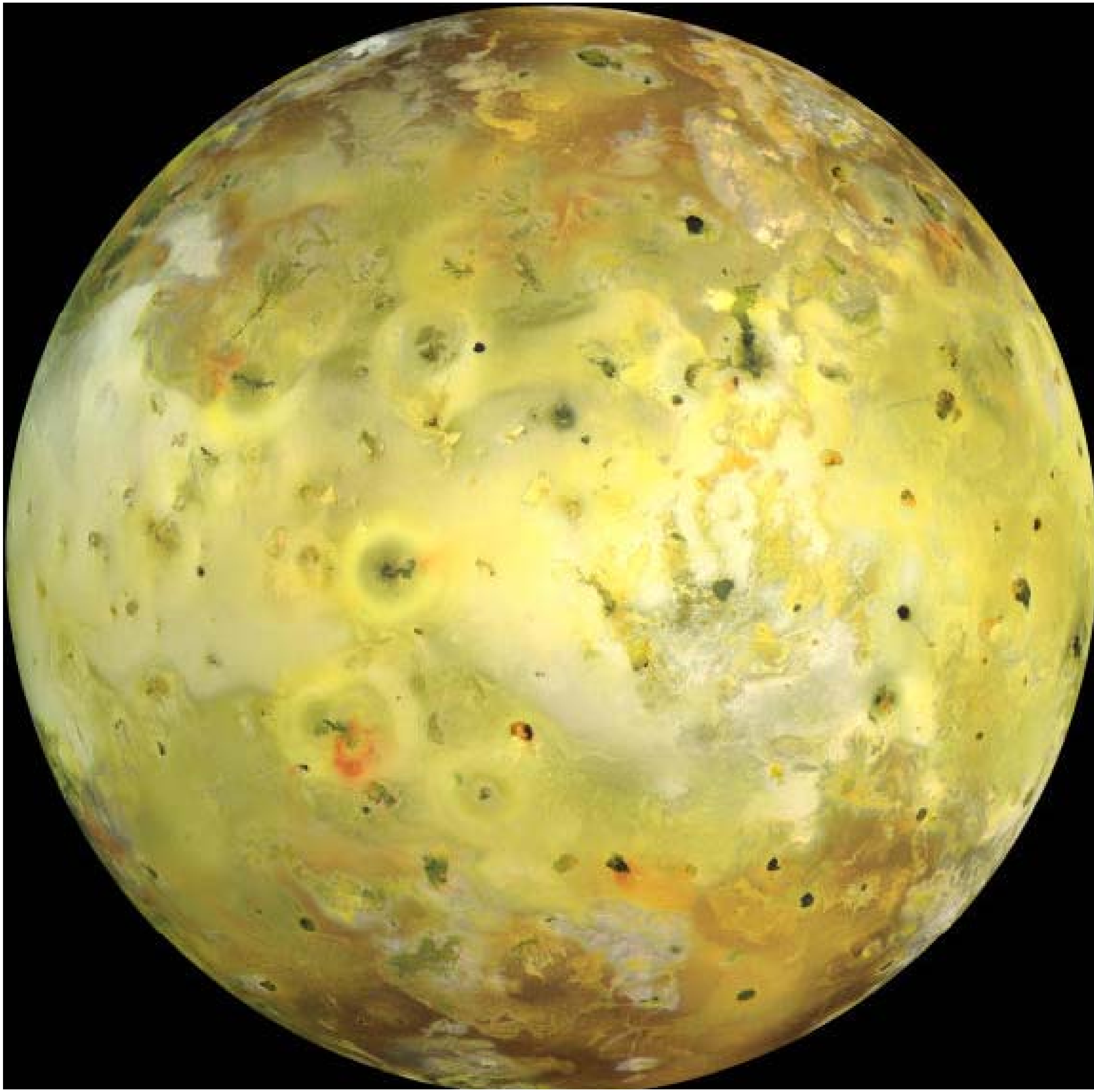
The Dotted Dunes of Mars

Mars' moon - Phobos

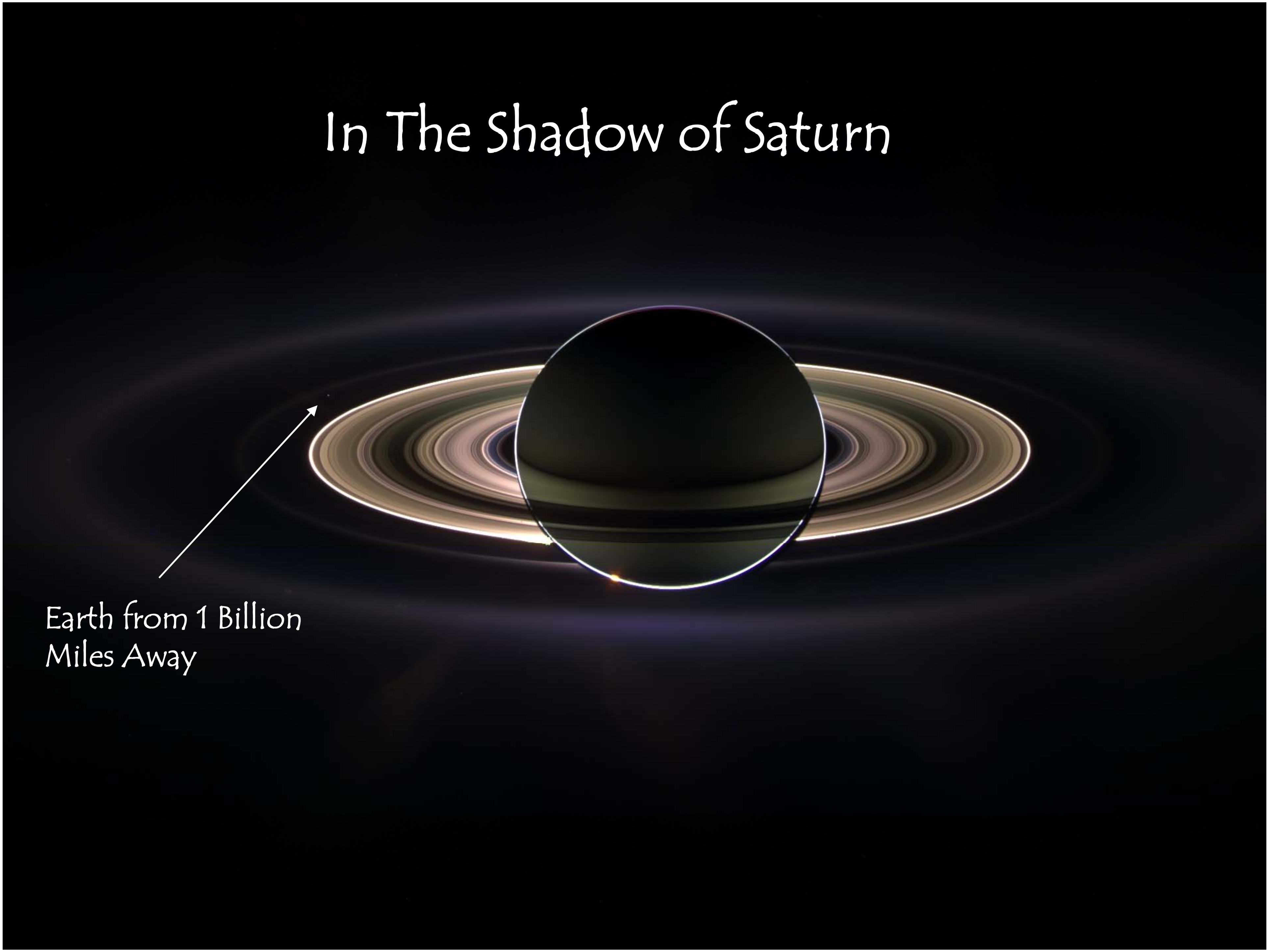


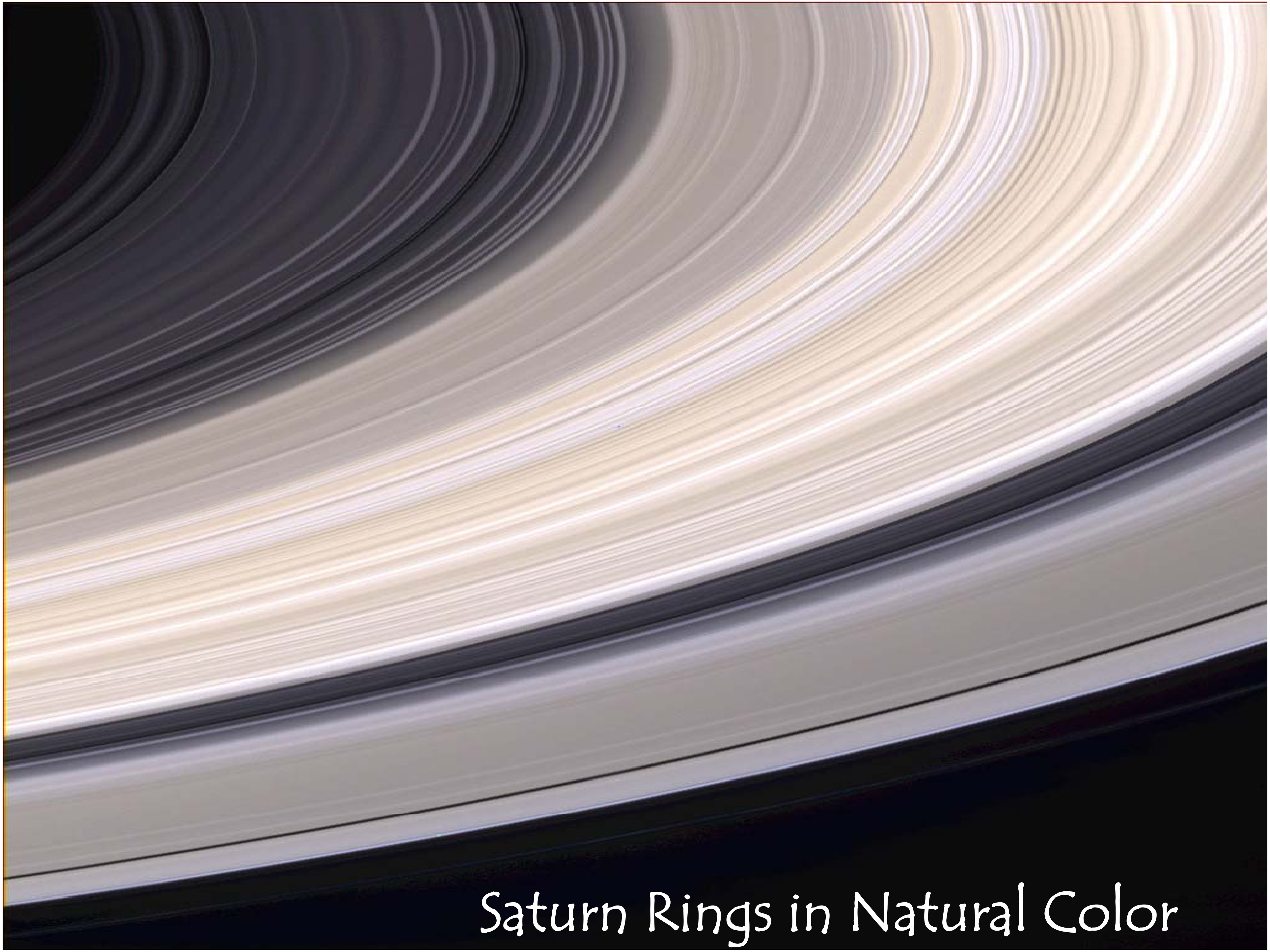

Jupiter

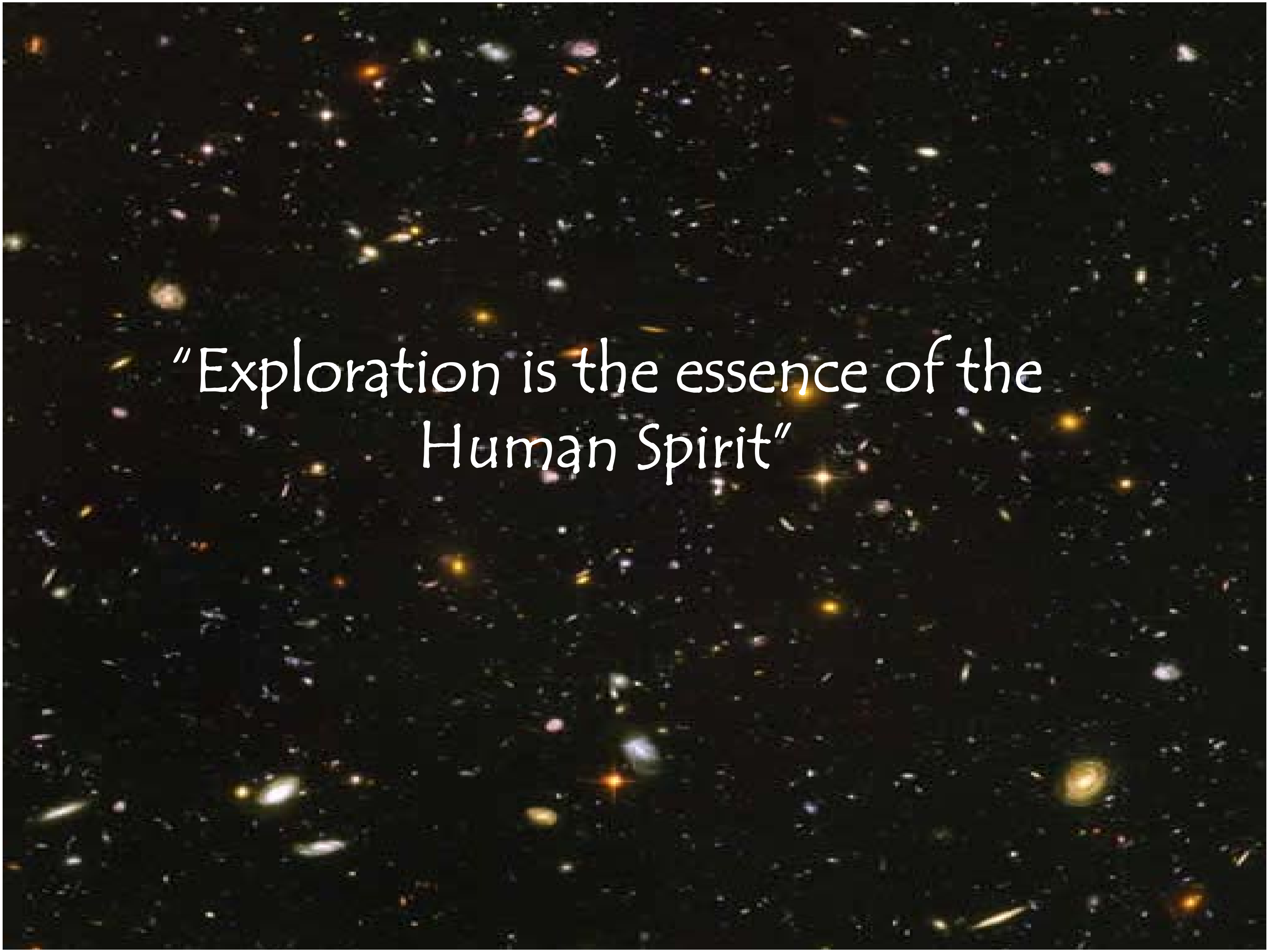

Jupiter and His Moon - Io



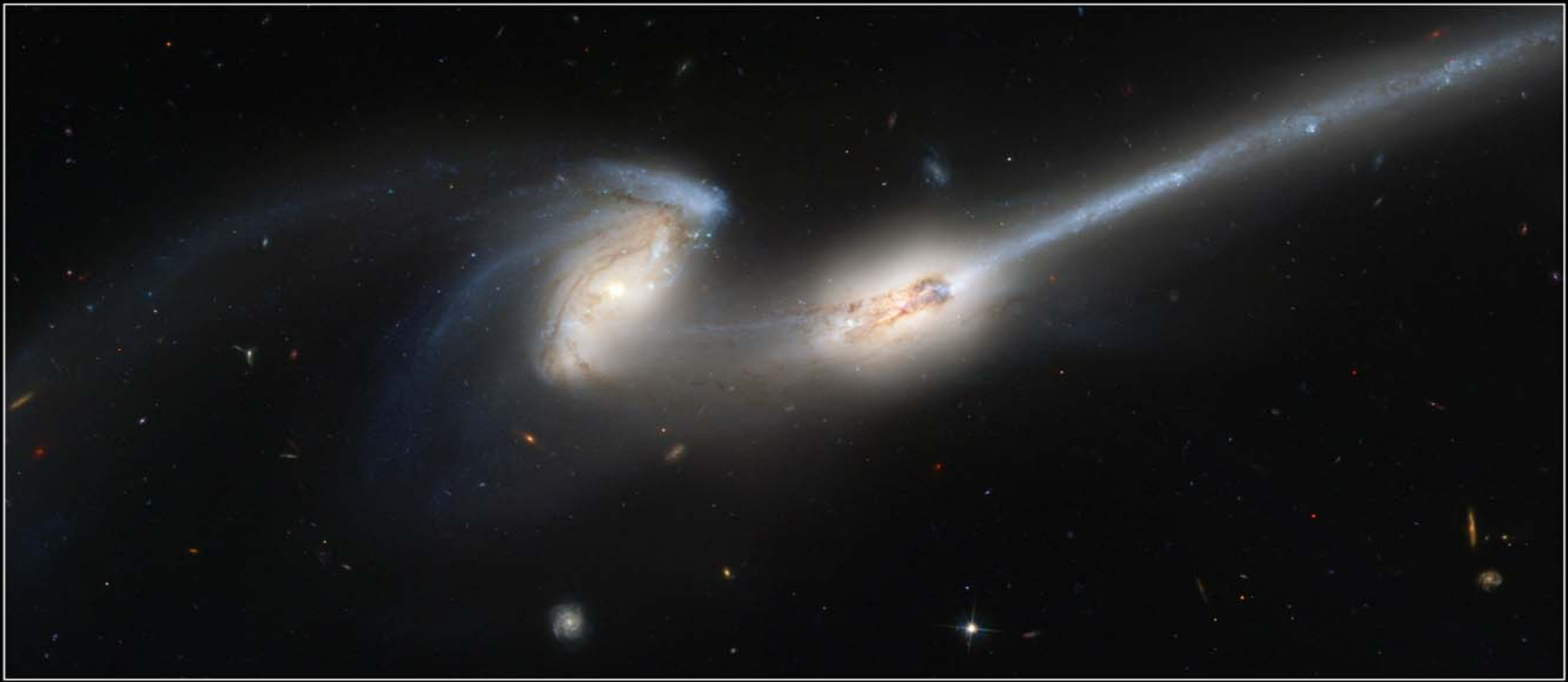
Io
In True
