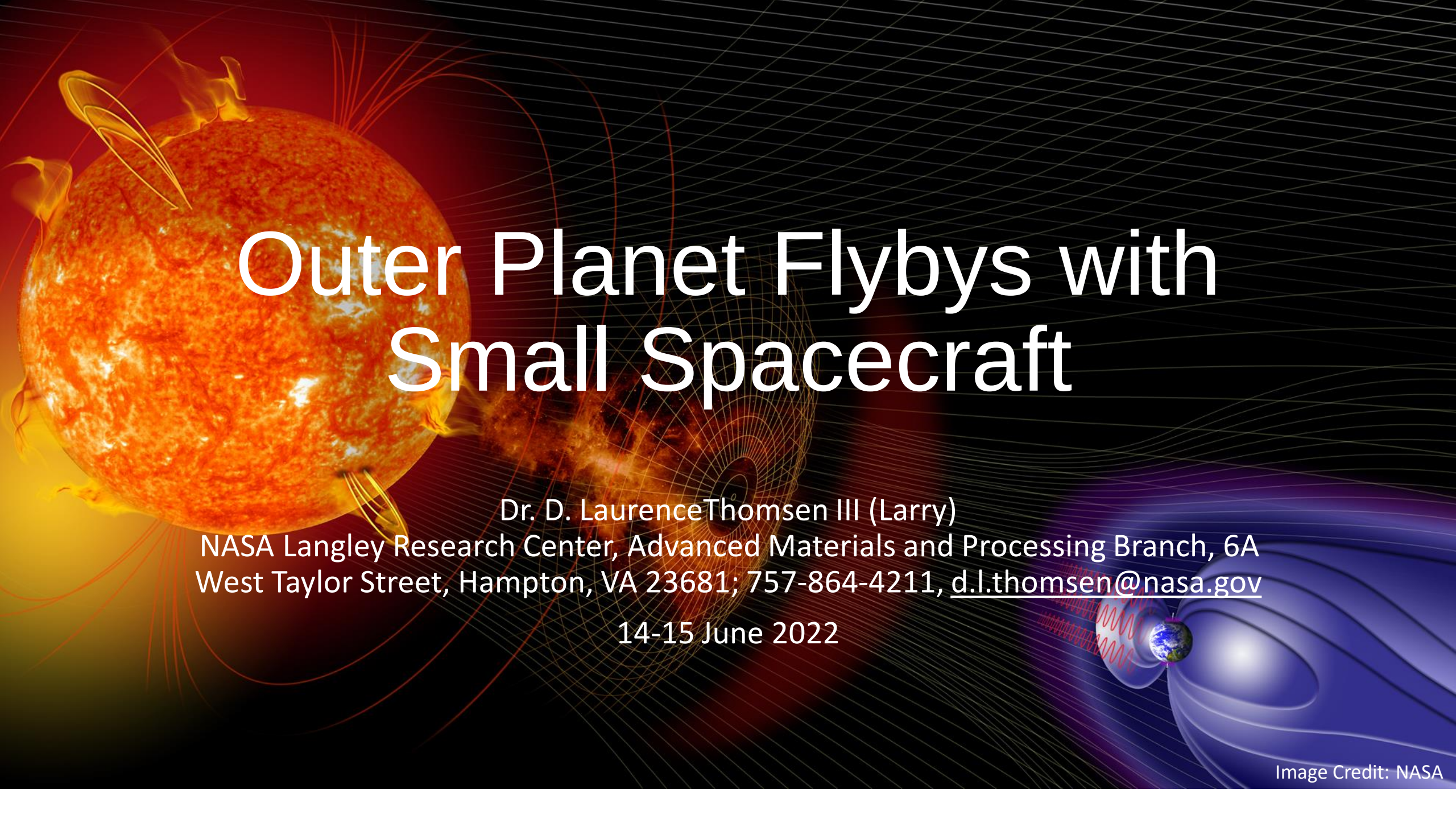




Outer Planet Flybys with Small Spacecraft

Dr. D. Laurence Thomsen III (Larry)

