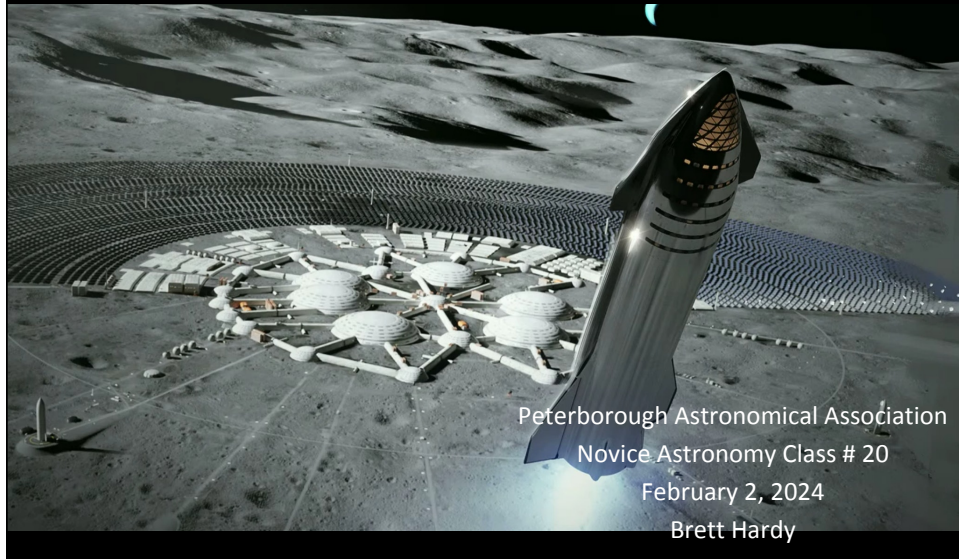


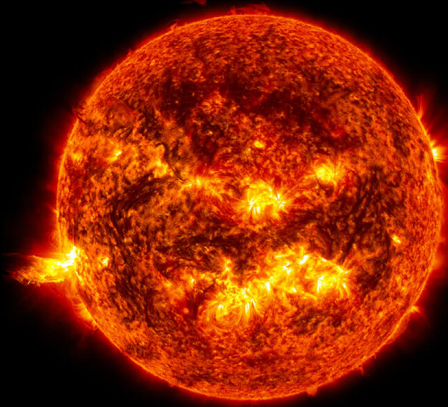
Space Exploration Part 2



Peterborough Astronomical Association
Novice Astronomy Class # 20
February 2, 2024
Brett Hardy

Sun

- Parker Solar Probe
- NASA
- Launch August 2018
- To study our nearest star



NASA/SDO

Mercury

- Bepi-Colombo
- JAXA & ESA joint mission
- Two orbiters
- Launch October 2018
- Arrival December 2025



