Talk for Daejeon Science High School for the Gifted, Korea

Space Age and Challenges

Civilization Led by NASA

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Note: All images credit NASA

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Giant Steps Made by NASA

- Astronauts Landed on the Moon
- Air and space transportation
- Weather satellites
- Satellite telecommunications and broadcasting
- Global positioning system (GPS) for land, maritime, and air activities
- Space telescopes and Imaging technology
- Propulsion technology
- Big data
- Artificial intelligence (AI): after relational data management
- Virtual reality (VR), Augmented reality (AR), and Mixed reality (MR)
- Extreme technology
- Space science
- Planetary science
- Etc.

Great Stream of Civilization

Inception of Modern Rocket Science



On June 14, 1914, the first patent for a liquid-fuel rocket design was granted to Dr. Robert Goddard, an American scientist and rocket pioneer.

In the patent, Goddard described a rocket fueled with liquid propellants (liquid nitrous oxide and gasoline) or with a solid fuel (explosive material).

In this same year, he was also granted a patent for a multi-stage rocket fueled with solid “explosive material.” He would go on to launch the world’s first liquid-fueled rocket in 1926.

Goddard’s work in the field was revolutionary and his achievements helped make space flight possible. He has even been called the “Usherer of the Space Age.”

NASA’s Goddard Space Flight Center in Greenbelt, Maryland, is named in his honor.