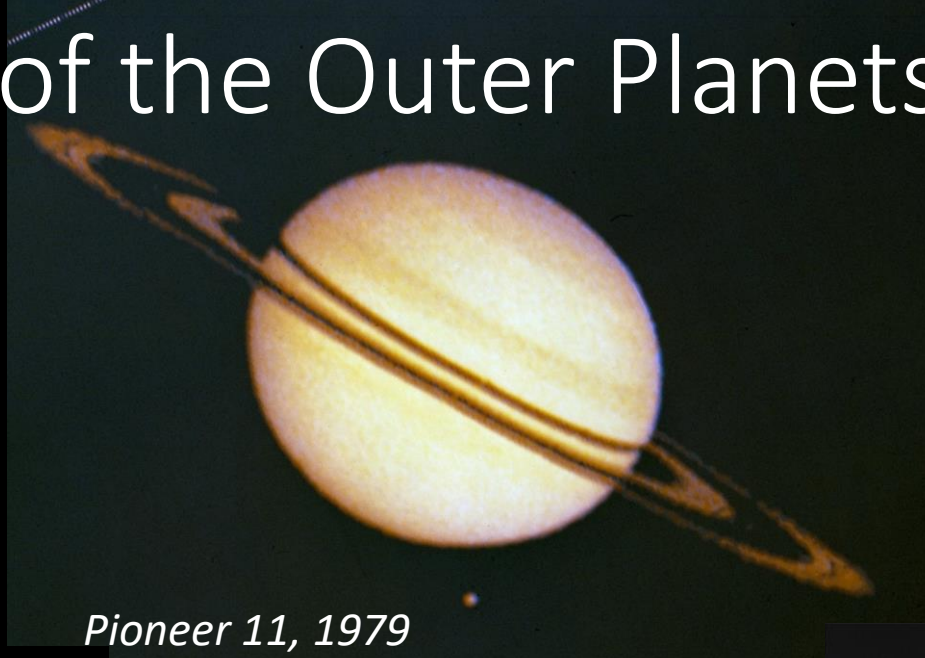
NASA Langley Research Center, Advanced Materials and Processing Branch, 6A
West Taylor Street, Hampton, VA 23681; 757-864-4211, d.l.thomsen@nasa.gov