Color


In The Shadow of Saturn
Earth from 1 Billion
Miles Away


Saturn Rings in Natural Color


"Exploration is the essence of the
Human Spirit"

Galaxies Colliding



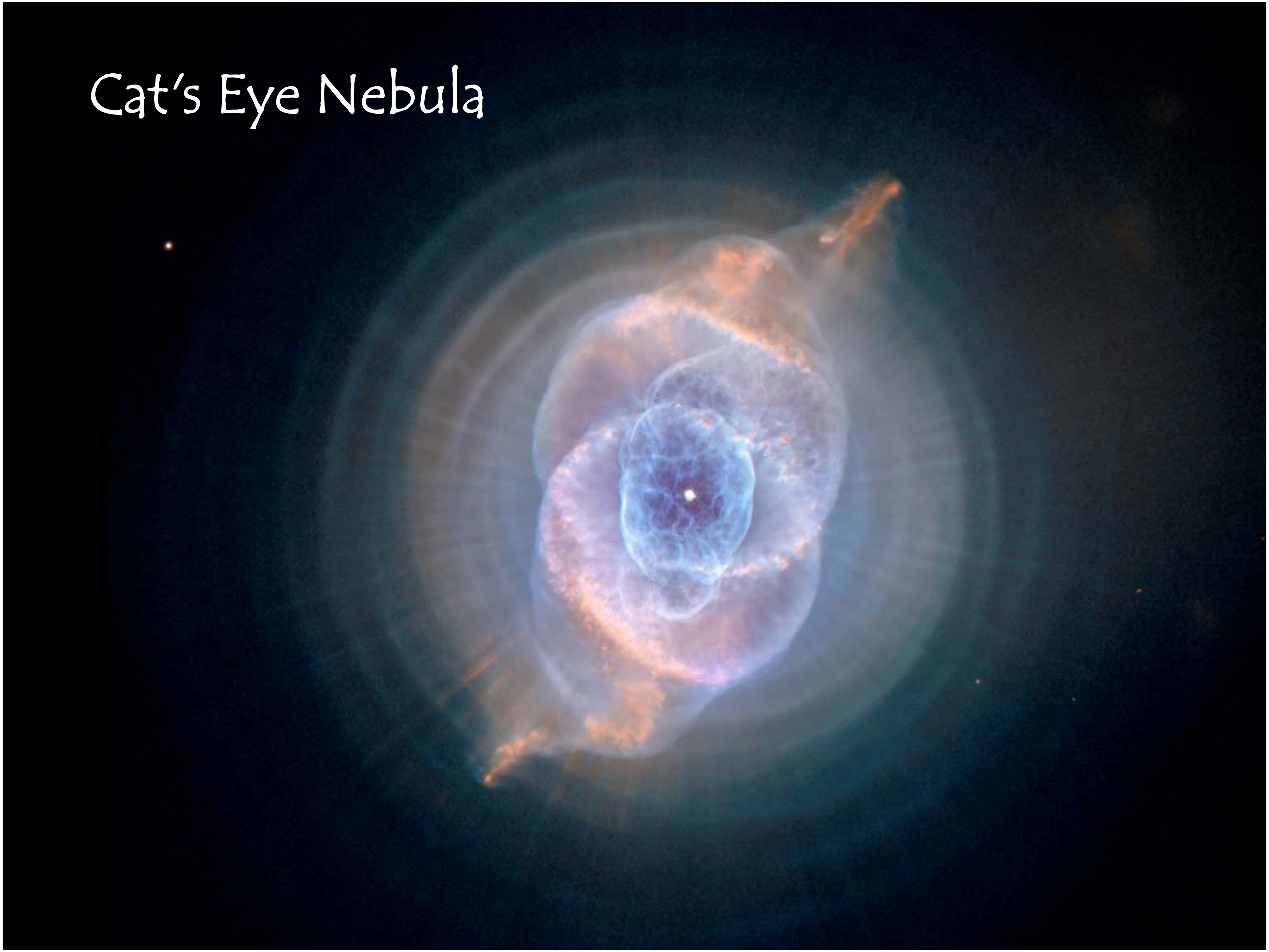
The Mice • Interacting Galaxies NGC 4676
Hubble Space Telescope • Advanced Camera for Surveys