NACA: 1917.7.14 ~ 1958.9.30
NASA: 1958.10.1 ~ present

Mercury Project



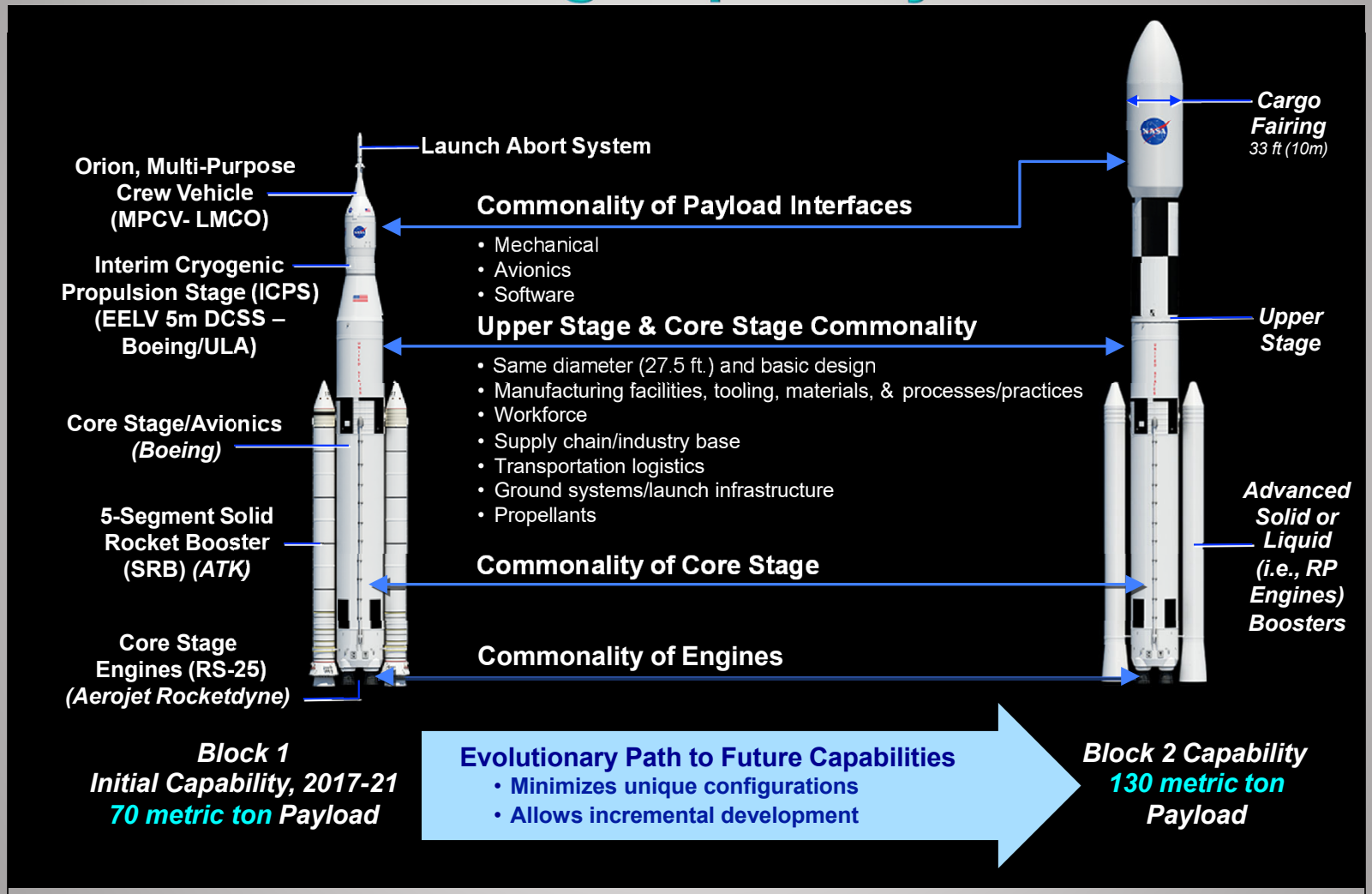


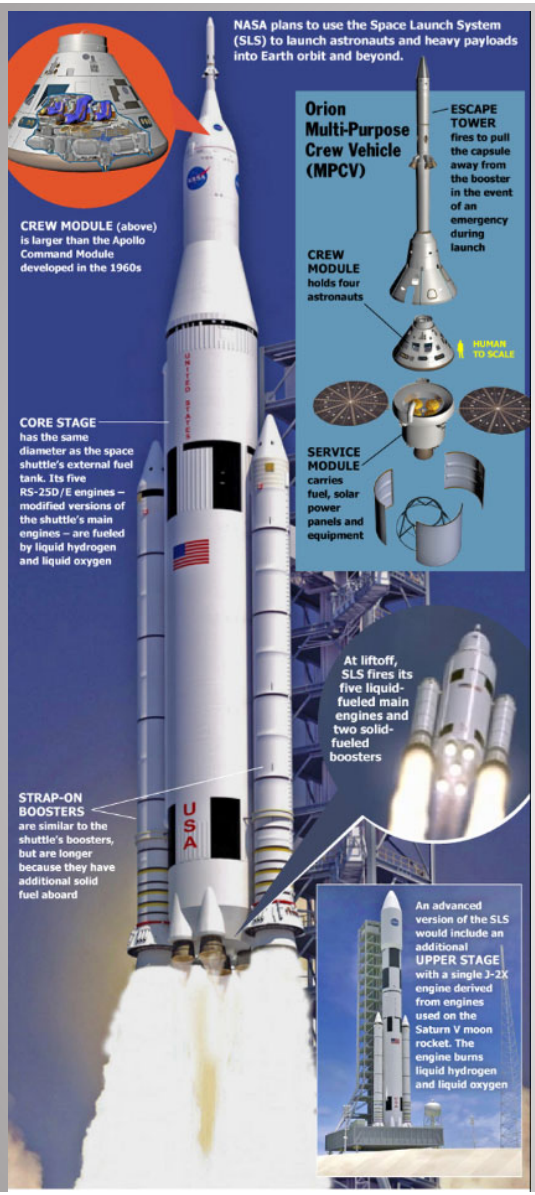
Gemini Project

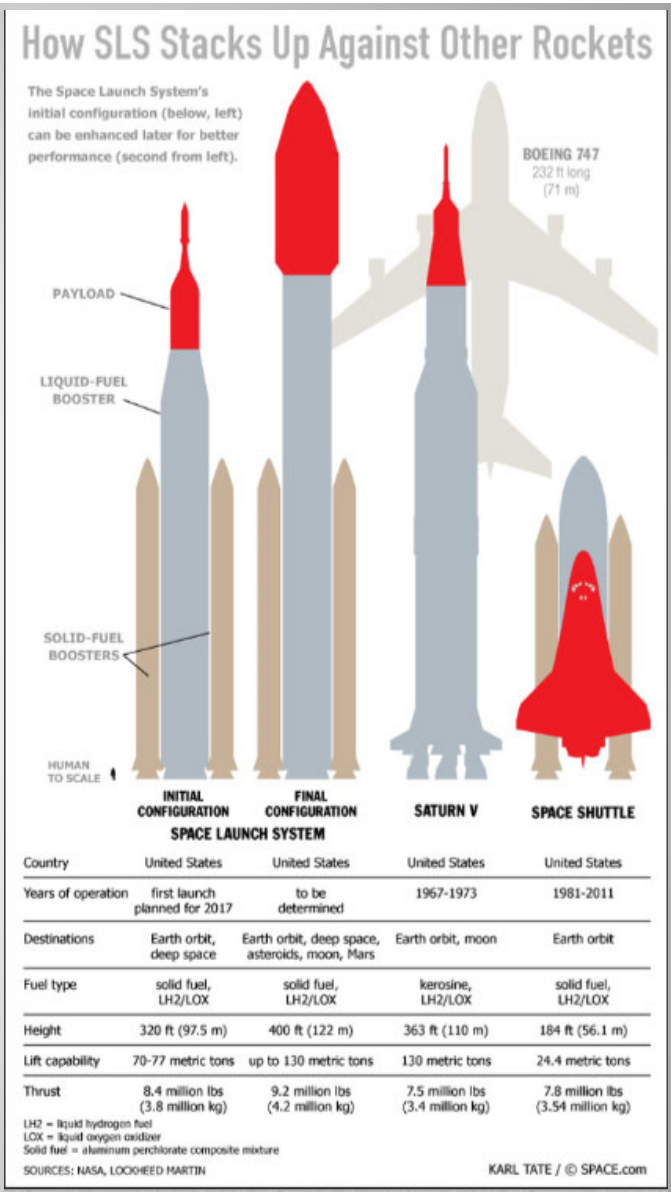




SLS: An Evolving Capability







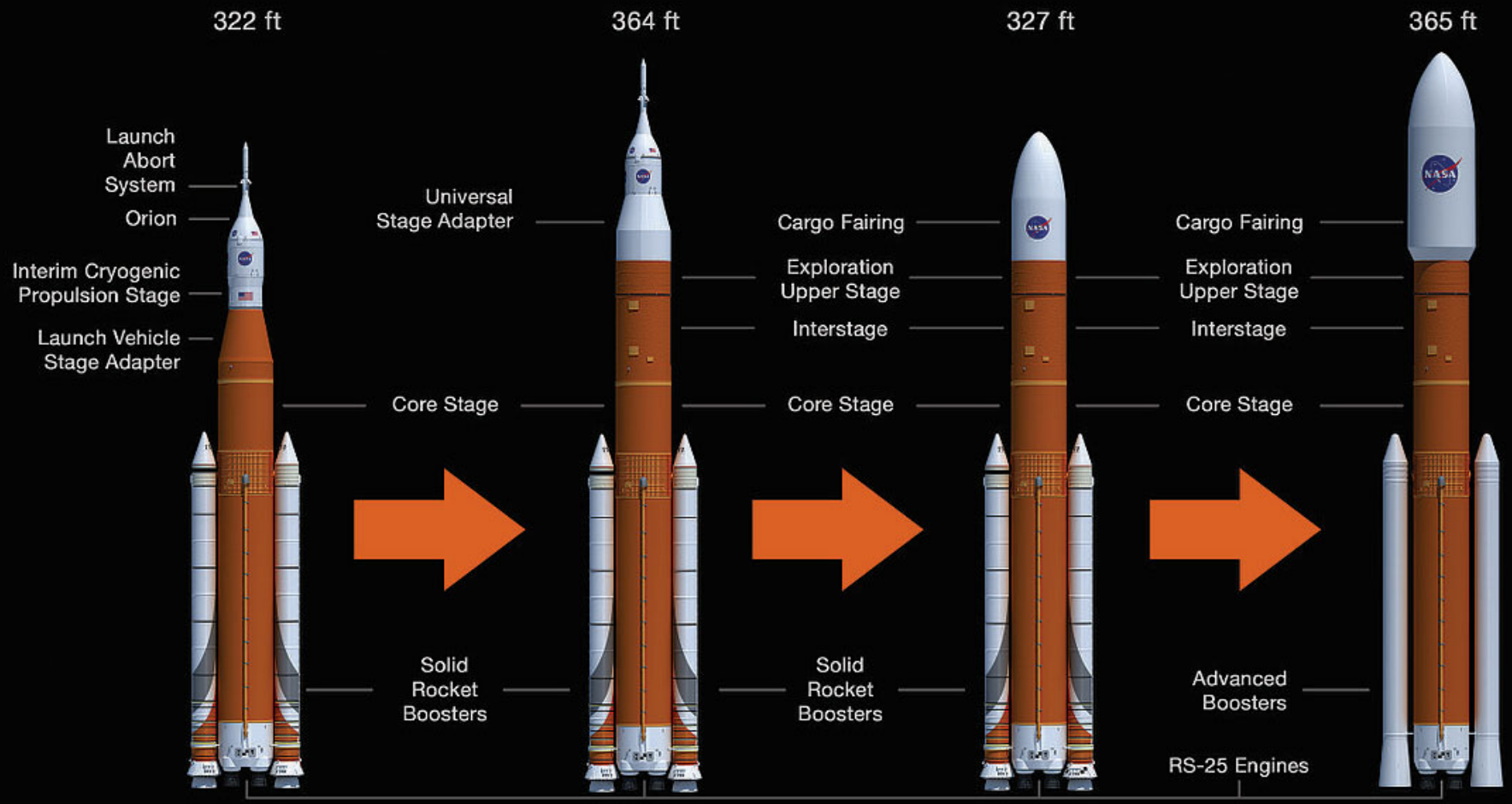
	SPACE LAUNCH SYSTEM		SATURN V	SPACE SHUTTLE
Country	United States	United States	United States	United States
Years of operation	first launch planned for 2017	to be determined	1967-1973	1981-2011
Destinations	Earth orbit, deep space	Earth orbit, deep space, asteroids, moon, Mars	Earth orbit, moon	Earth orbit
Fuel type	solid fuel, LH2/LOX	solid fuel, LH2/LOX	kerosine, LH2/LOX	solid fuel, LH2/LOX
Height	320 ft (97.5 m)	400 ft (122 m)	363 ft (110 m)	184 ft (56.1 m)
Lift capability	70-77 metric tons	up to 130 metric tons	130 metric tons	24.4 metric tons
Thrust	8.4 million lbs (3.8 million kg)	9.2 million lbs (4.2 million kg)	7.5 million lbs (3.4 million kg)	7.8 million lbs (3.54 million kg)