14-15 June 2022

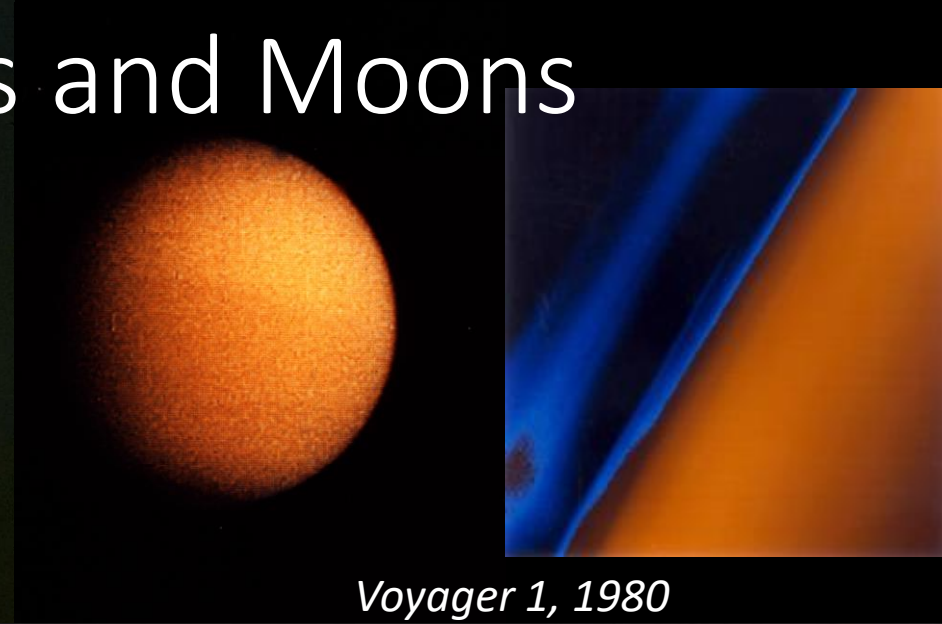
Flybys of the Outer Planets and Moons



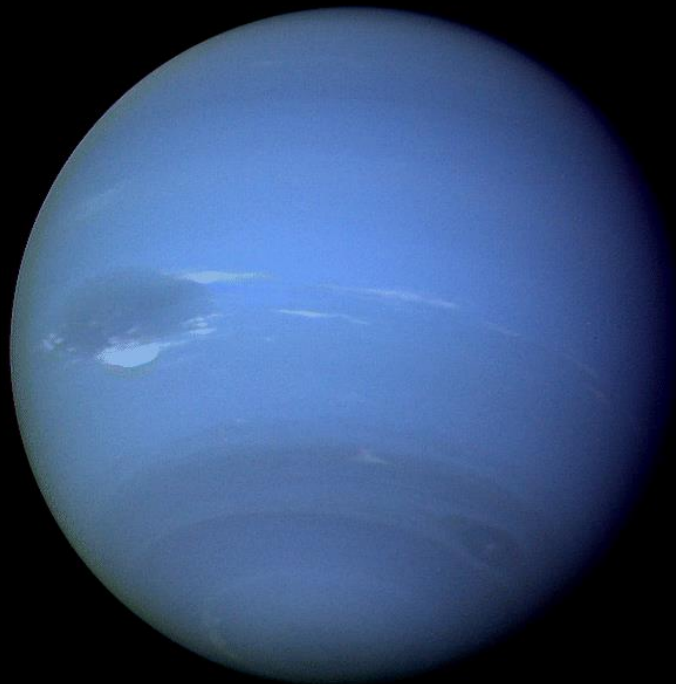
New Horizons, 2015



Pioneer 11, 1979



Voyager 1, 1980

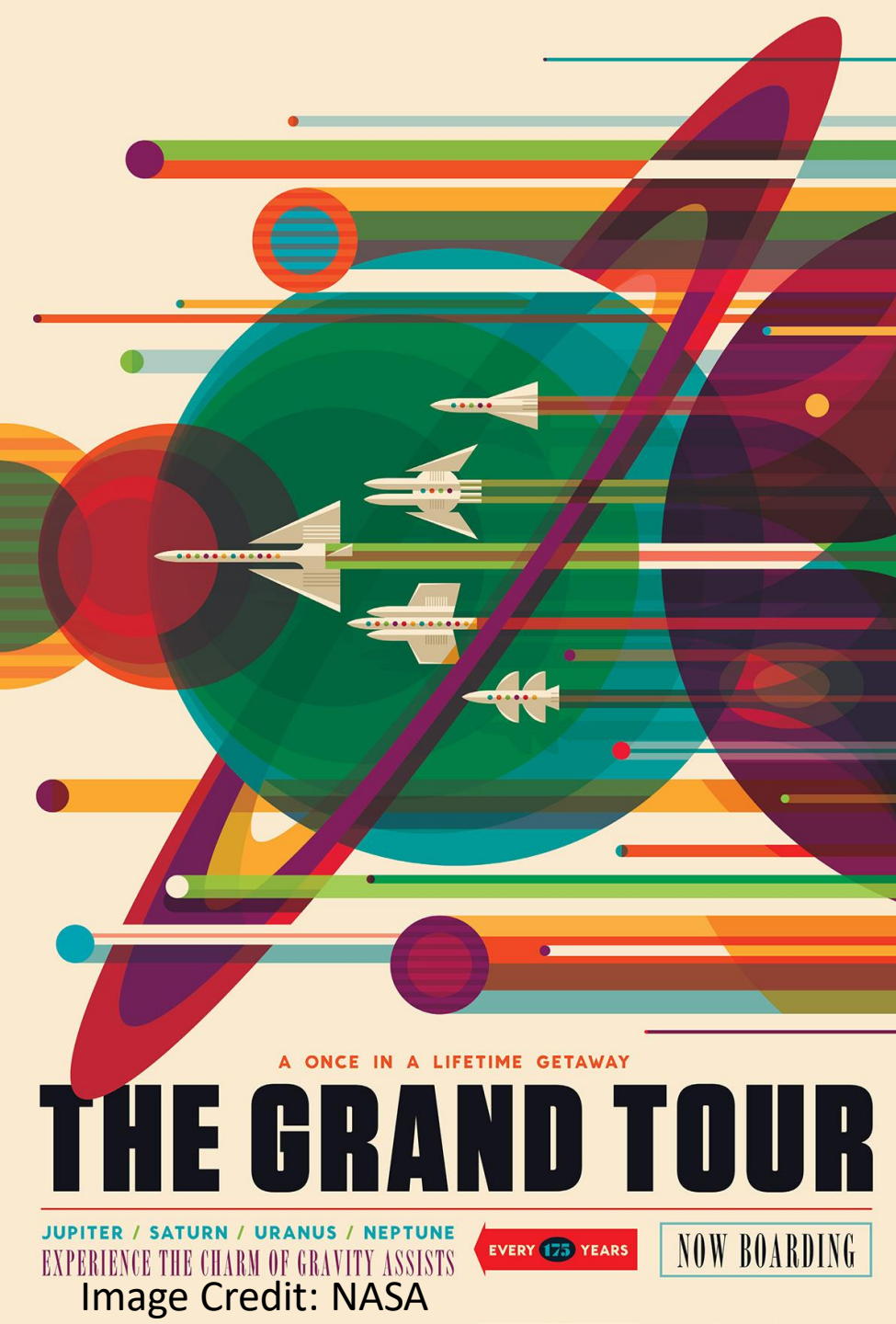


Voyager 2, 1986 and 1989

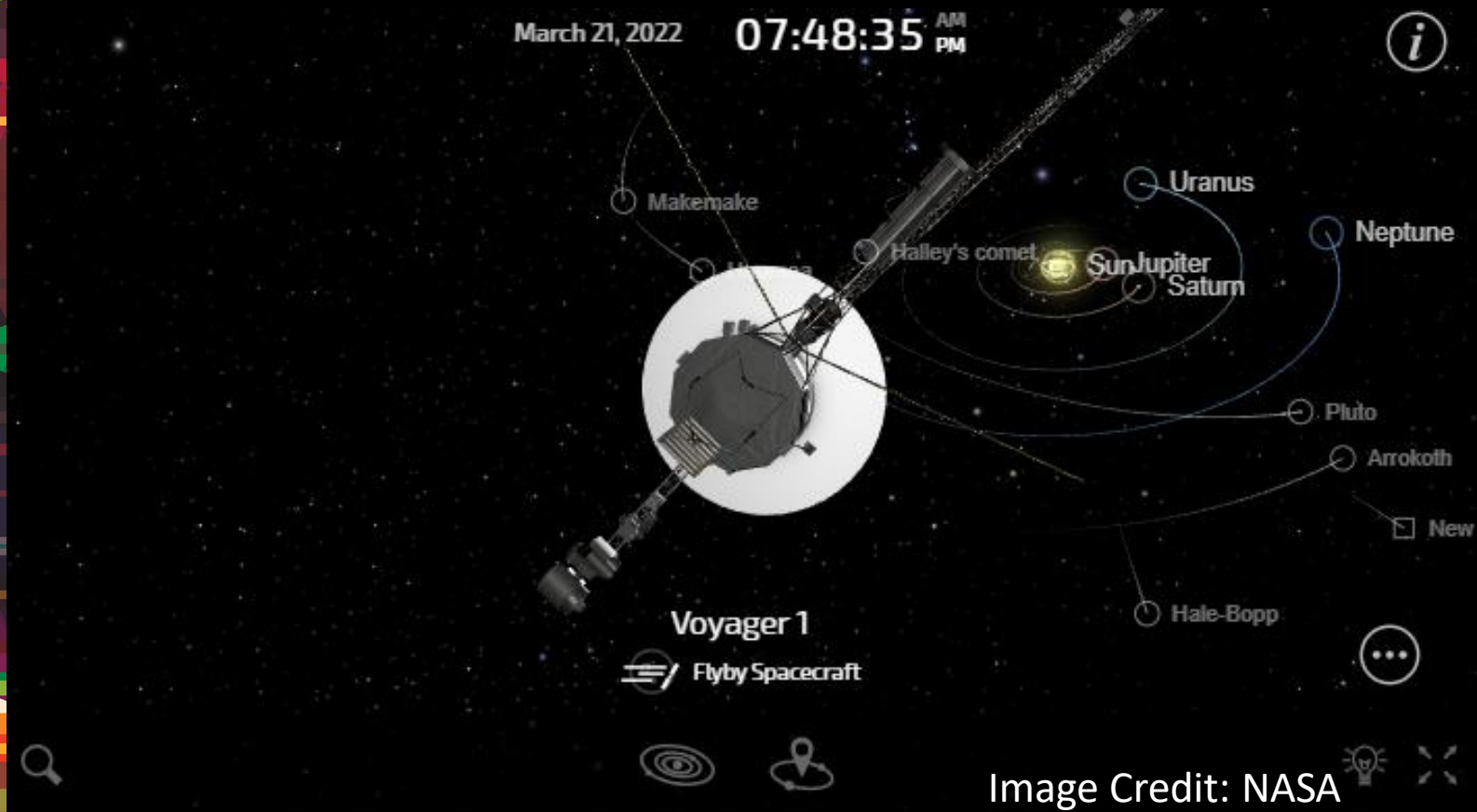


Pioneer 10, 1973

Image Credits: NASA



Previous Outer Planet Flybys and Beyond



Mission Elapsed Time 44:06:16:10:52:35
