Scientific Satellite Applications for Exploration of Outer Space

KyuTech Space Engineering Seminar

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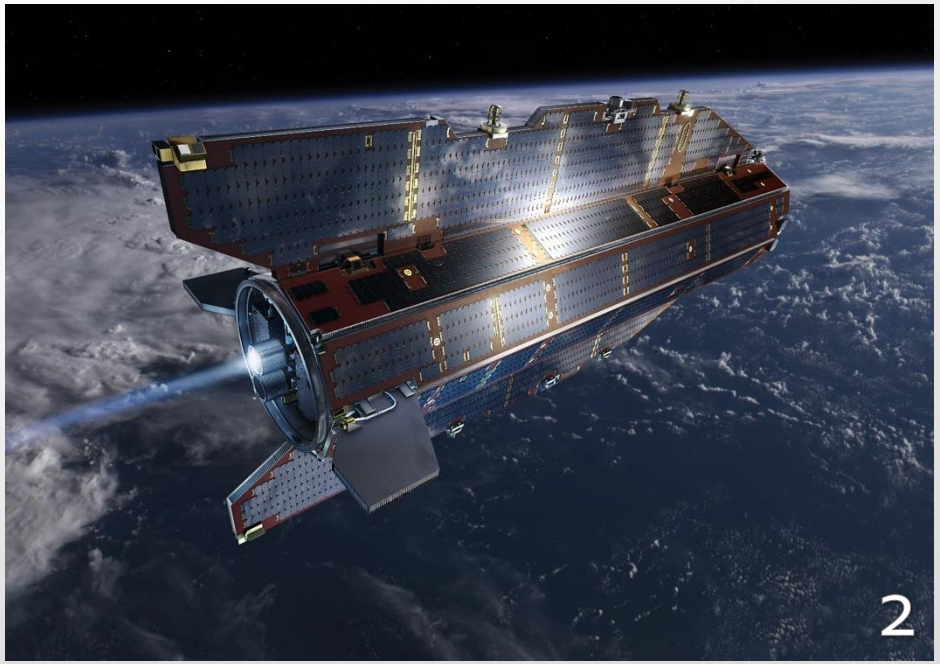
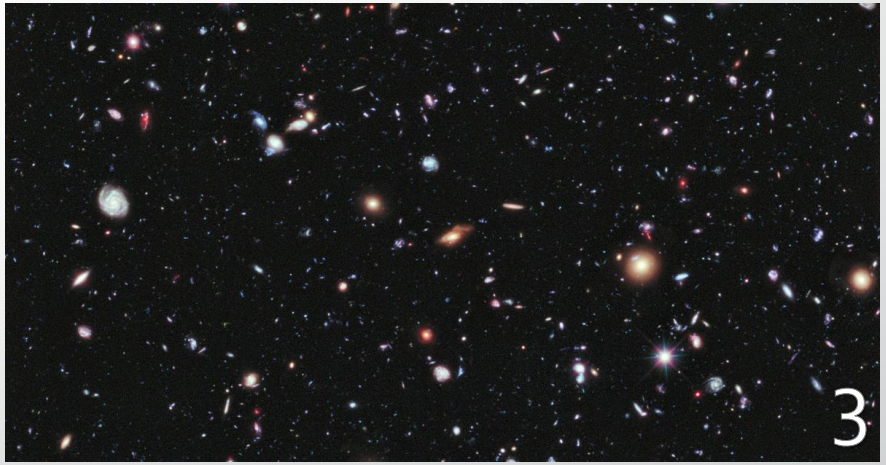