NASA

Venus

- Shukrayaan 1
- ISRO
- Launch 2026
- Orbiter
- Aerobot Balloon
- 4 year mission

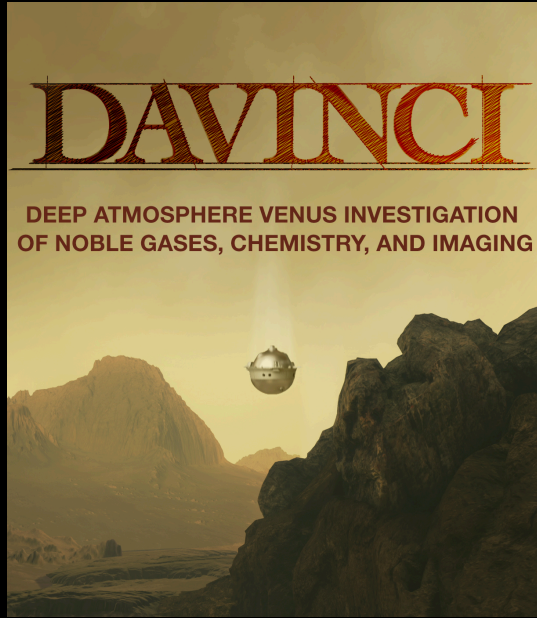


ISRO SHUKRAYAAN MISSION

Gareeb Scientist

Venus

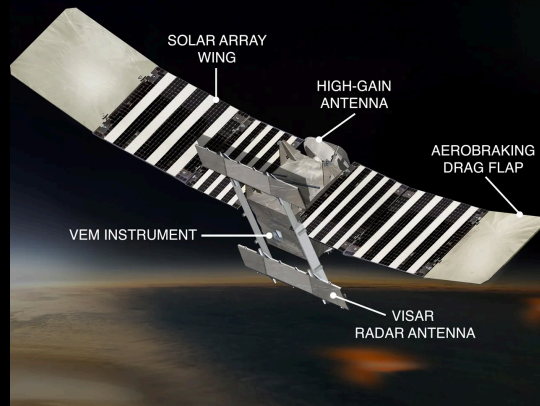
- Davinci
- NASA orbiter & atmospheric probe
- 2029



NASA

Venus

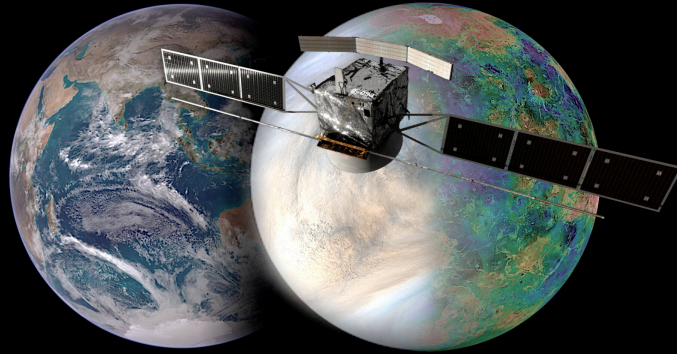
- Veritas
- NASA orbiter
- study how the climates of Venus and Earth diverged
- 2031



Gareeb Scientist

Venus

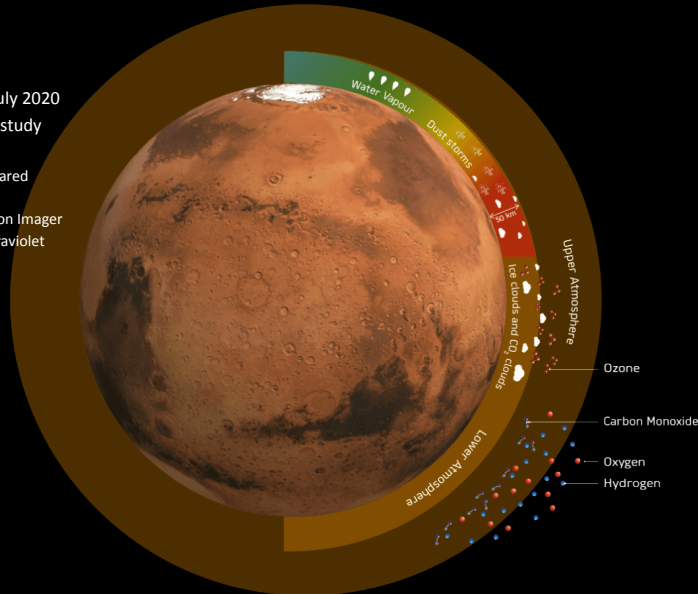
- EnVision
- ESA orbiter
- study planet's history, activity & climate
- 2030's