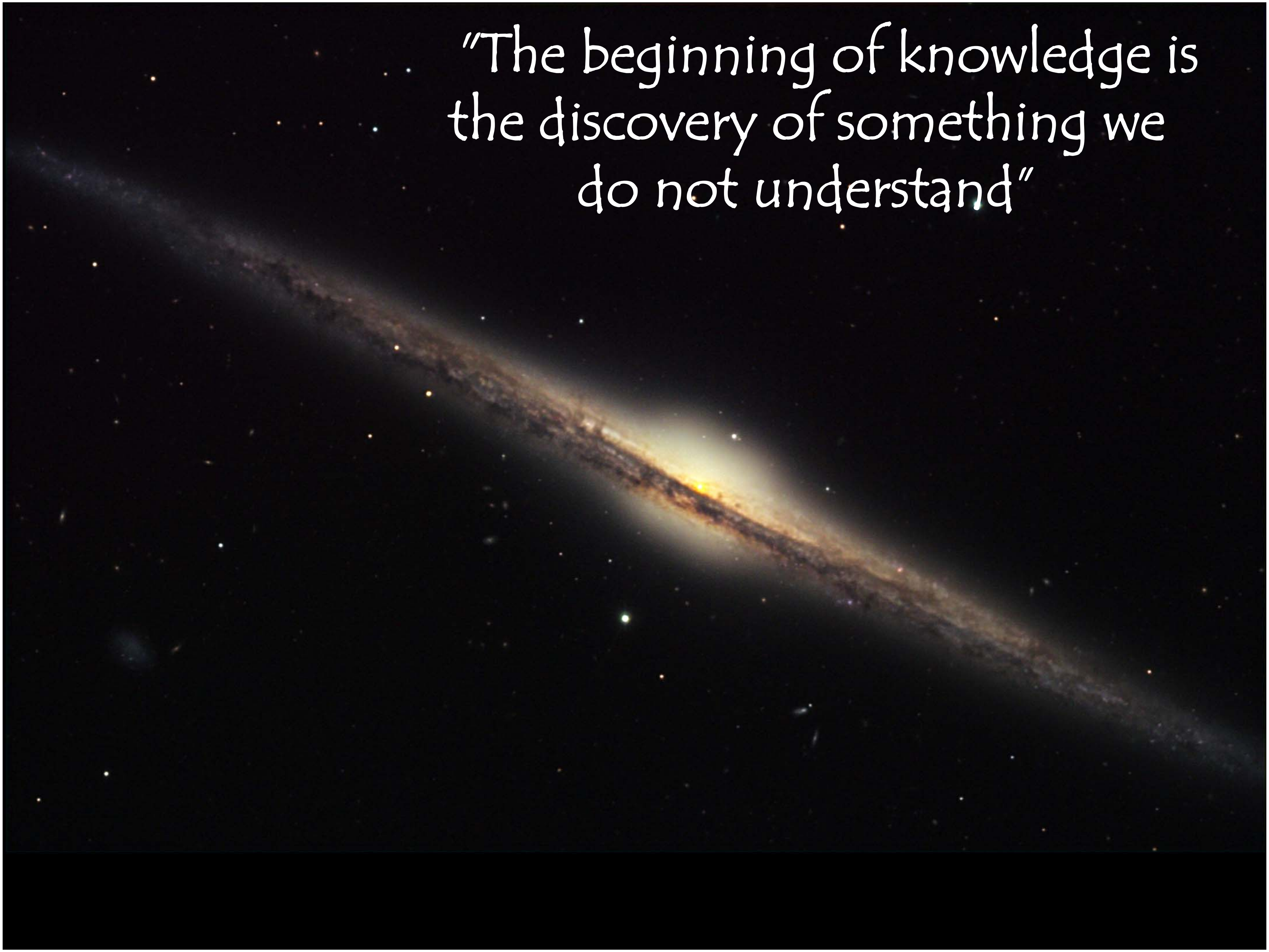
NASA, H. Ford (JHU), G. Illingworth (UCSC/LO), M. Clampin (STScI), G. Hartig (STScI) and the ACS Science Team • STScI-PRC02-11d

Galaxies Colliding


The Eagle Nebula
in Infrared


The Sombrero
Galaxy
in
Infrared


Cat's Eye Nebula


"The beginning of knowledge is
the discovery of something we
do not understand"