YRS MOS DAYS HRS MINS SECS

Small Spacecraft Missions: Increasing Complexity and Duration at a Fraction of the Cost of Larger Spacecraft

 Topics | Missions | Galleries | NASA TV | Follow NASA | Downloads | About | NASA Audiences

Small Spacecraft Technology Program

Earth Science Technology Office

CubeSat Launch Initiative

CubeSats on Exploration Mission-1

Ames Small Satellite Portal

JPL Small Satellite Portal

Related Topics

Commercial Space

CubeSats

CYGNSS Hurricane Mission

Space Station

Space Tech

All Topics A-Z



Living in Space
BioSentinel



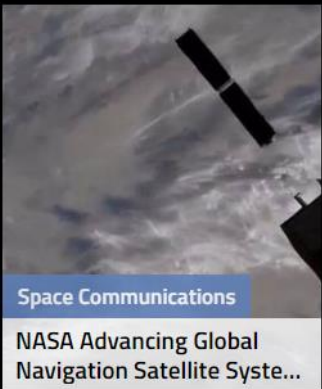
Sun
CuPID CubeSat Will Get New Perspective on Sun...



Asteroids
NASA Solar Sail Asteroid Mission Readies for Launch...



Exoplanets
Pandora Mission Would Expand NASA Capabilities...



Space Communications
NASA Advancing Global Navigation Satellite System...