ESA

Mars Invasion

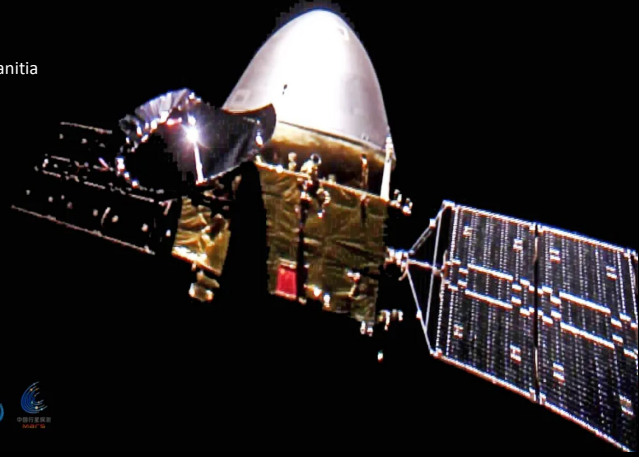
- United Arab Emirates
- Hope Orbiter launch July 2020
- Intensive atmosphere study
- Three instruments
 - Emirates Mars Infrared Spectrometer
 - Emirates Exploration Imager
 - Emirates Mars Ultraviolet Spectrometer



UAE

Mars Invasion

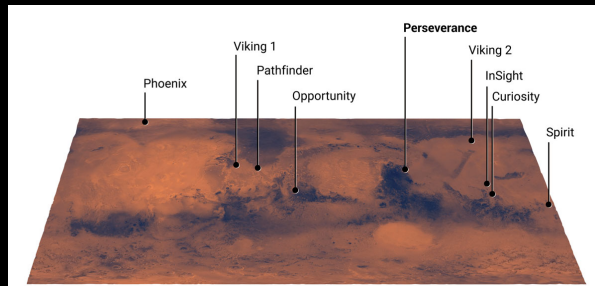
- Tianwen-1 : orbiter lander & rover
- CNSA - Chinese orbiter, lander & rover
- July 2020
- May 2021 landing – Utopia Planitia



CNSA

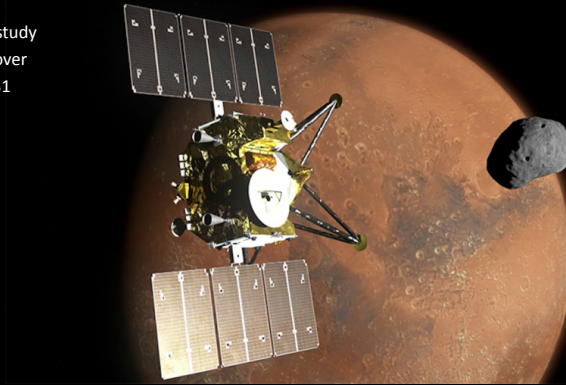
Mars Invasion

- NASA Perseverance rover
- July 2020
- Jezero Crater
- Ingenuity helicopter



Mars Invasion

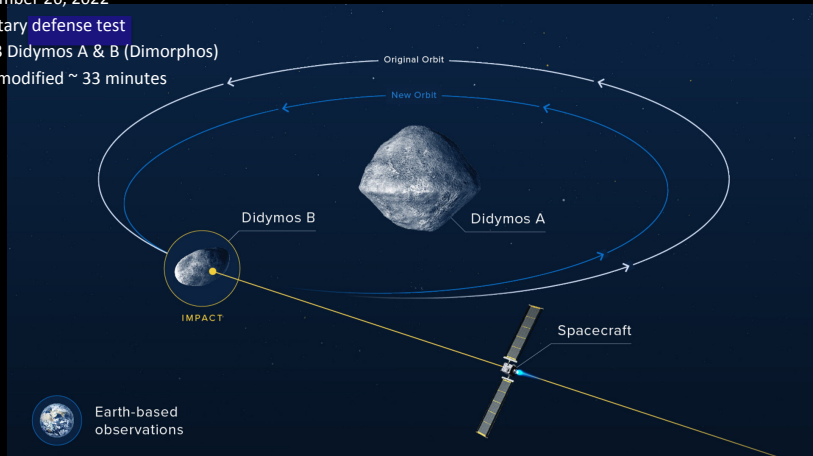
- MMX - Martian Moons eXploration
- JAXA
- 2026 launch
- Phobos & Deimos study
- Phobos lander & rover
- Sample return 2031