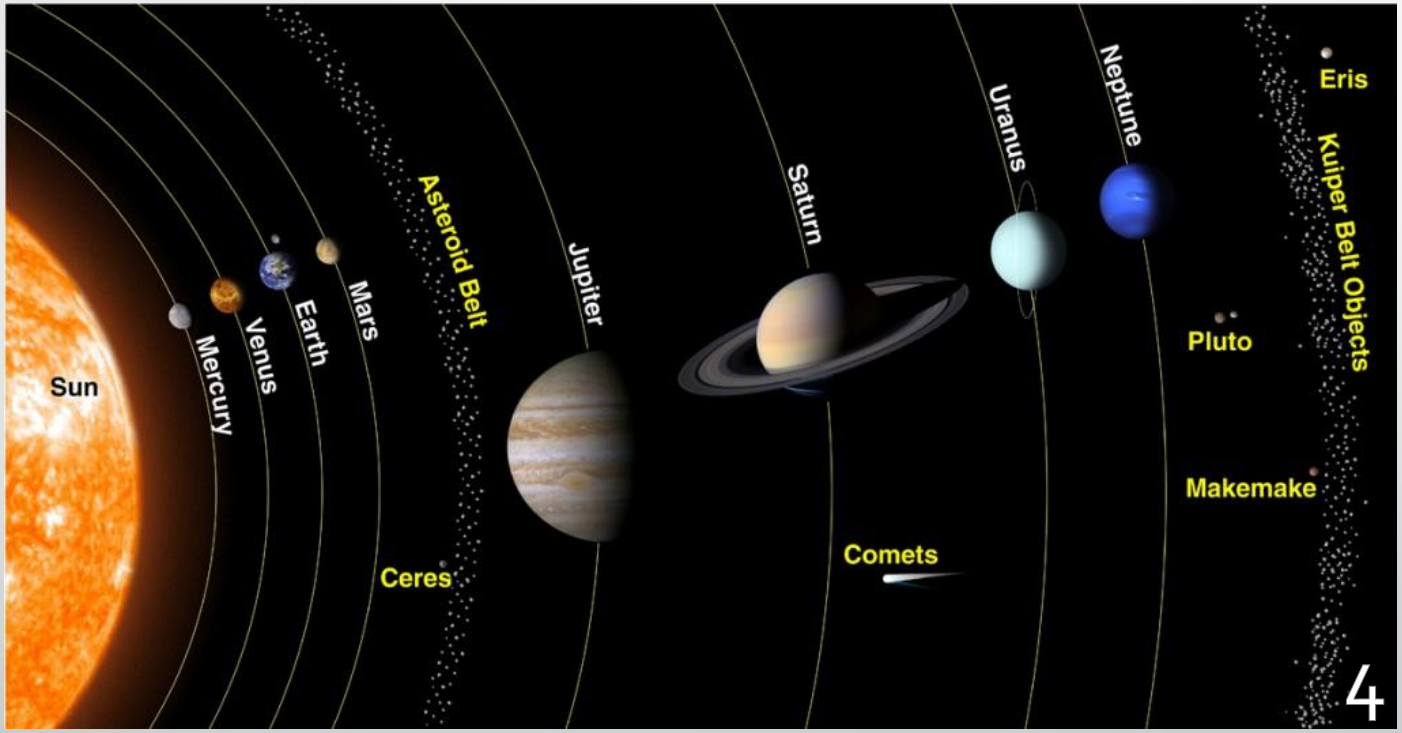
Introduction

- Aim: To introduce current scientific satellite exploration results
- Earth, Sun, Moon and Mars
- Uses of scientific satellites
  - Space observation
  - In-situ measurements
  - No attenuation and blocking
  - Understanding global phenomenon
  - Earth sciences, solar physics, astronomy and astrophysics

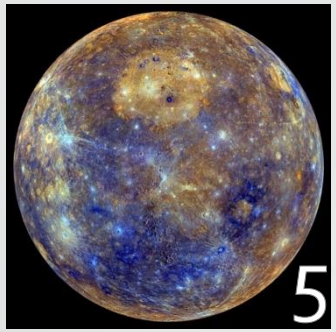


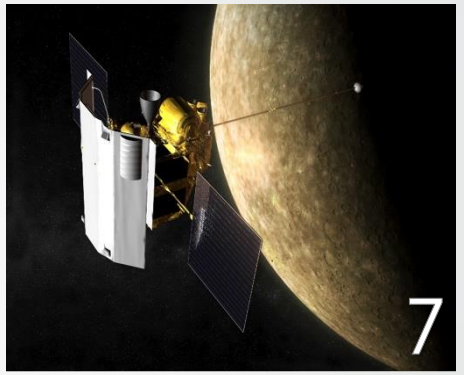
Missions for Studying Planets of the Solar System