Ring Galaxy AM 0644-741

Hubble Heritage

Big Bright Bug Nebula

Hoag's Object

Hubble Heritage

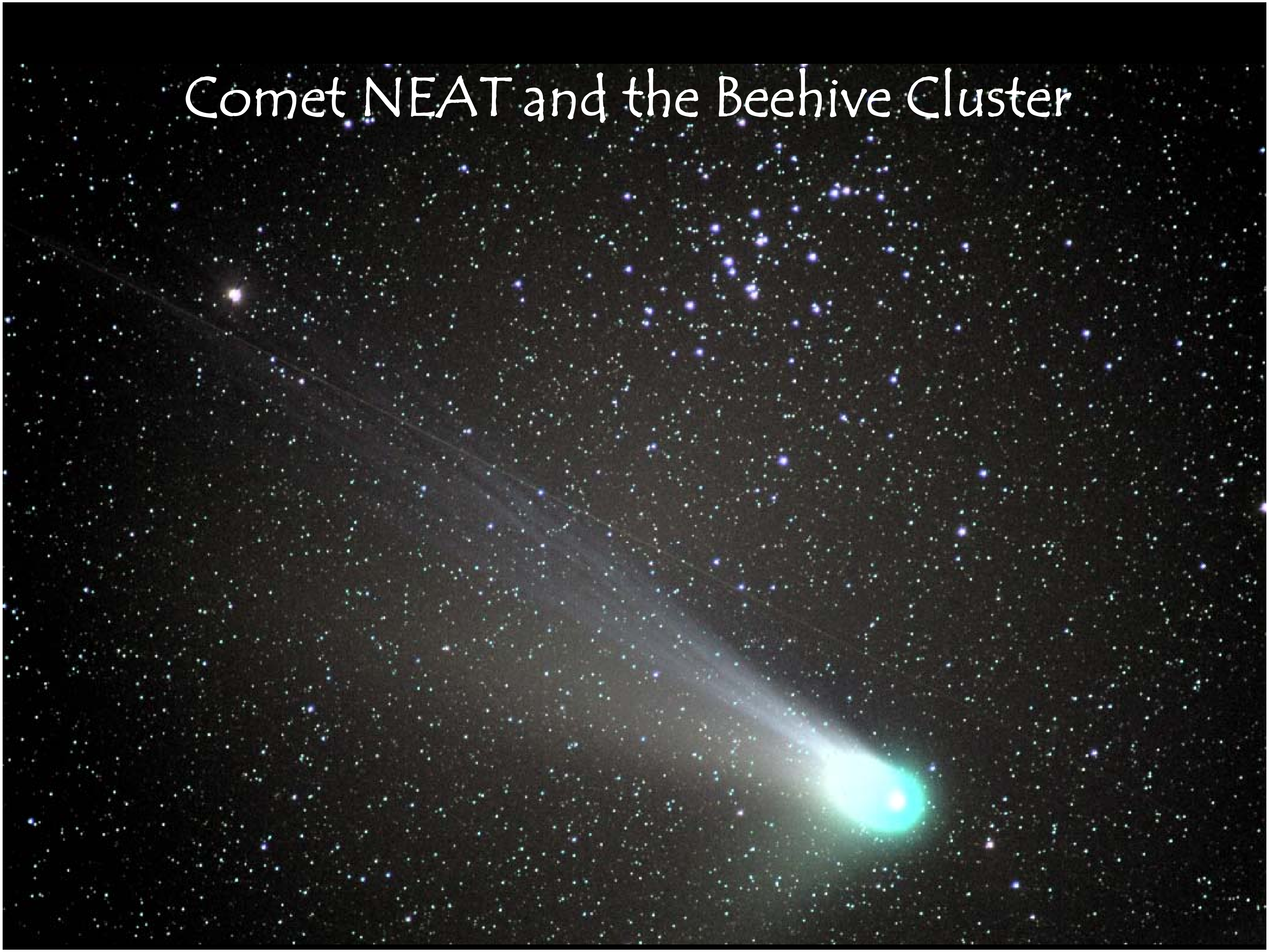
Cone Nebula

Hubble Space Telescope • Advanced Camera for Surveys

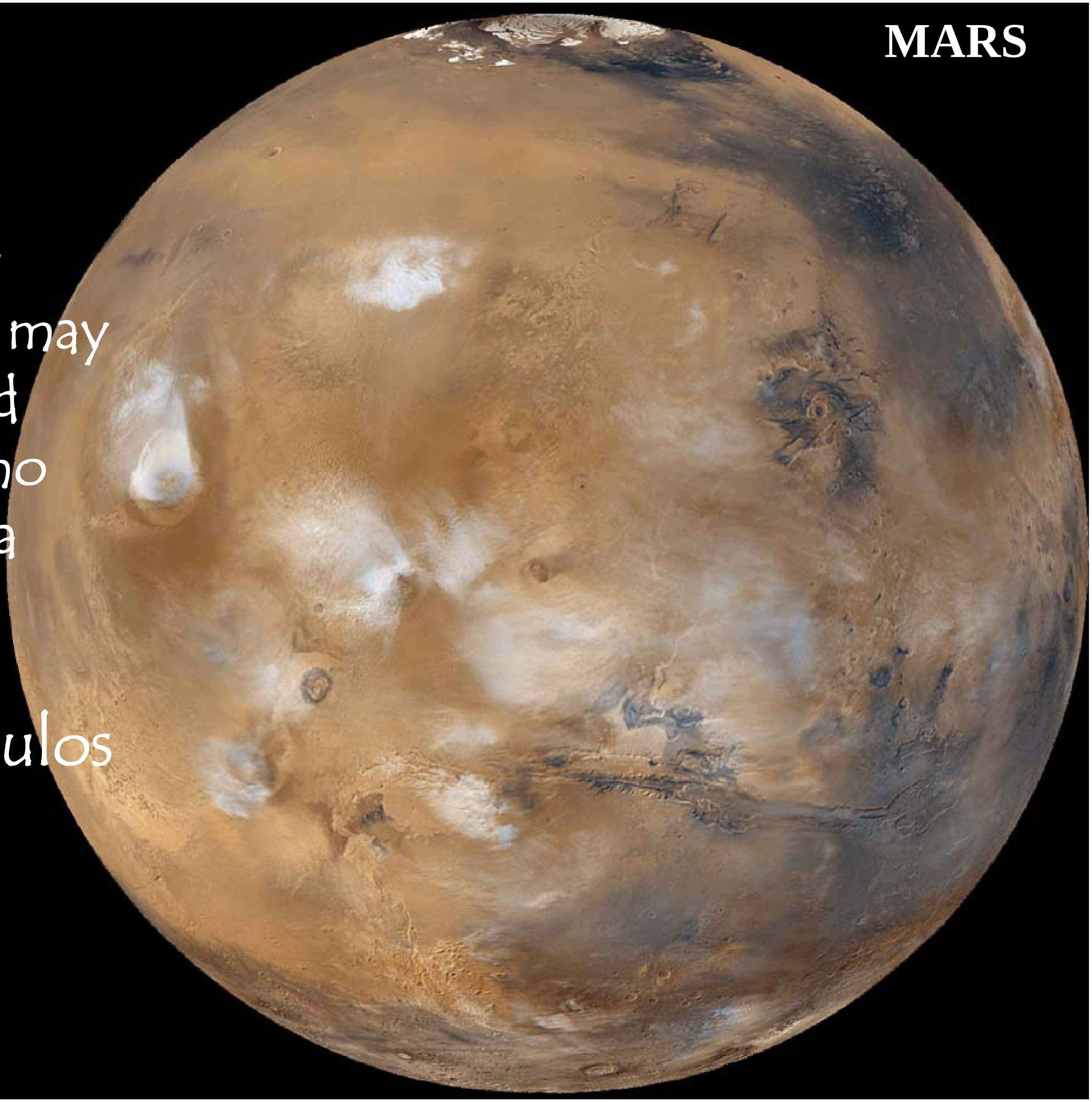
NASA, H. Ford (JHU), G. Illingworth (UCSC/LO), M. Clampin (STScI), G. Hartig (STScI)
and the ACS Science Team • STScI-PRC02-11b

Orion


The Great Andromeda Galaxy


Comet NEAT and the Beehive Cluster

MARS



"Do not follow where the path may lead. Go instead where there is no path and leave a trail."

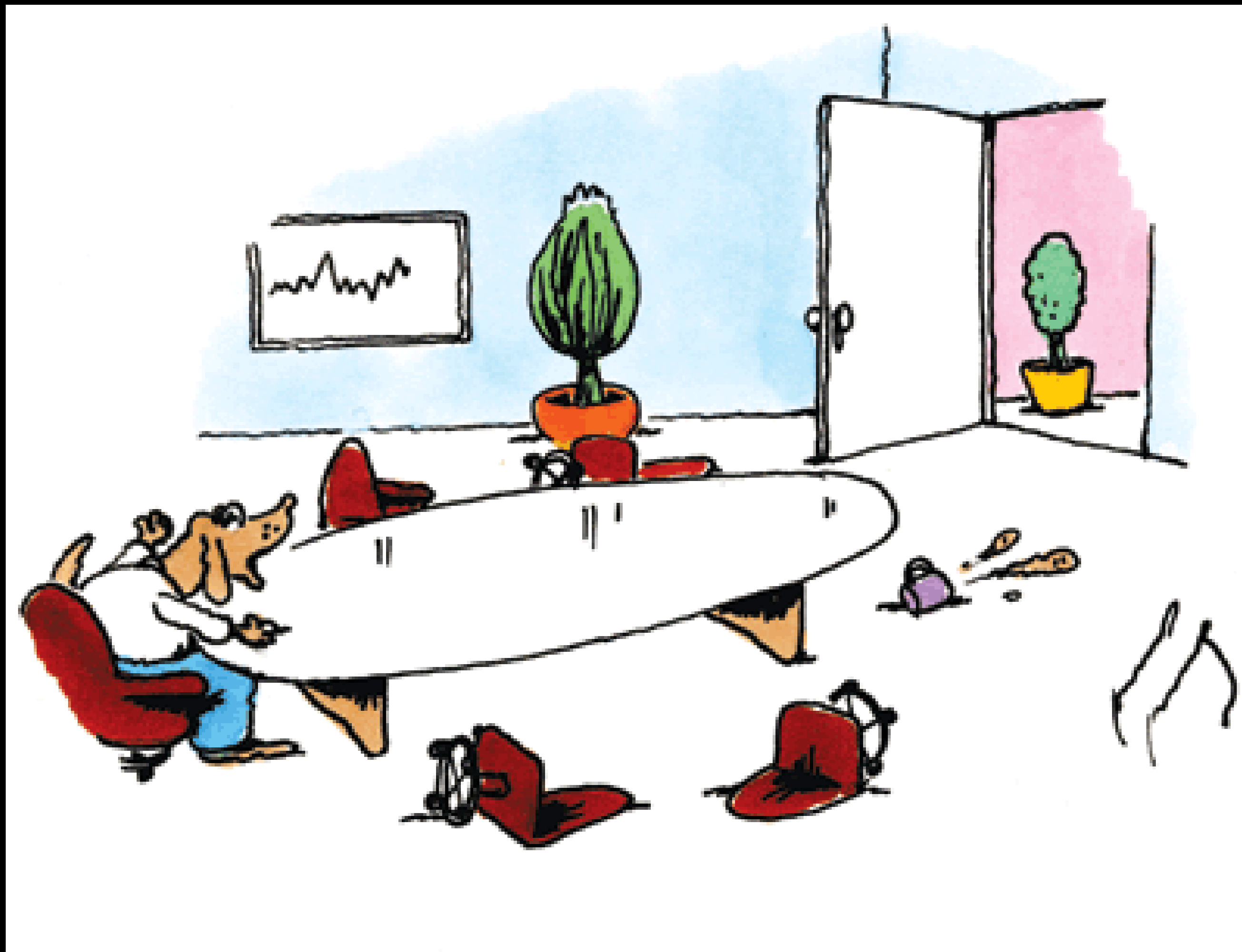
R. Zaphiropoulos

NASA


"Earth is the cradle of mankind.
But one cannot live in the cradle
forever."
Konstantin E. Tsiolkovsky

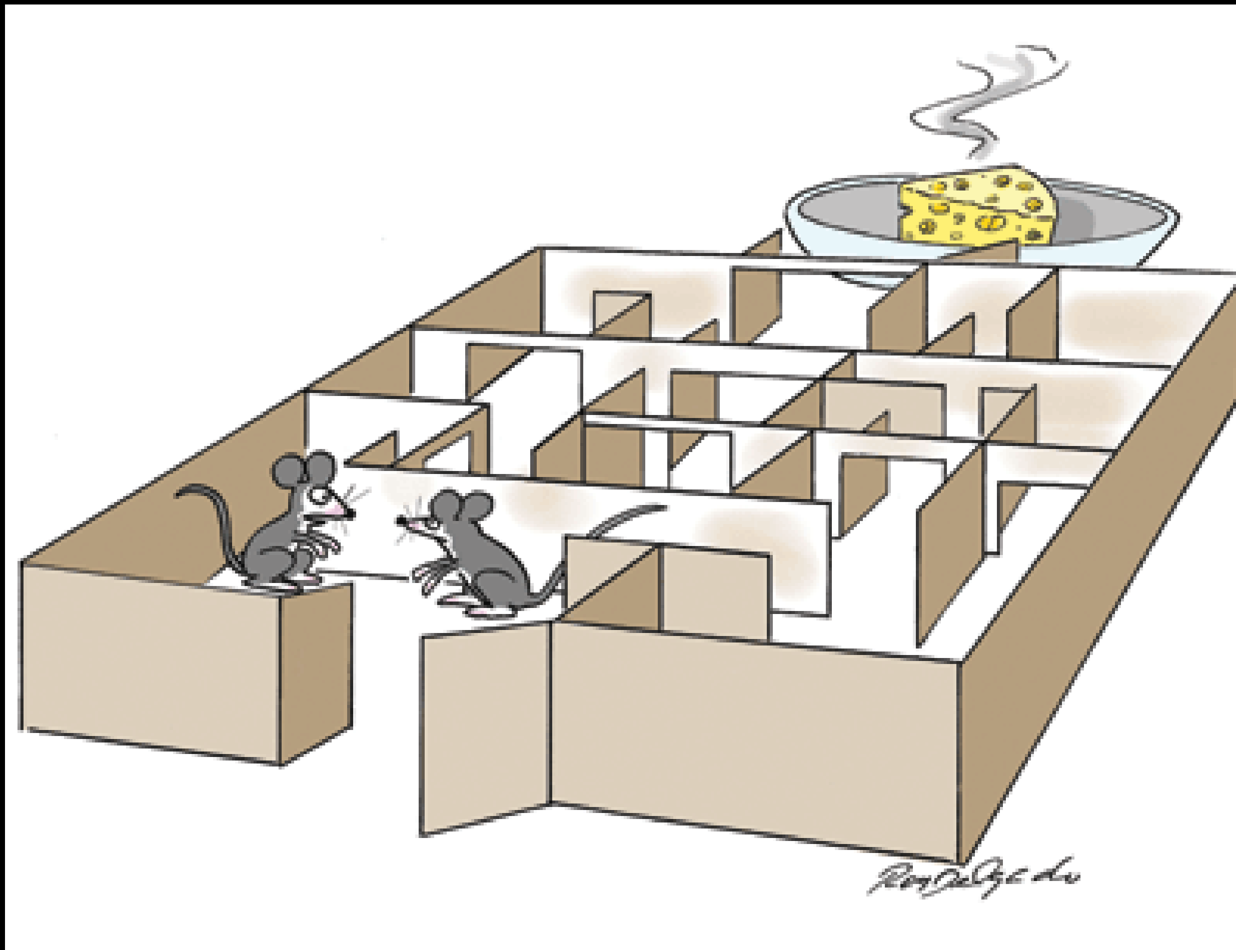
NASA Web Site

http://spaceflight.nasa.gov



"Oh sure, you're all focused and motivated until the first electric can opener goes off!"