JAXA

Asteroids

- DART
- November 2021
- September 26, 2022
- Planetary defense test
- 65803 Didymos A & B (Dimorphos)
- orbit modified ~ 33 minutes

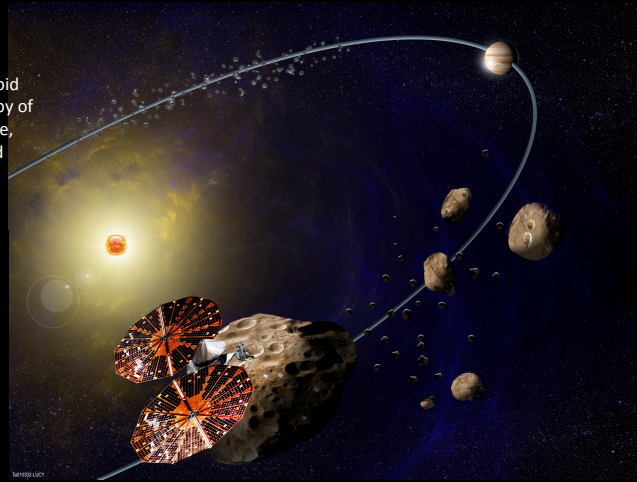
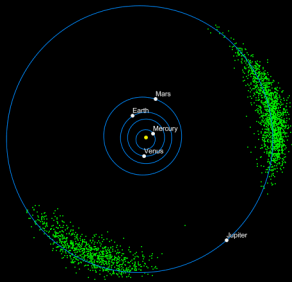


NASA

Asteroids

- Lucy
- October 2021
- 12 Year mission
- First study of Jupiter's Trojans
- 52246 Donaldjohanson (asteroid belt), 3548 Eurybates (first flyby of Jupiter trojan), 15094 Polymele, 11351 Leucus, 21900 Orus and 617 Patroclus, Menoetius

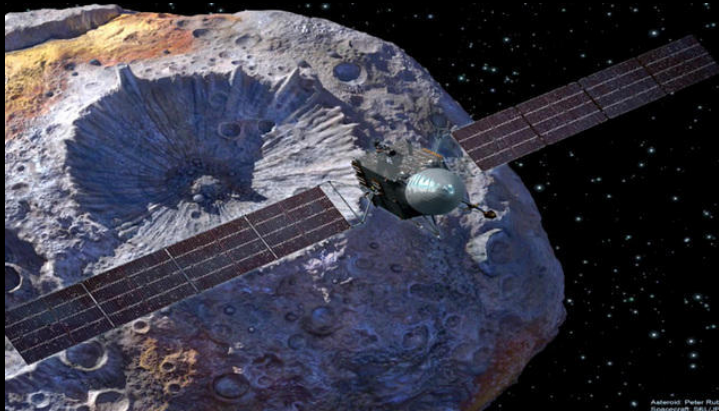
Date: 2021/01/21



NASA

Asteroids

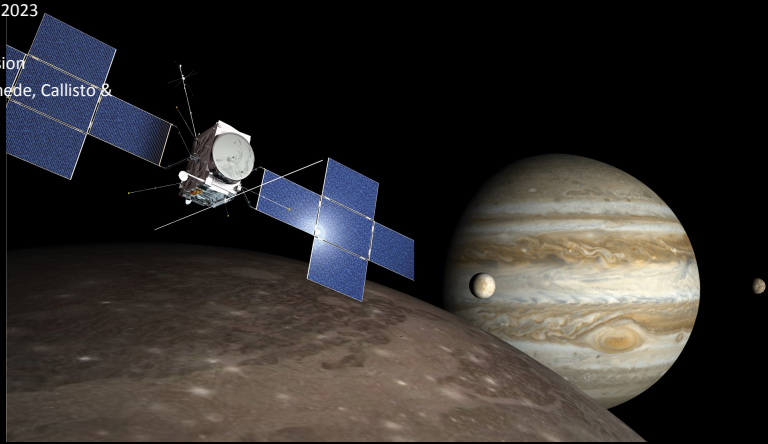
- Psyche Mission
- Launch October 2023
- Metal asteroid
- Arrival 2029
- 16 Psyche