- Orbiters
- Landers
- Fly-by missions

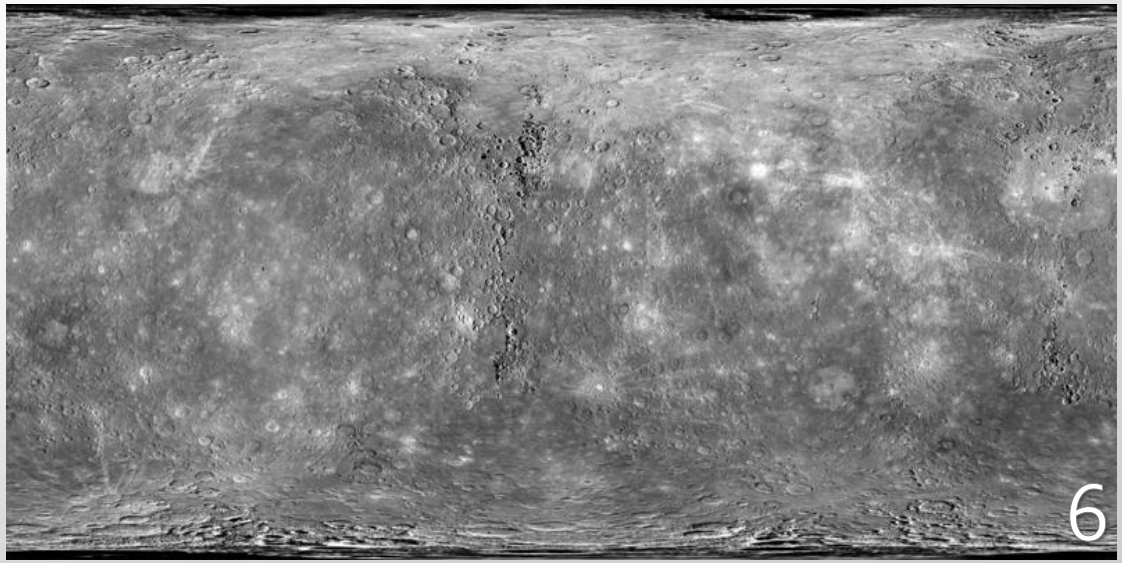


Mercury

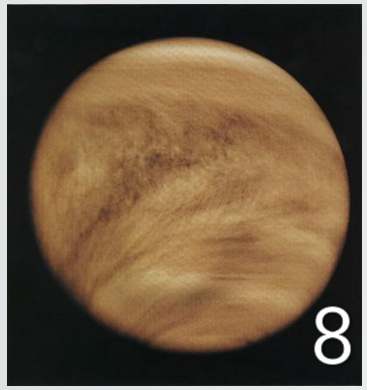


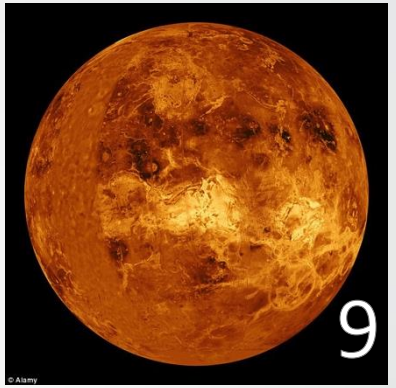


- Mariner-10 (1994) & MESSENGER (2004)
- Atmospheric pressure, surface temperature, magnetic field and surface structure
- Heavily cratered by meteorites
- The surface composition, geologic history, core and mantle, magnetic field and tenuous atmosphere
- Northern volcanic plains [2]
- Morning meteor showers by comets in the exosphere [2]
- BepiColombo Mission (launch planned in this month) [3]
  - Delay due to EPS malfunction in MPO before the launch
  - To be sent in next 6 months
  - MPO (Mercury Planetary Orbiter) by ESA
  - MMO (Mercury Magnetospheric Orbiter) by JAXA