Cartoon by Scott Arthur Masear



"For me, it's more about a job well done and less about the cheese."

Cartoon by Roy Delgado

"Of all the obstacles on my way to the top,
the Invisible Fence was the toughest."

Cartoon by Scott Arthur Masear

Q&A

How We Plan to Return to the Moon
Crew Exploration Vehicle

- **A blunt body capsule is the safest, most affordable and fastest approach**
  - Separate Crew Module and Service Module configuration
  - Vehicle designed for lunar missions with 4 crew
    - Can accommodate up to 6 crew for Mars and Space Station missions
  - System also has the potential to deliver pressurized and unpressurized cargo to the Space Station if needed

- **5 meter diameter capsule scaled from Apollo**
  - Significant increase in volume
  - Reduced development time and risk
  - Reduced reentry loads, increased landing stability and better crew visibility

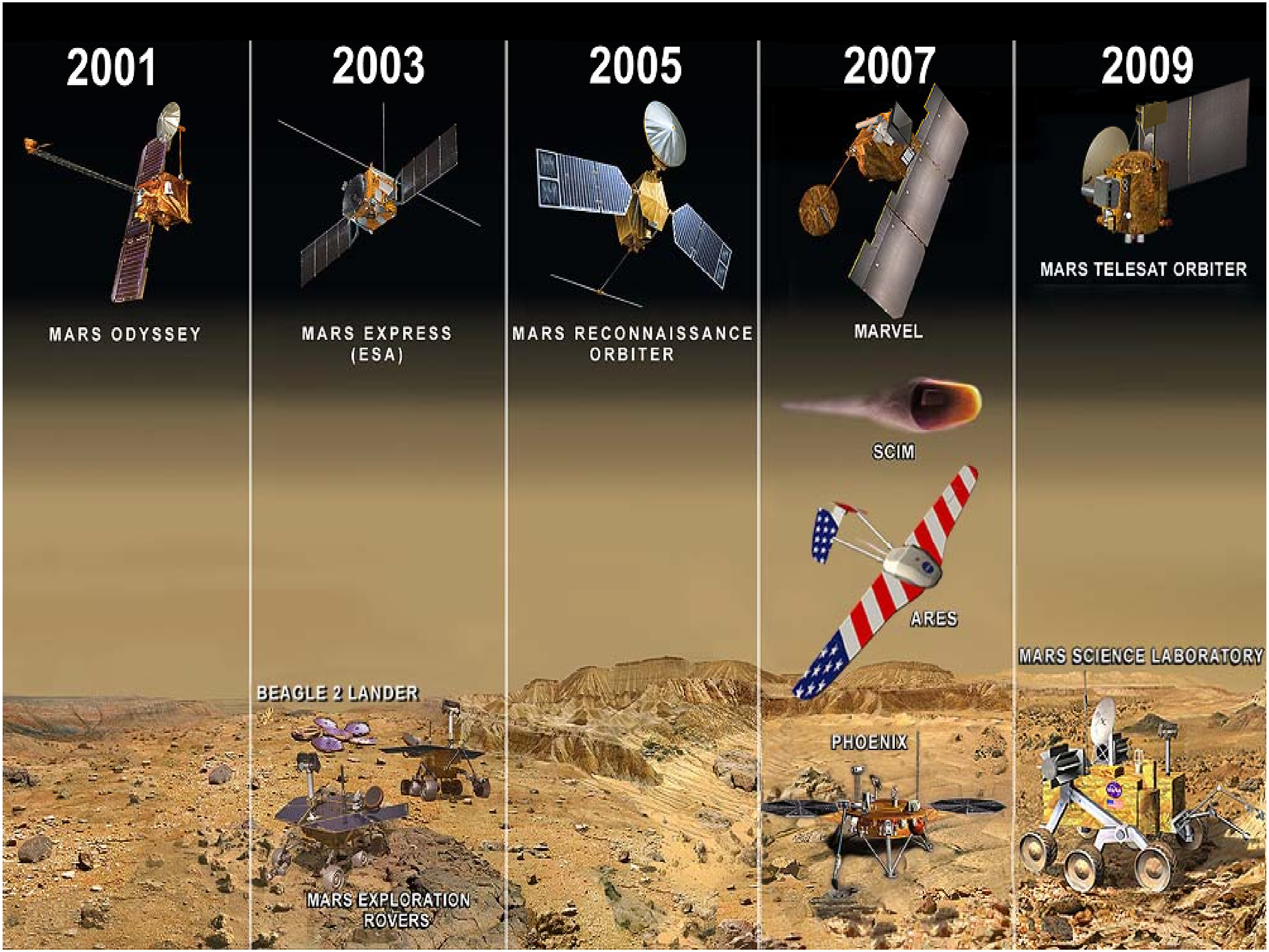
Earth Departure Stage

- **Liquid oxygen / liquid hydrogen stage**
  - Heritage from the Shuttle External Tank
  - J-2S engines (or equivalent)
- **Stage ignites suborbitally and delivers the lander to low Earth orbit**
  - Can also be used as an upper stage for low-earth orbit missions
- **The CEV later docks with this system and the earth departure stage performs a trans-lunar injection burn**
- **The earth departure stage is then discarded**