NASA

Icy Moons

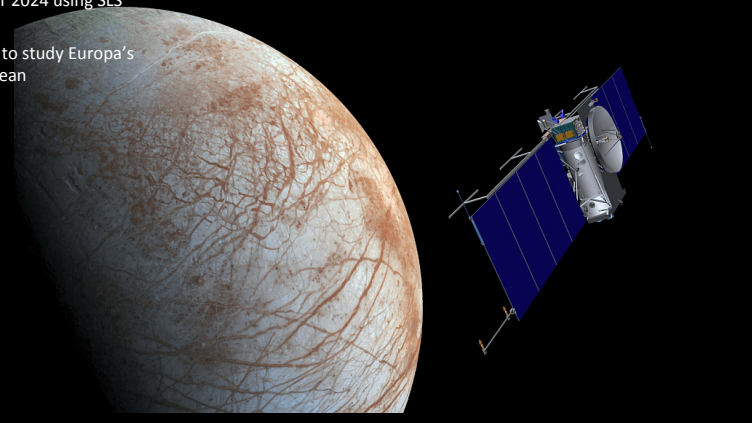
- JUICE
- ESA
- Launch April 2023
- Arrival 2031
- 3.5 year mission
- Study Ganymede, Callisto & Europa

An illustration of the JUICE (Jupiter Icy Moons Explorer) spacecraft in orbit. The spacecraft, with its large blue solar panels, is positioned in the foreground. In the background, the planet Jupiter is visible with its characteristic bands, and the icy moon Europa is seen in the distance. The scene is set against a black space background.

ESA

Icy Moons

- Europa Clipper
- NASA
- Launch October 2024 using SLS
- Arrival 2028
- Jupiter Orbiter to study Europa's liquid water ocean

An illustration of the Europa Clipper spacecraft in orbit. The spacecraft, with its blue solar panels, is shown in the foreground. In the background, the icy moon Europa is depicted with its characteristic reddish-brown surface markings. The scene is set against a black space background.

NASA

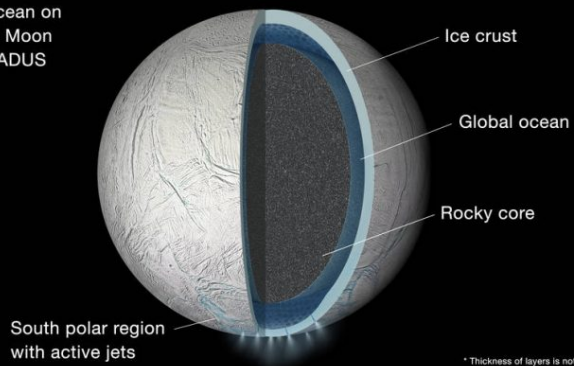
Icy Moons

- Dragonfly



Icy Moons

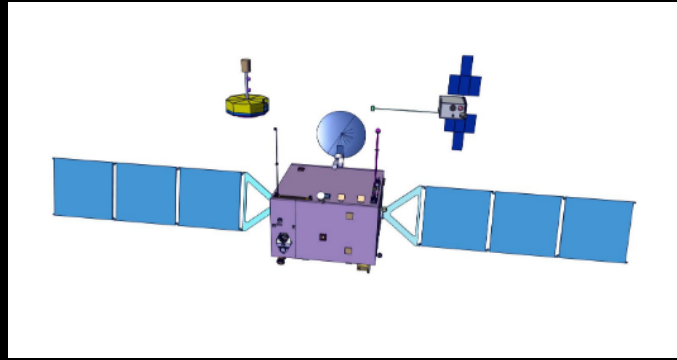
- Yuri Milner
- Breakthrough Enceladus
- First privately funded deep space mission
- Habitable ocean? Global Ocean on Saturn's Moon ENCELADUS
- Life?