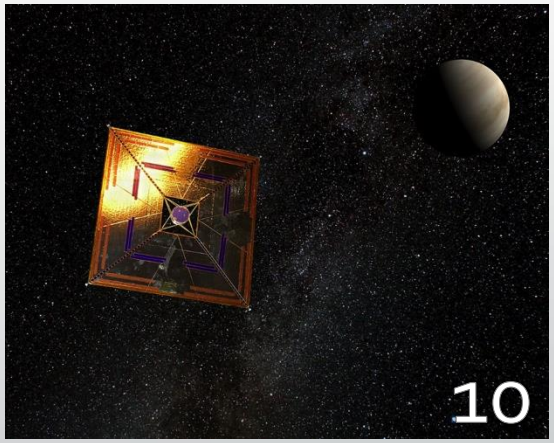


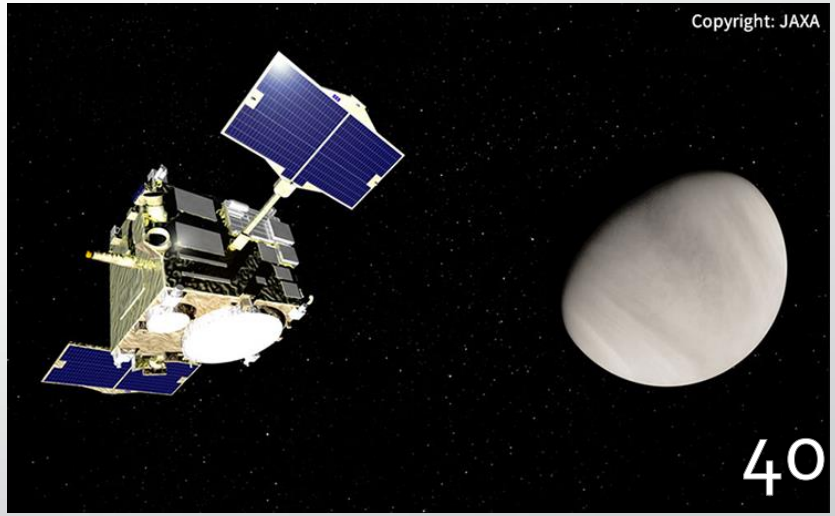
Venus





- Mariner 2 (1962) & Magellan (1990)
- Surface consists of gently rolling plains covered by lava flows, with two large highland areas deformed by geological activity
- Still volcanically active
- Has almost negligible magnetic field
- Atmosphere → CO_2 (95%) and N_2
- Sulfuric acid clouds
- Surface temperature of 450-500°C
- IKAROS (2011) with Venus Climate Orbiter (Planet-C or Akatsuki)