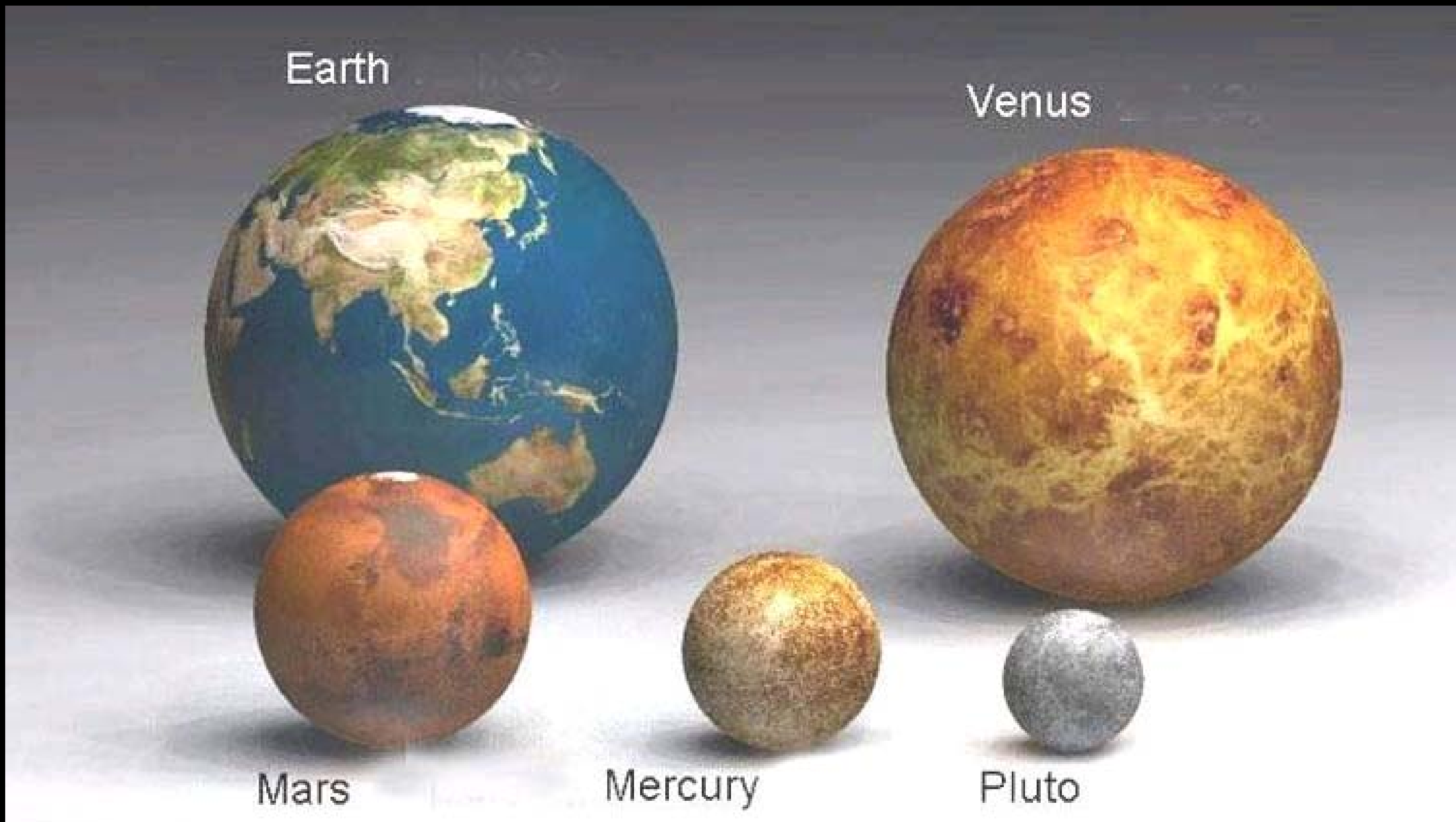
How We Plan to Return to the Moon

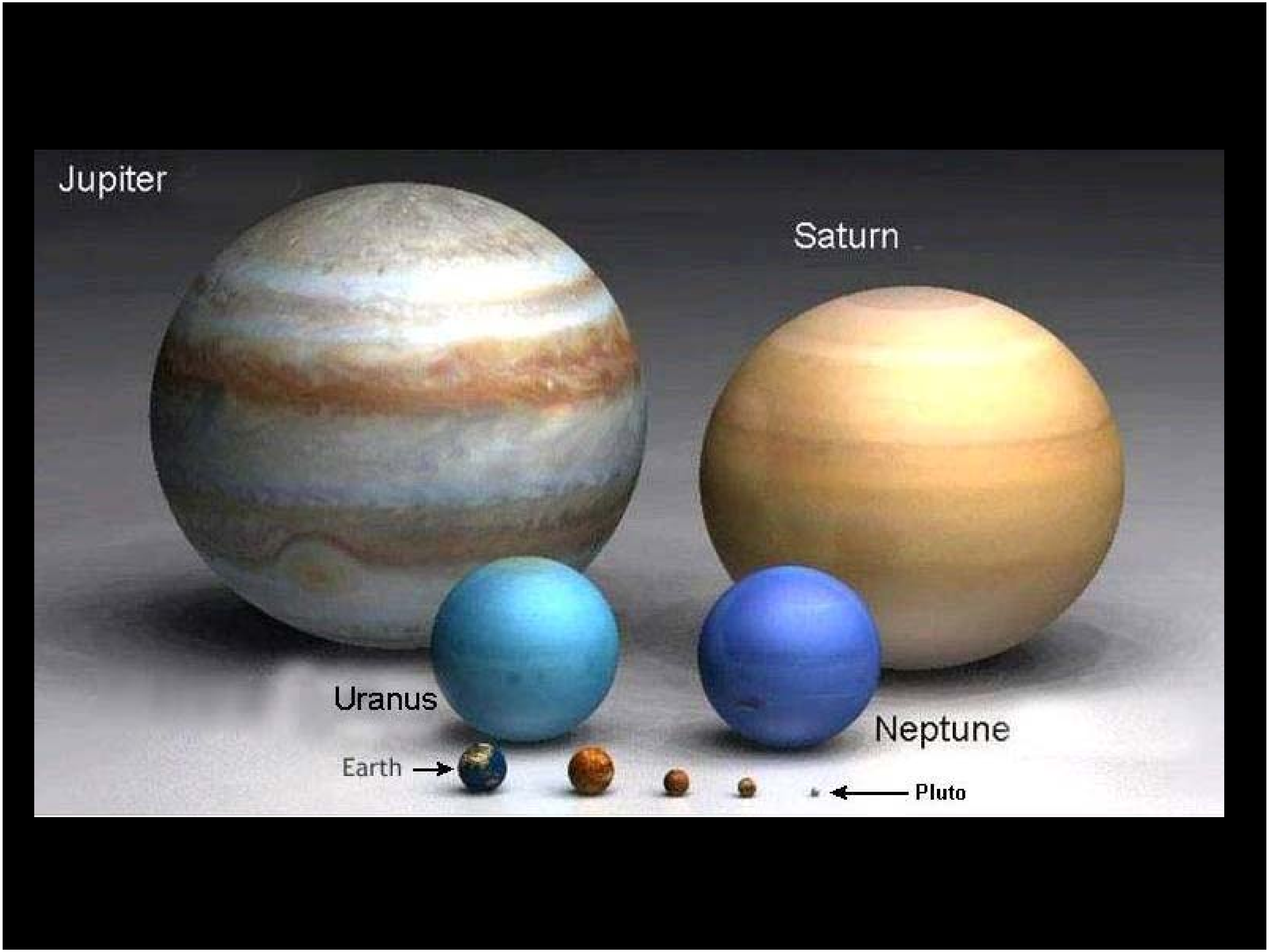
Lunar Lander and Ascent Stage

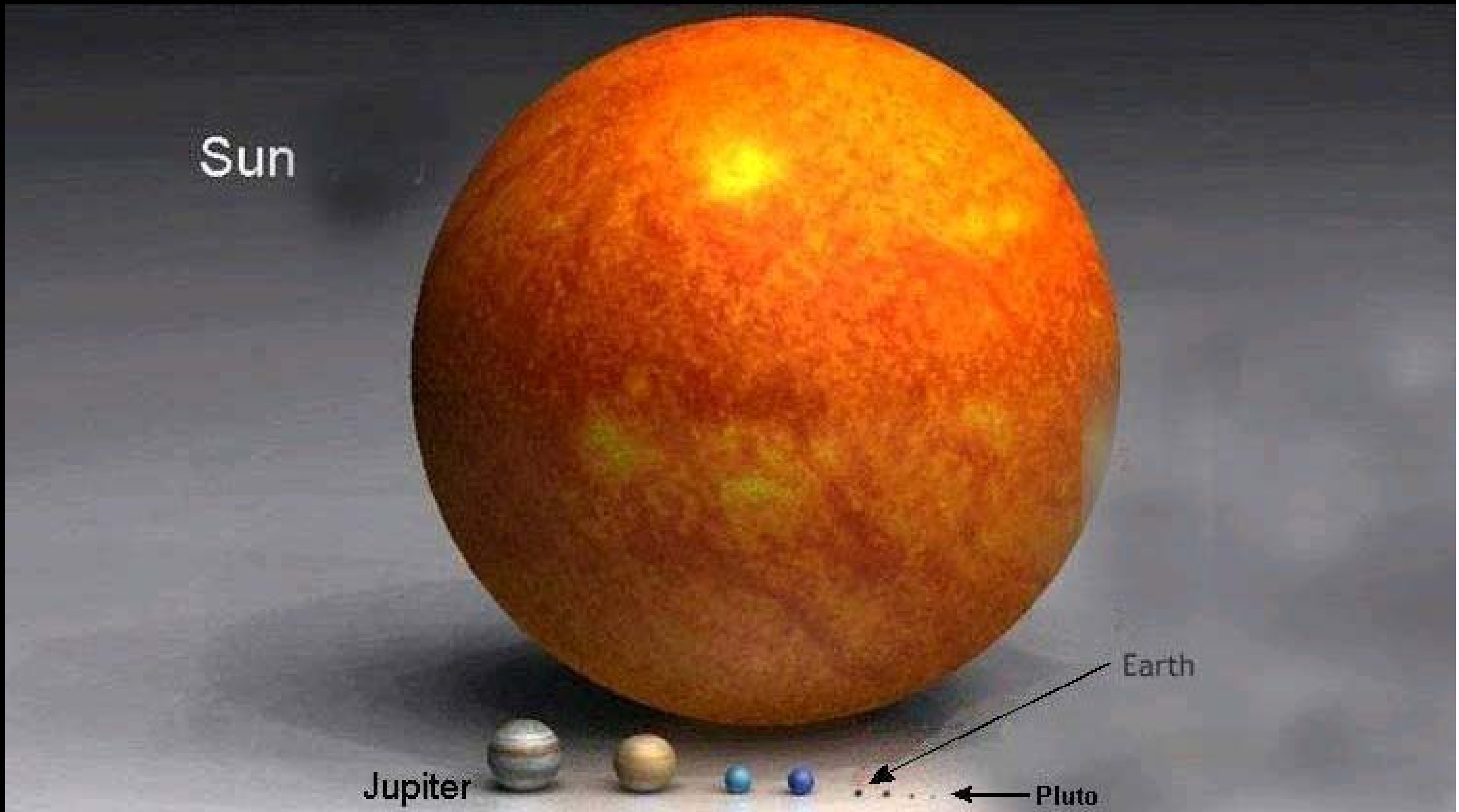
- **4 crew to and from the surface**
  - Seven days on the surface
  - Lunar outpost crew rotation
- **Global access capability**
- **Anytime return to Earth**
- **Capability to land 21 metric tons of dedicated cargo**
- **Airlock for surface activities**
- **Descent stage:**
  - Liquid oxygen / liquid hydrogen propulsion
- **Ascent stage:**
  - Liquid oxygen / liquid methane propulsion

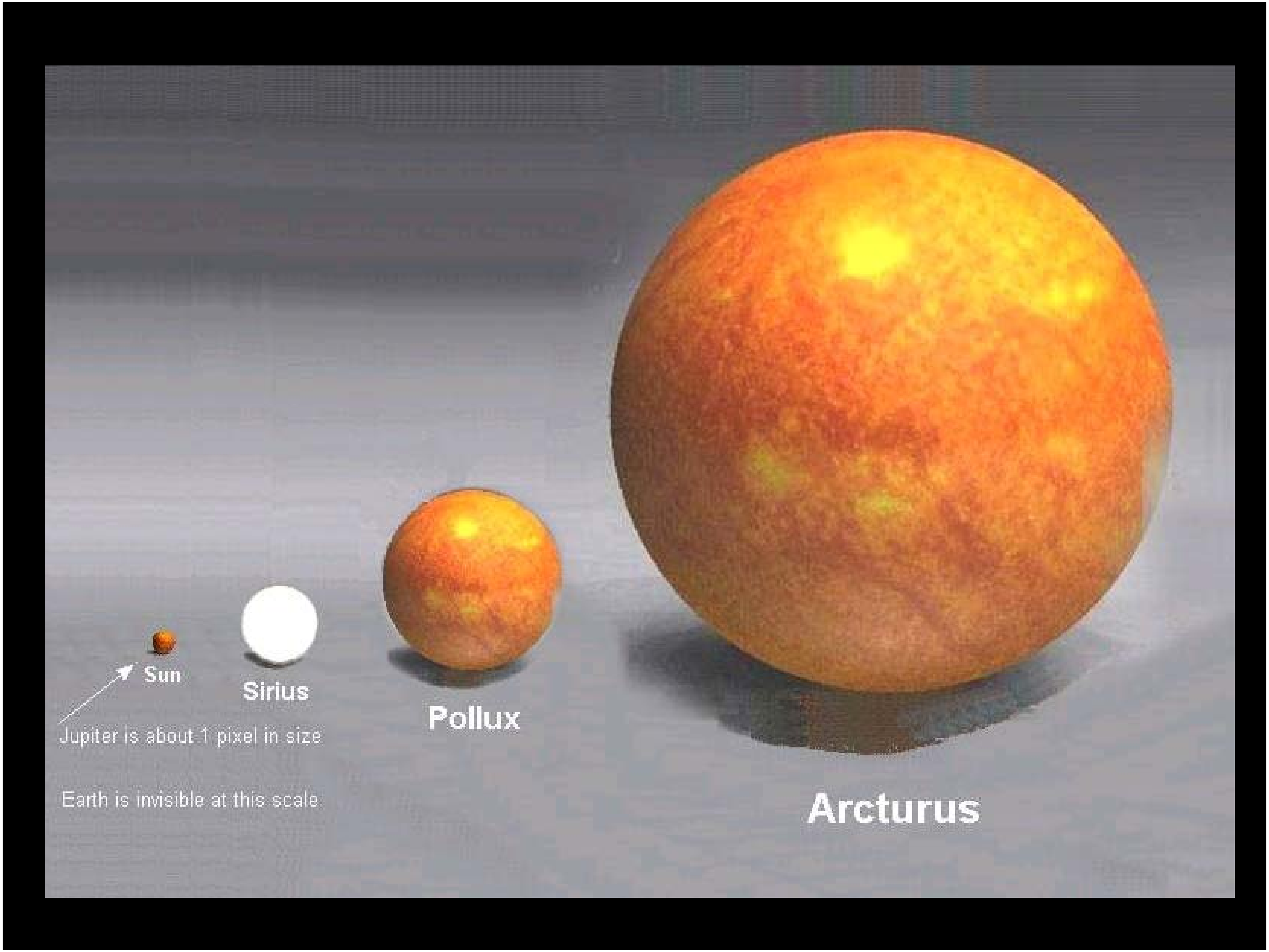

2001
2003
2005
2007
2009
MARS ODYSSEY
MARS EXPRESS (ESA)
MARS RECONNAISSANCE ORBITER
MARVEL
MARS TELESAT ORBITER
SCIM
ARES
MARS SCIENCE LABORATORY
BEAGLE 2 LANDER
PHOENIX
MARS EXPLORATION ROVERS

How Big is this challenge?