NASA/JPL - Caltech

Comets

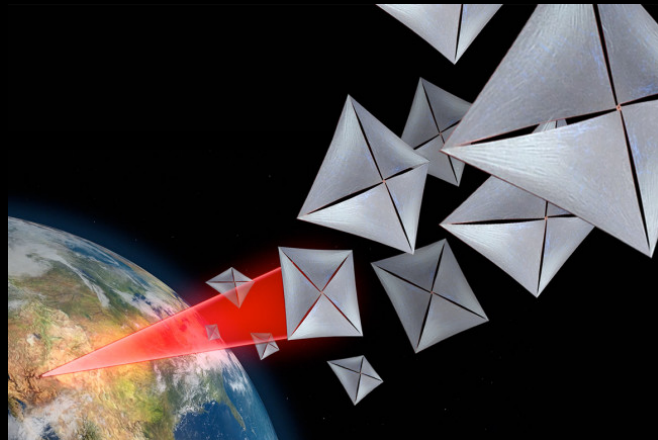
- Comet Interceptor
- ESA/JAXA collaboration
- Pristine comet search
- 3 spacecraft design
- New science



ESA

Interstellar Space

- Breakthrough Starshot
- Light sail fleet to Alpha Centauri
- Proxima b



Breakthrough Initiatives

Space Telescopes

- James Webb Space Telescope
- December 2022 launch
- Largest space telescope
- 6.5 m mirror
- L2 orbit

The James Webb Space Telescope

Secondary mirror
Reflects gathered light from the primary mirror into the science instruments

Segmented primary mirror
18 hexagonal segments made of the metal beryllium and coated with gold to capture infrared light

Science Instrument module
Houses all of Webb's cameras and science instruments

Multi-layer sunshield
Five layers that shield the observatory from the light and heat from the Sun and Earth

Trim flap
Helps stabilize the satellite

Solar power array
Eighteen hexagonal segments made of the metal beryllium and coated with gold to capture infrared light

Spacecraft control systems

NASA

Private Sector

- SpaceX
- Reusable launch vehicles
- Falcon
- Cargo Dragon
- Crew Dragon
- Starship & Super Heavy