LH2 = liquid hydrogen fuel
LOX = liquid oxygen oxidizer
Solid fuel = aluminum perchlorate composite mixture

SOURCES: NASA, LOCKHEED MARTIN

KARL TATE / © SPACE.com

SLS for Cargo and Astronauts



Energy Sources in Space

Solar Energy



d =1 AU



d =1.52 AU



- **Burns 660 million tons/sec of H_2.**
- **Leaves 600 million tons/sec of He.**
- **Gives off the rest as radiation.**

174,000 TW of sunlight hit the Earth every day

AM0 = 1370 W/m^2
AM1 = 1353 W/m^2

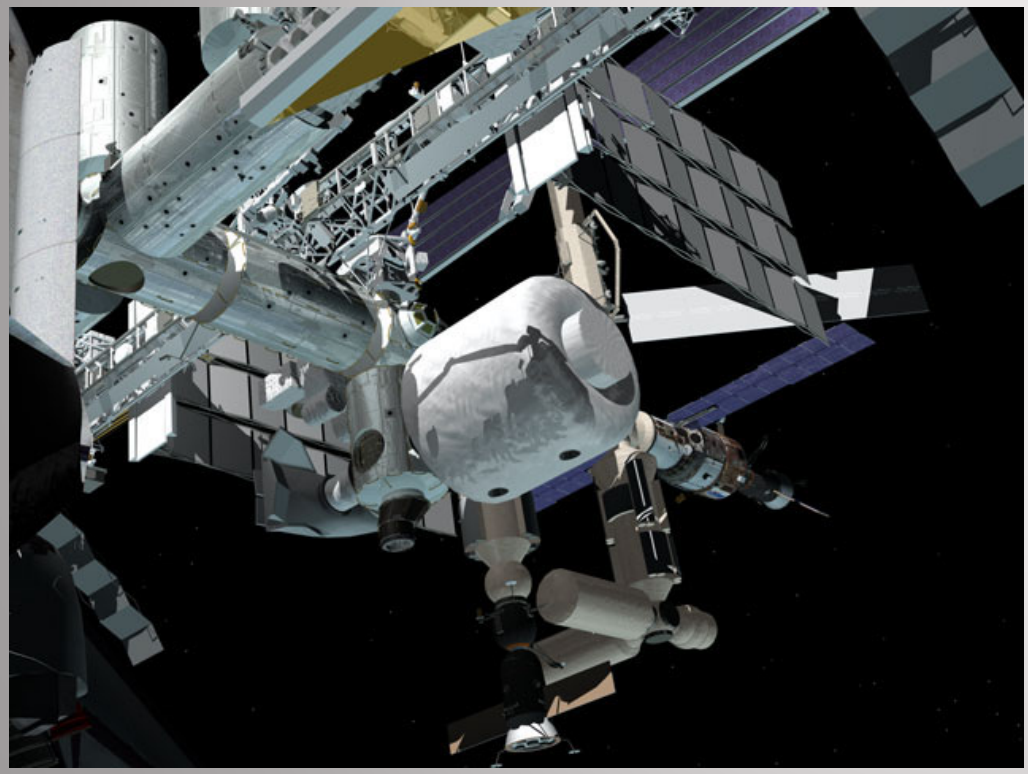
21,000 TW of sunlight hit the Mars every day