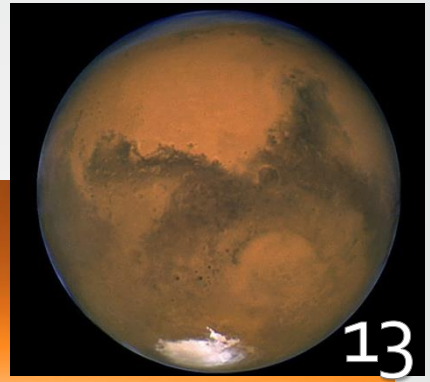




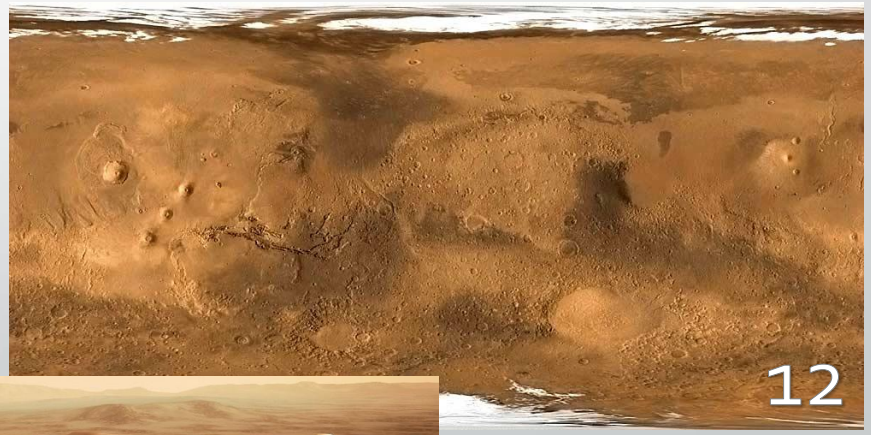
Talk of "How to survive on Mars"

https://www.ted.com/talks/stephen_petranek_your_kids_might_live_on_mars_here_s_how_they_ll_survive#

Mars

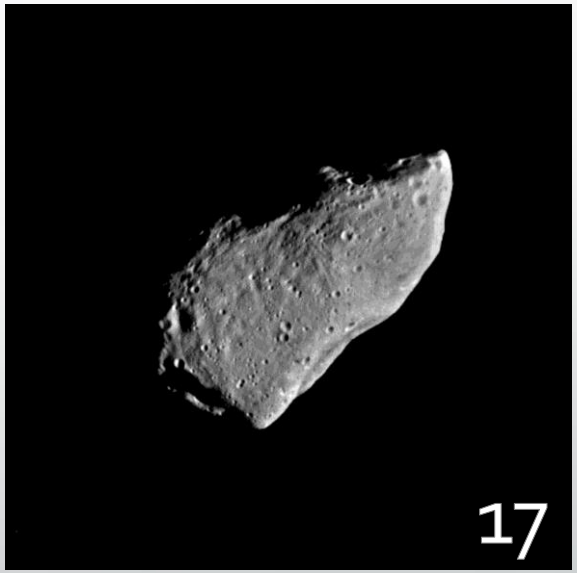


- Mariner-4 (1965)
- No metallic core
- Largest number of missions
- Southern highlands → craters
- Northern plains → lava flows, small cinder cones, dunes, wind streaks and major channels and basins similar to dry 'river valleys'
- Polar regions → polar ice caps made of frozen CO (dry ice)
- Small amount of water vapor in the atmosphere