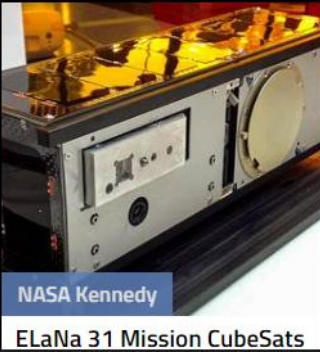
CubeSats
CubeSat Platform Enabled an Inexpensive Space Telescope



NASA Kennedy
NASA's ELaNa 20 Mission First to Fly on Virgin Orbit...



Solar System and Beyond
SIMPLEX Mission Small



NASA Kennedy
ELaNa 31 Mission CubeSats



Solar System and Beyond

Image Credits: NASA

CubeSat Market: \$0.5B - \$1B over 3yrs

- Over 1700 small satellites forecasted for 2017-2023 (www.spaceworksforecast.com)
- Over 500 over next 3 yrs into polar low earth orbit (PLEO) (www.spaceworksforecast.com)
- Typical CubeSats costs \$1M - \$2M* (https://esto.nasa.gov/techval_space.html)

**NASA ESTO Office reported that a CubeSat costs \$1M- \$1.5M per unit (U) at the 2017 SmallSat Conference.*

CubeSat values: \$0.5B - \$1B in the next three years alone

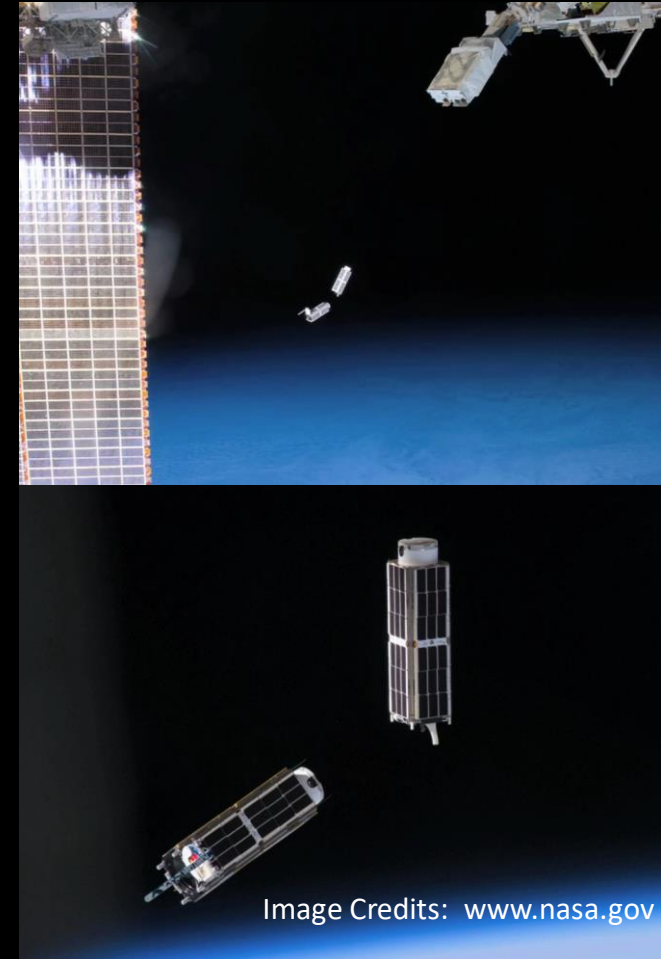


Image Credits: www.nasa.gov

Planting the Seeds of Multi-generational Exploration

- Develop and prepare small spacecrafts that can withstand solar radiation environment, galactic cosmic radiation, and long duration missions
- Nurture academic, government, citizen interest
- Engaging our scientific curiosity
- Gifting forward:
 - The story of our existence in the Solar System, Milky Way, and Universe
 - Training our next science, technology, engineering, and mathematics (STEM) explorers
- Coordinate multi-generational effort and data availability
- Adding to peaceful cooperation amongst multiple cultures and countries



Image Credit: NASA