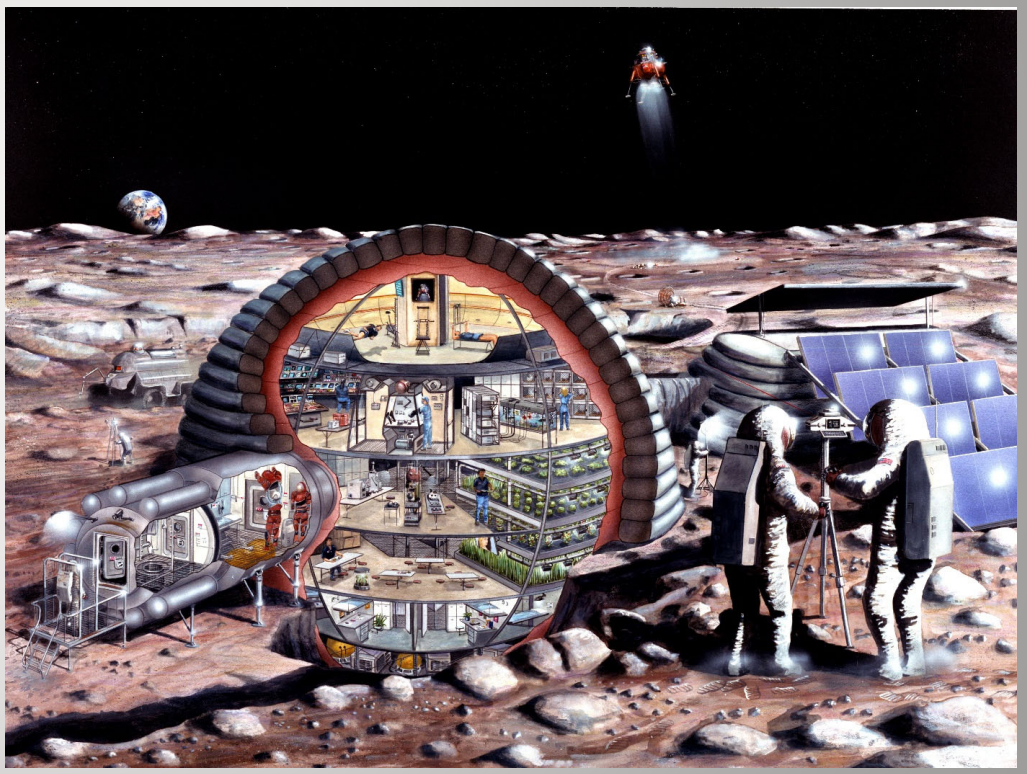
AM0 = 593 W/m^2
AM1 = 588 W/m^2

What are the other energy sources available for deep space exploration?