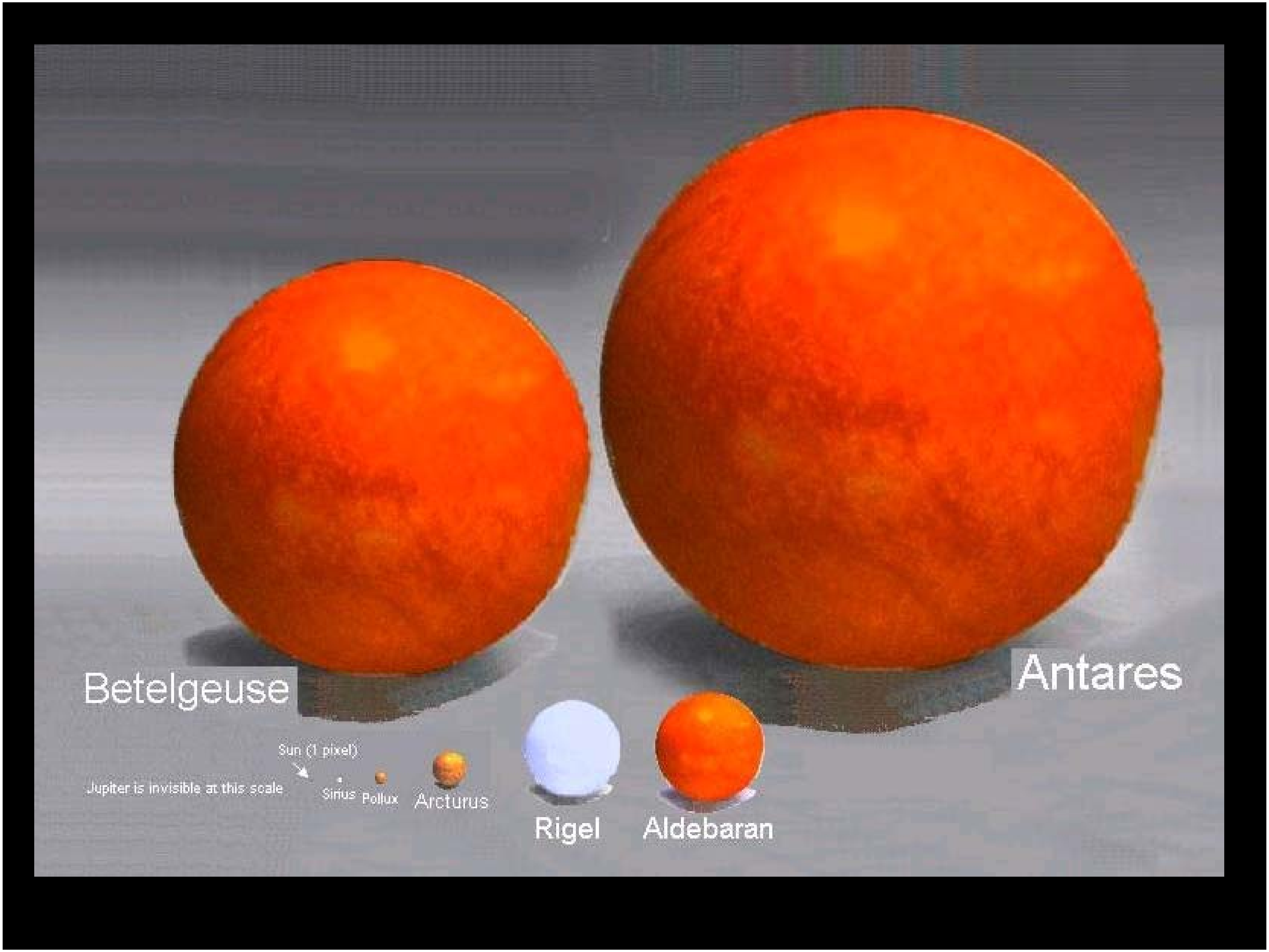

Earth
Venus
Mars
Mercury
Pluto


Jupiter
Saturn
Uranus
Neptune
Earth
Pluto


Sun
Earth
Jupiter
Pluto



Sun
Sirius
Pollux
Arcturus
Jupiter is about 1 pixel in size
Earth is invisible at this scale


Betelgeuse
Antares
Sun (1 pixel)
Jupiter is invisible at this scale
Sirius
Pollux
Arcturus
Rigel
Aldebaran

Space Shuttle Columbia

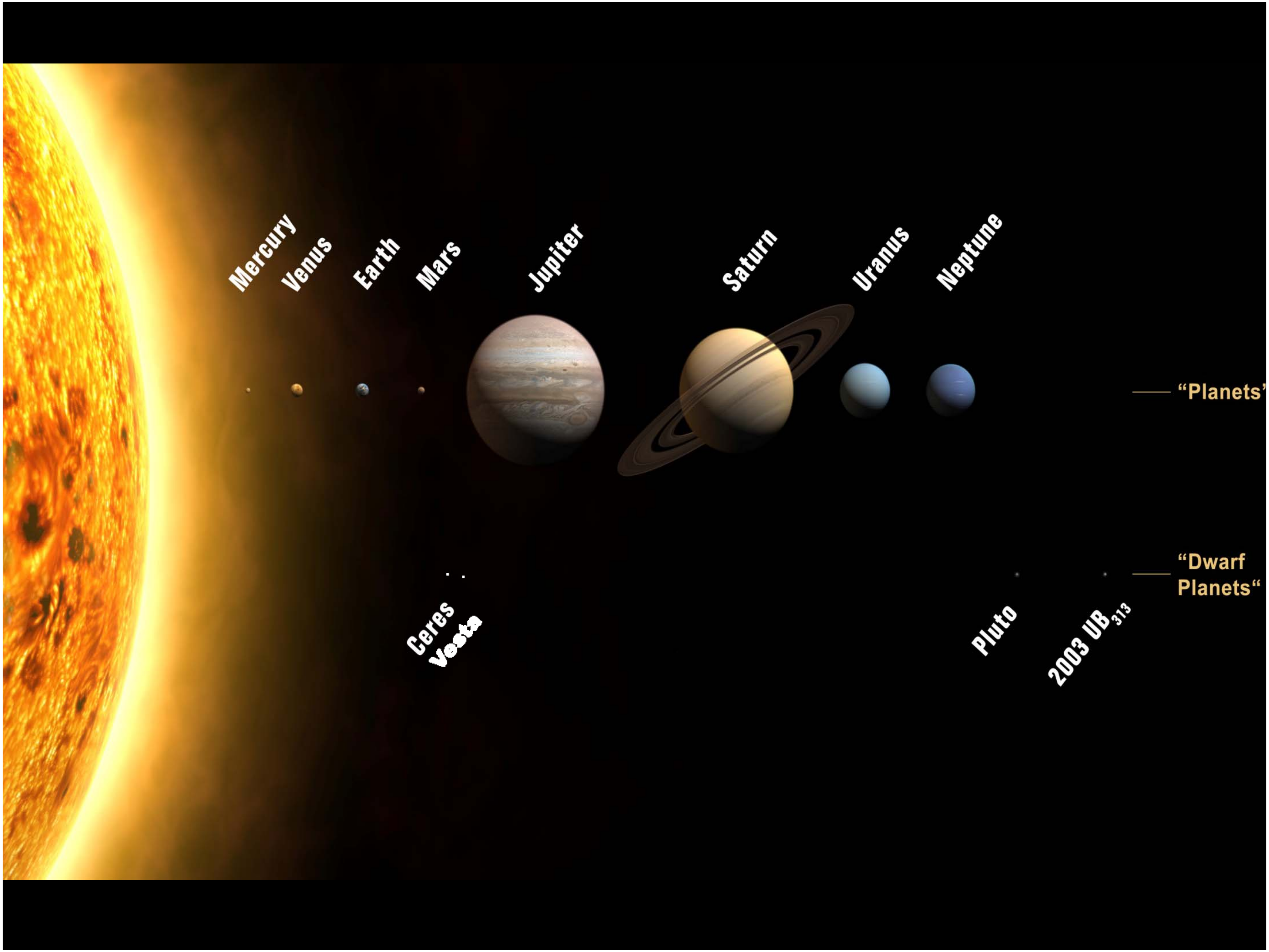

Test 1
Mon Jul 07 2003 13:29:08.509064 S

The Columbia Accident Investigation Board (CAIB)