Private Sector

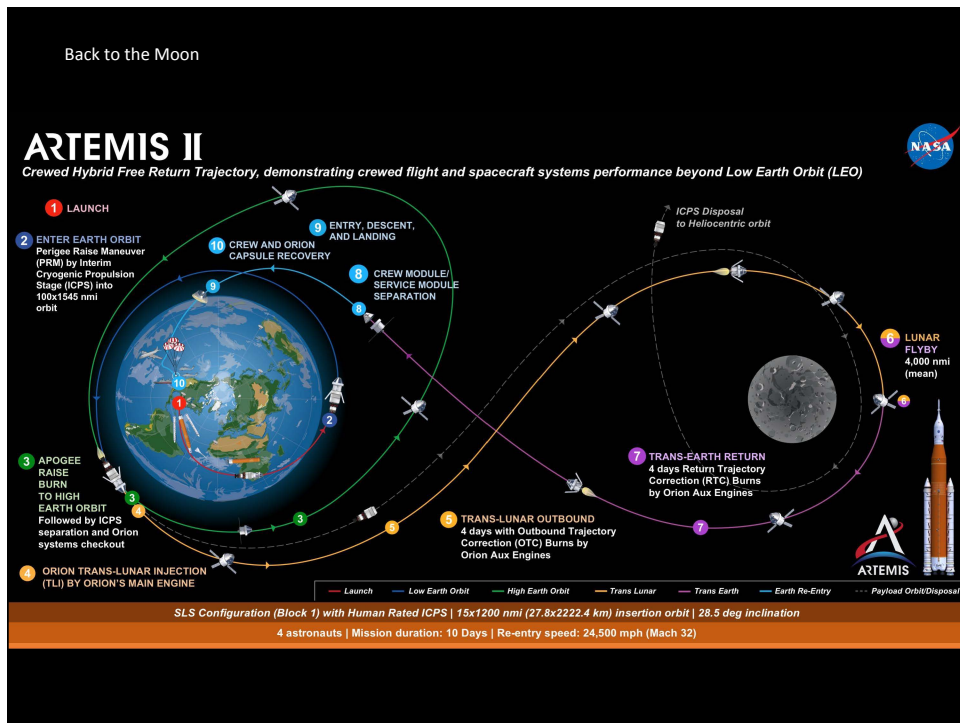
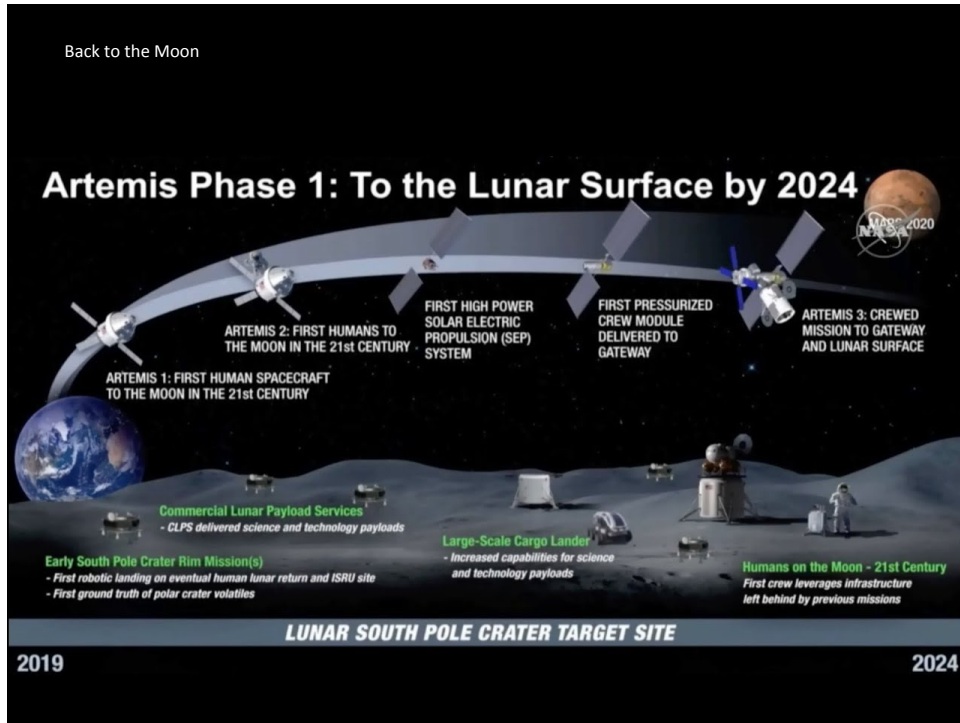
- Blue Origin
- Reusable launch vehicles
- New Shepard
- New Glenn



Private Sector

- Virgin Galactic
- Space tourism
- Virgin Orbit
- Satellite deployment





Back to the Moon

ARTEMIS PREPARES FOR MARS

Testing landing and ascent capabilities

Expanding the range of surface exploration and ISRU demonstrations

Gateway augmented with international habitat for increased capabilities

Foundation Surface Habitat and Habitable Mobility Platform delivered to complete Artemis Base Camp

Expanded habitation capability added to Gateway to enable Mars mission dress rehearsal at the Moon

Mars mission dress rehearsal with longer in-space and surface durations

Lunar Terrain Vehicle

Foundation Surface Habitat

Habitable Mobility Platform

SUSTAINABLE LUNAR ORBIT STAGING CAPABILITY AND SURFACE EXPLORATION

MULTIPLE SCIENCE AND CARGO PAYLOADS | INTERNATIONAL PARTNERSHIP OPPORTUNITIES | TECHNOLOGY AND OPERATIONS DEMONSTRATIONS FOR MARS

NASA

Colonization & Resource Utilization

- Moon
- Mars
- Space mining

MIT/NOVA