- ✓ Pu-238 (t

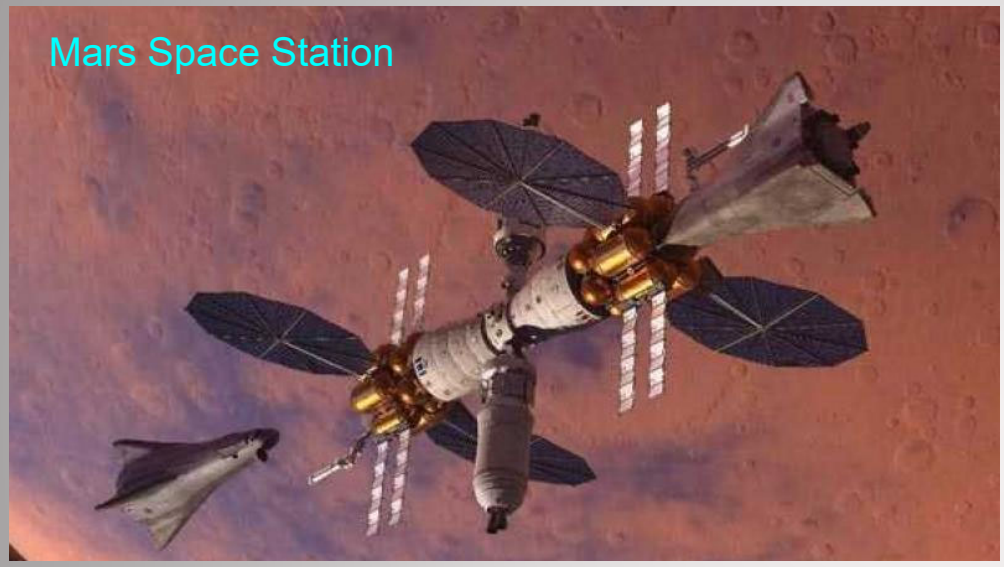
Cis-Lunar Base and Lunar Habitats





Mars Exploration

Mars Space Station



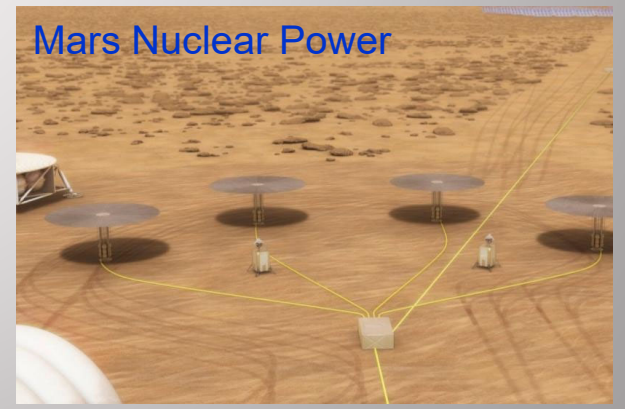
Mars Rover



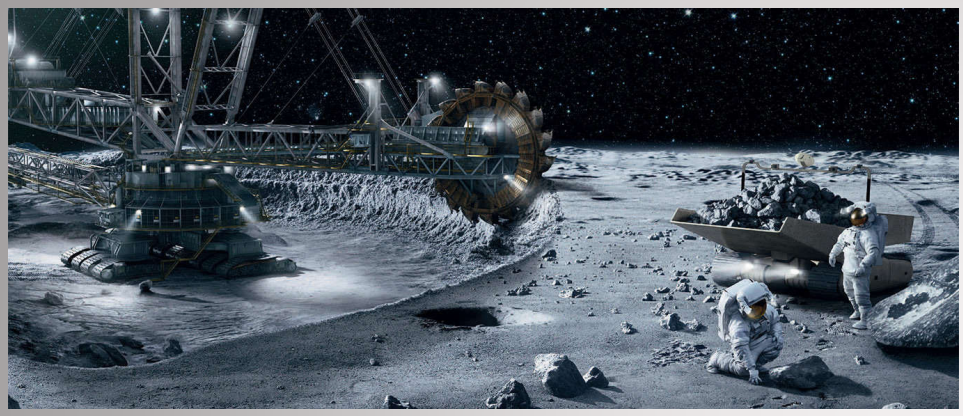
Mars Colony



Mars Nuclear Power

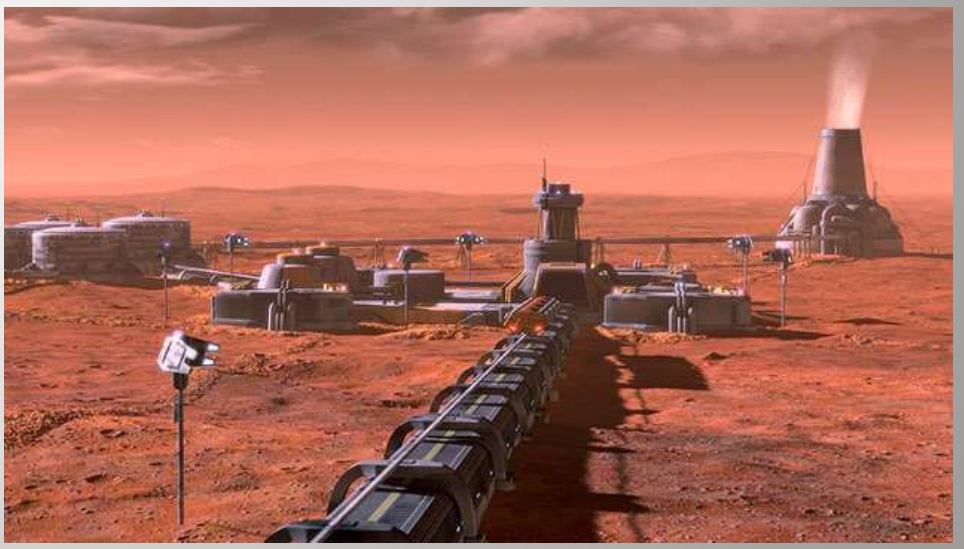


Space Mining



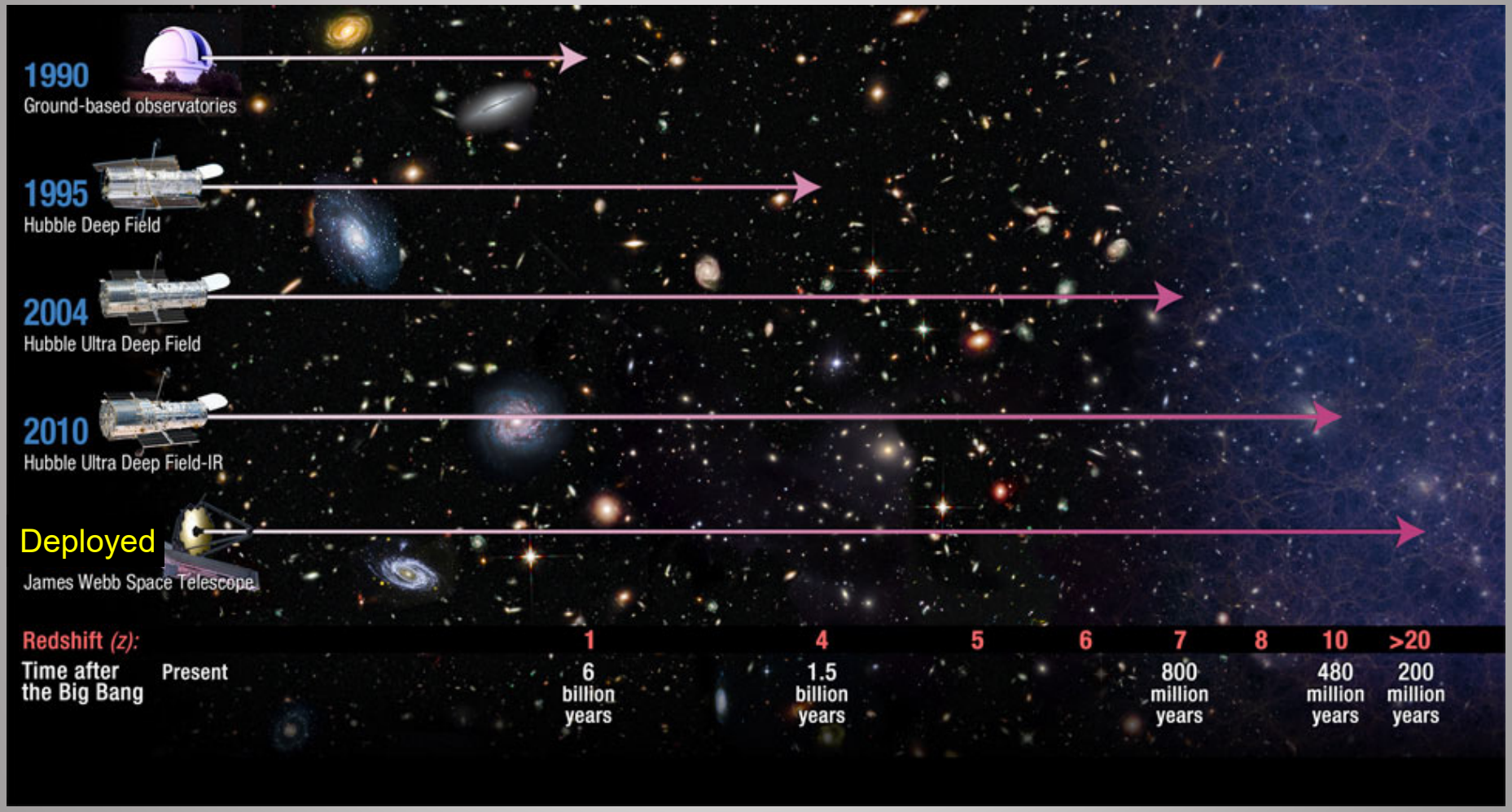


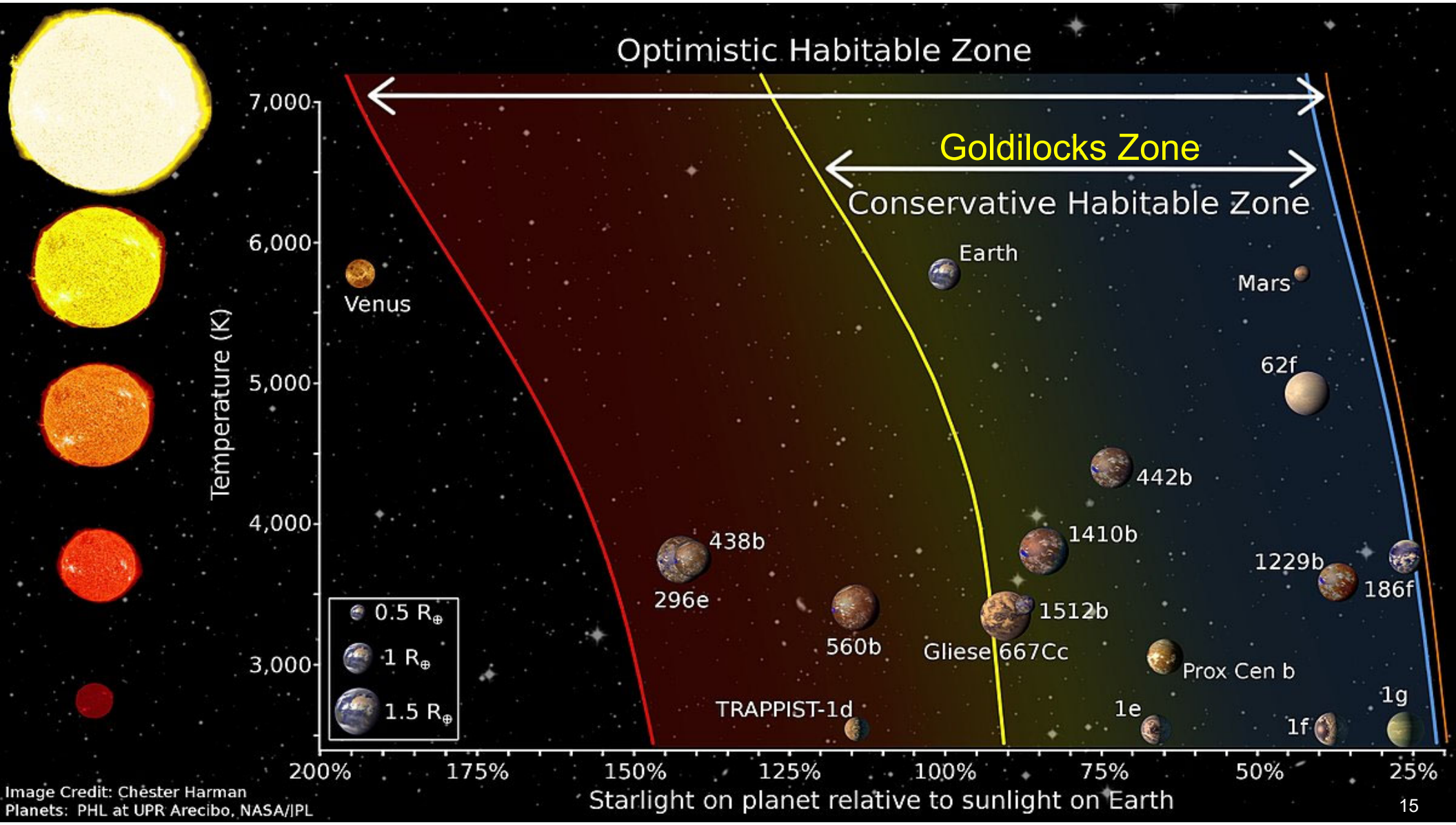