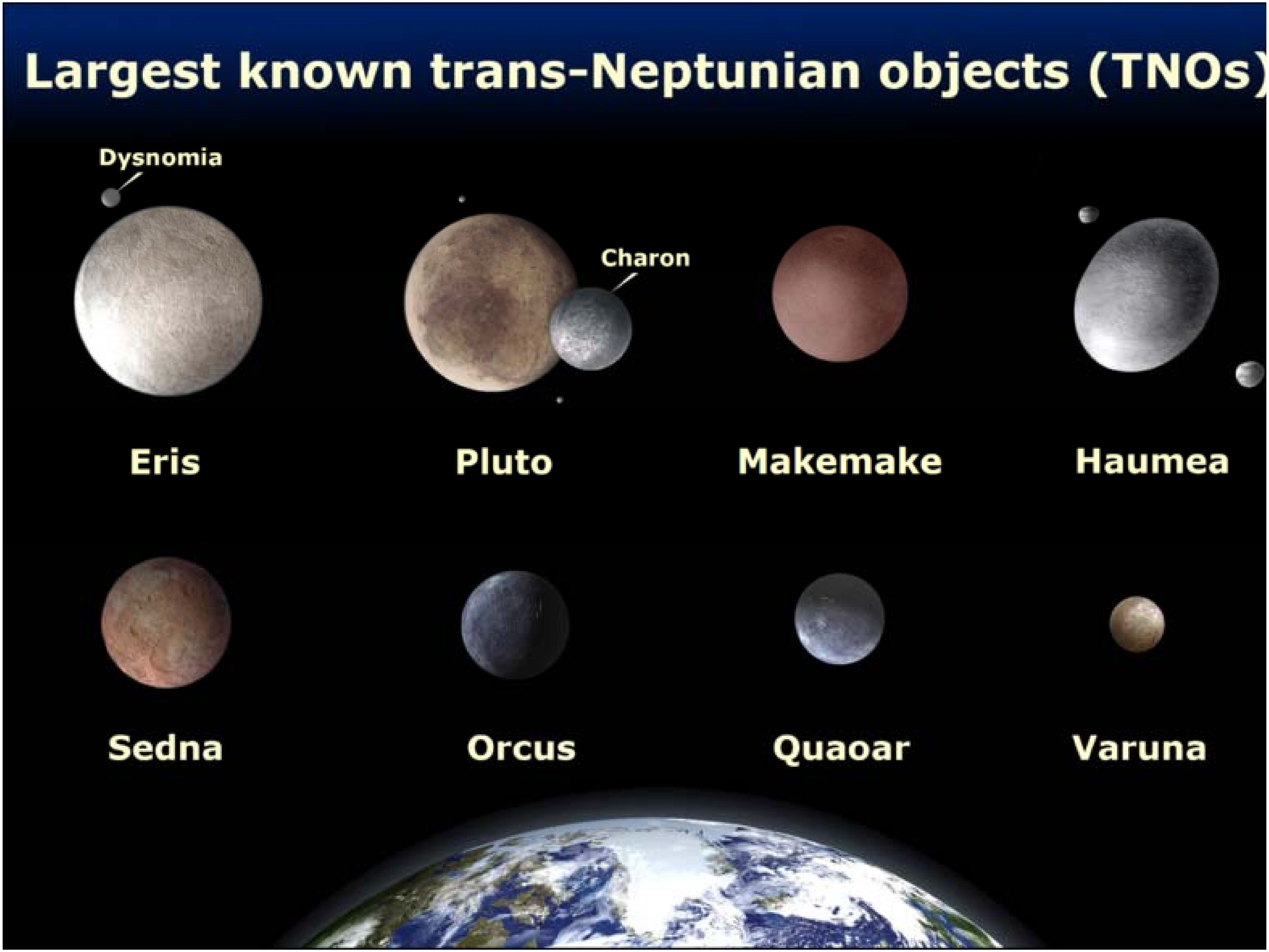
- Presented its final report on the causes of the 1 February, 2003 Space Shuttle accident to the White House, Congress and the National Aeronautics and Space Administration (NASA) on the 26 August, 2003.
- The CAIB report concludes that while NASA's present **Space Shuttle is not inherently unsafe**, a number of mechanical fixes are required to make the Shuttle safer in the short term.
- The Board determined that physical and organizational causes played an equal role in the Columbia accident and that the NASA **organizational culture** had as much to do with the accident as the foam that struck the Orbiter on ascent. The report also notes other significant factors and observations that may help prevent the next accident.
- The Board crafted the report to serve as a framework for a **national debate about the future of human space flight**, but suggests that it is in the nation's interest to replace the Shuttle as soon as possible as the primary means for transporting humans to and from Earth's orbit.
- The Board made **29 recommendations** in the 248 page final report, including 15 return-to-flight recommendations that should be implemented before the Shuttle returns to flight

Space Exploration: Real Reasons and Acceptable Reasons
Michael D. Griffin
Administrator,
National Aeronautics and Space Administration

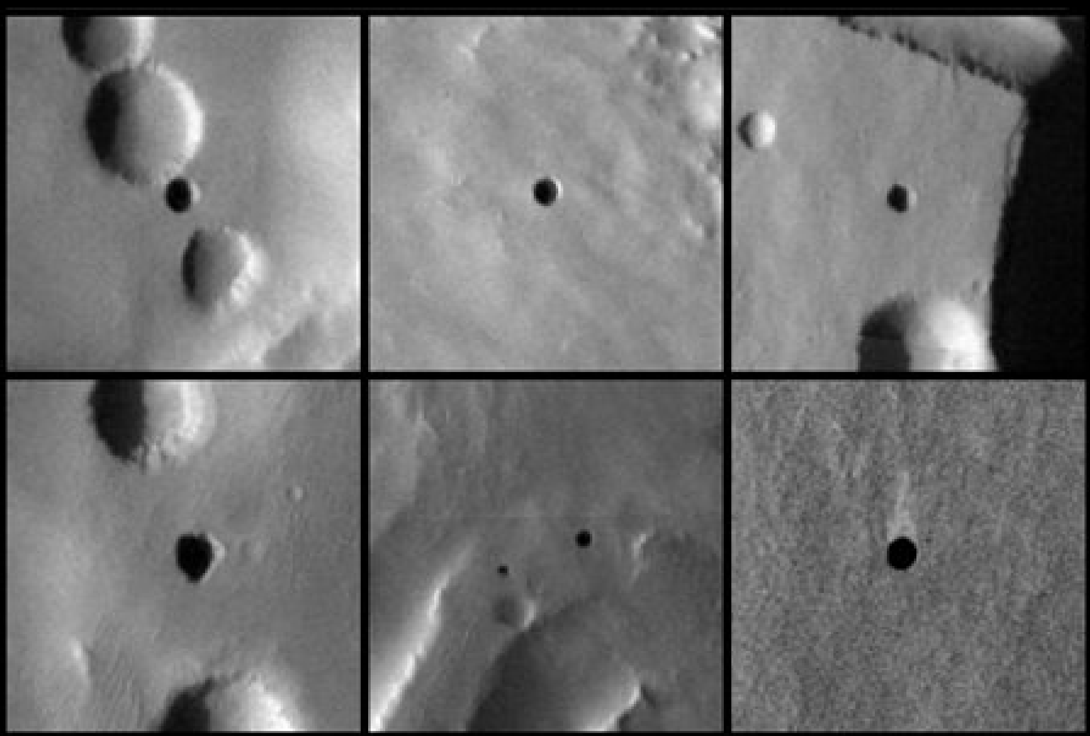
- http://www.nasa.gov/
  - For Media and Press
  - Speeches
  - View Archives
  - **01.19.07 - Remarks at Quasar Award Dinner**
    If we don't have public support that is both strong and specific, the things we want to do, and believe to be important, will not survive.
    + View PDF (32 Kb PDF)



Mercury
Venus
Earth
Mars
Jupiter
Saturn
Uranus
Neptune
"Planets"
Ceres
Vesta
Pluto
2003 UB313
"Dwarf Planets"


Largest known trans-Neptunian objects (TNOs)
Dysnomia
Charon
Eris
Pluto
Makemake
Haumea
Sedna
Orcus
Quaoar
Varuna

Cave Skylights Spotted on Mars



NASA's Mars Odyssey spacecraft has discovered entrances to seven possible caves on the slopes of a Martian volcano.

The find is fueling interest in potential underground habitats and sparking searches for caverns elsewhere on the Red Planet.

66 Flights to ISS (11/98-12/07)

23 USA

43 Russian

23 shuttle flights

STS 88/2A	U.S. Node
STS 96/2A.1	Logistics
STS 101/2a.2a	Logistics
STS 106/2B.2B	Logistics
STS 92/3A	Z-1 Truss
STS 97/4A	P6 Solar Array
STS 98/5A	Destiny Lab
STS 102/5A.1	MPLM, Expedition 2
STS 100/6A	Canada Arm2
STS 104/7A	U.S. Airlock
STS 105/7A.1	MPLM, Expedition 3
STS 108/UF1	Expedition 4
STS 110/ 8A	SO Truss and Mobil Transporte
STS 111/ UF2	MBS, Science and Expedition 5
STS 112/ 9A	S1 Truss, CETA Cart
STS 113/11A	P1 Truss, CETA Cart
STS 114/LF-1	MPLM / ISS ORU's
STS 121/ULF1.1	MPLM / ISS ORU's
STS 115/12A	P3/P4 Truss
STS 116/12A.1	P5 Truss- SpaceHab module
STS 117/13A	S3/S4 Truss
STS 118/13A.1	S5 Truss
STS 120/10A	Node 2

42 Russian Flights

- 2 Proton Flights (Service Module and FGB)
- 26 Progress Resupply Flights
- 14 Manned Soyuz Crew Flights
- 1 Unmanned Soyuz, Docking Compartment Assembly Flight

The Moon - the 1st Step to Mars and Beyond….

- **Gaining significant experience in operating away from Earth's environment**
  - Space will no longer be a destination visited briefly and tentatively
  - "Living off the land"
  - Field exploration techniques
  - Human support systems
  - Dust mitigation and planetary protection

- **Developing technologies needed for opening the space frontier**
  - Crew and cargo launch vehicles (125 metric ton class)
  - Earth entry system – Crew Exploration Vehicle
  - Mars ascent and descent propulsion systems (liquid oxygen / liquid methane)

- **Conduct fundamental science**
  - Astrobiology, historical geology, exobiology, astronomy, physics

Next Step in Fulfilling Our Destiny As Explorers

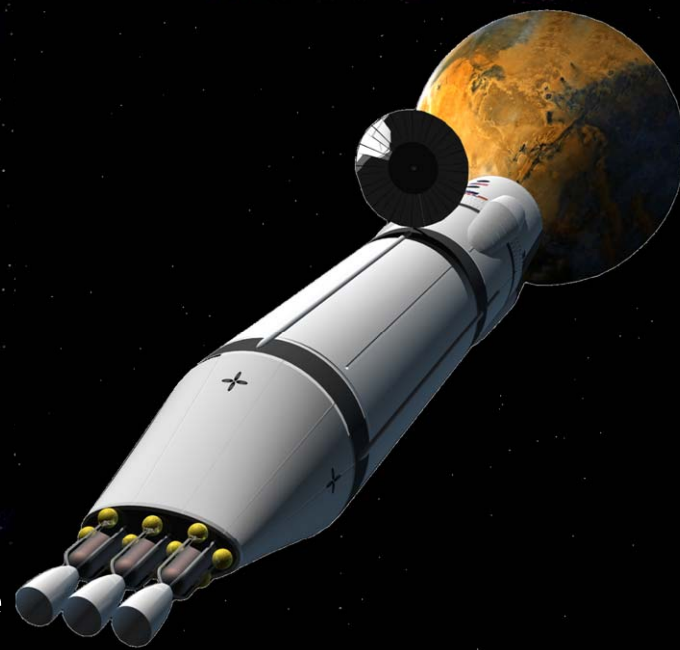
How We Humans Get to Mars

- **4 – 5 assembly flights to low Earth orbit with a 100 metric ton class launch system**

- **Pre-deployed Mars surface outpost before the crew launches**
  – Habitat and support systems
  – Power
  – Communications
  – Mars ascent / descent vehicle

- **180 day transit time to/from Mars**
  – 6 crewmembers
  – Dedicated in-space crew transit vehicle
  – Dedicated Earth entry system (CEV)

- **Up to 500 days on the surface**
  – Capability to explore large regions of the surface
  – Multi-disciplinary science investigations
  – In-Situ resource utilization
    - Consumables: Oxygen and water
    - Propellants: Liquid oxygen and methane



The Ming Dynasty's fleet of giant ships predates the Columbus expedition across the Atlantic.