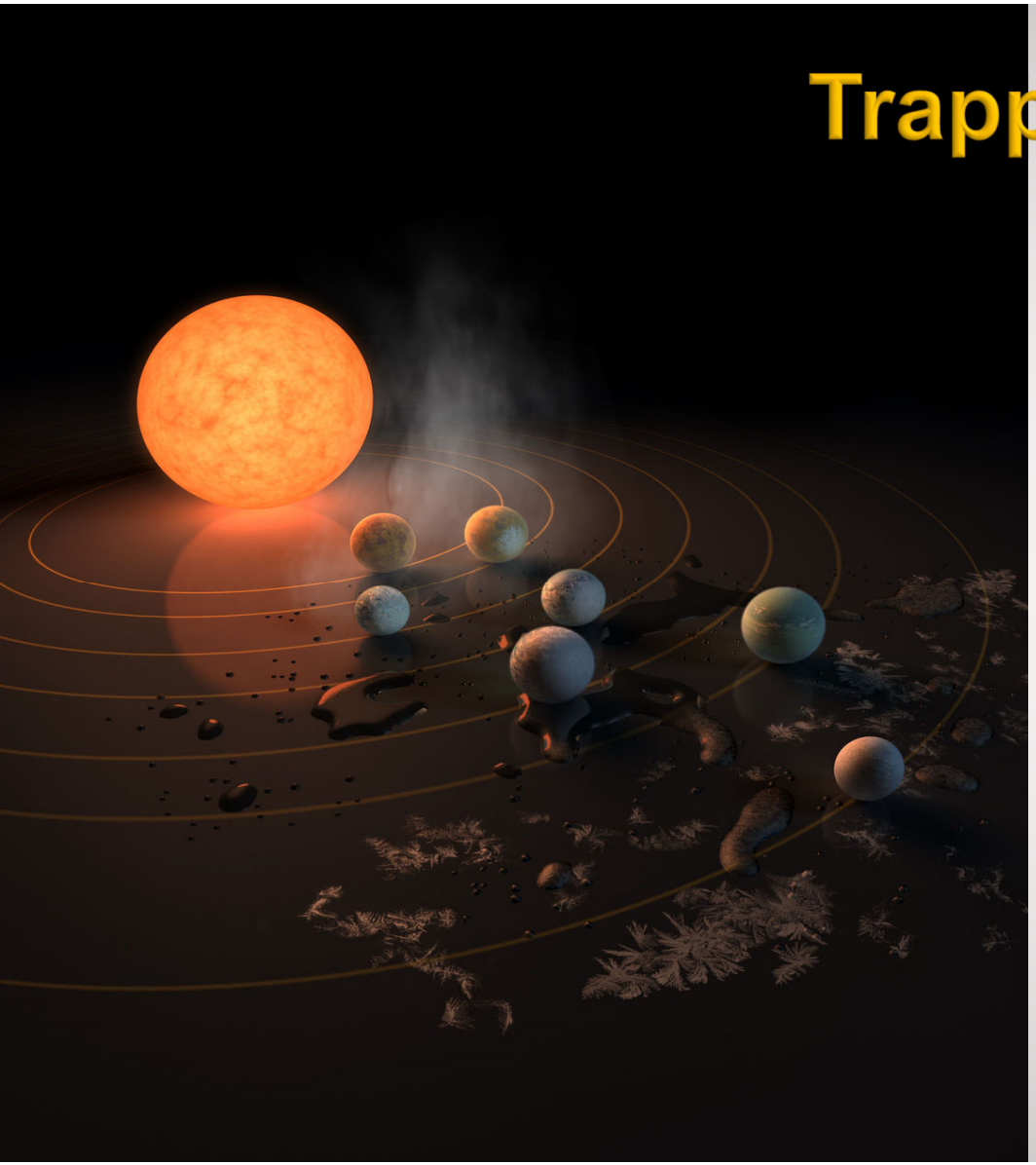

Exoplanet
Missions
NASA
JWST
WFIRST
AFTA
TESS
Transiting Exoplanet Survey Satellite
Kepler
New Worlds
Telescope
Spitzer
Hubble
Ground-based
Observatories
Astronomy and Astrophysics in the New Millennium
2001
Decadal
Survey
New Worlds, New Horizons
in Astronomy and Astrophysics
2010
Decadal
Survey

Space Telescopes




Optimistic Habitable Zone
Goldilocks Zone
Conservative Habitable Zone
Temperature (K)
7,000
6,000
5,000
4,000
3,000
Venus
Earth
Mars
62f
442b
438b
296e
1410b
1229b
186f
560b
1512b
Gliese 667Cc
Prox Cen b
TRAPPIST-1d
1e
1f
1g
0.5 R⊕
1 R⊕
1.5 R⊕
200%
175%
150%
125%
100%
75%
50%
25%
Starlight on planet relative to sunlight on Earth
Image Credit: Chester Harman
Planets: PHL at UPR Arecibo, NASA/JPL

Trappist-1





Thanks!!!

Questions?