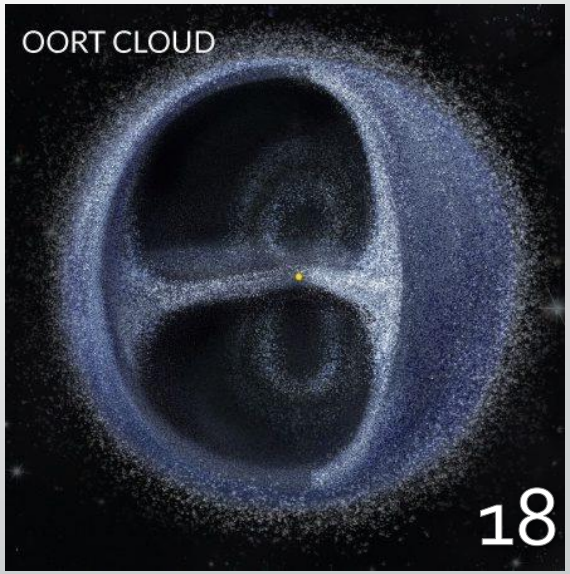


Asteroids

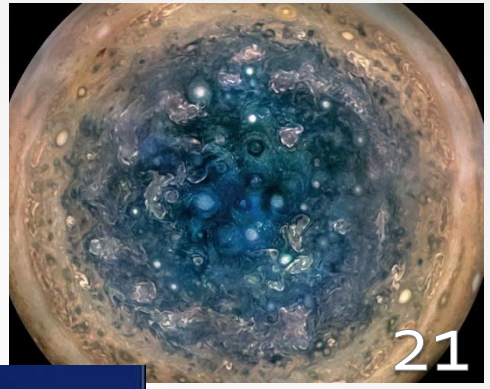
- Rocky and metallic objects
- Asteroid belt (Mars – Jupiter)
- Kuiper belt (After Neptune)
- Oort Cloud (surrounding the solar system)
- 951 Gaspra (1991) [4]
- NEAR (Near Earth asteroid rendezvous) Shoemaker (1997)
- Hayabusa
  - 25143 Itokawa asteroid (land in 2005)
  - Sample return in 2010
- Hayabusa 2 [5]
  - 162173 Ryugu (planned landing in June-July 2018)
  - Sample return in 2020



951 Gaspra by Galileo

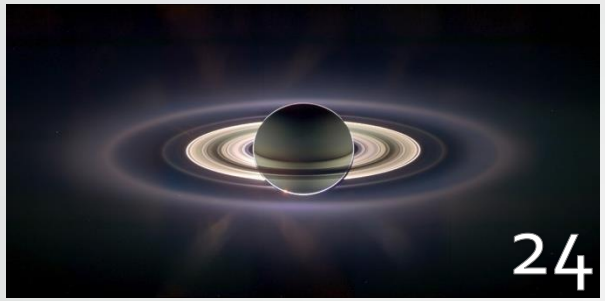


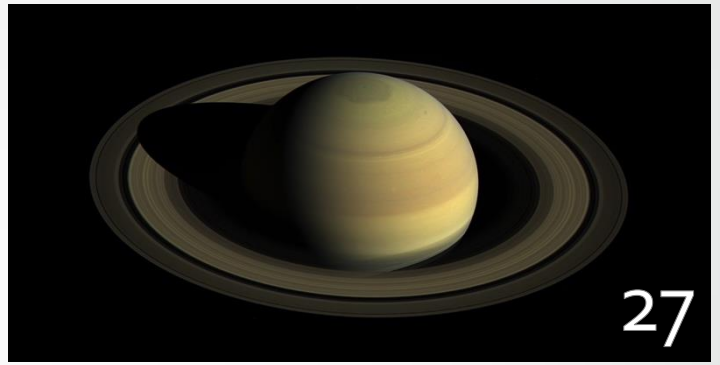
Jupiter



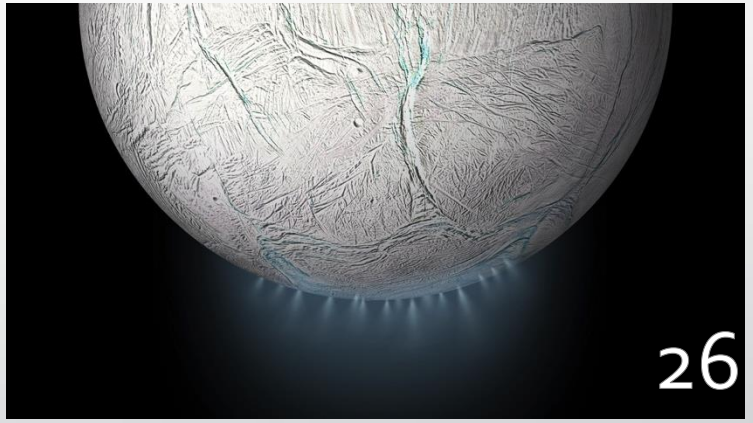
- Pioneer-10 and -11
- Voyager 1 and 2
- Ulysses
- Galileo (in orbit after Dec. 1995)
- Juno (arrived in July 4, 2016)
- Colored bands (cloud layers)
- Storms and turbulences (~600 km/h)
- Great Red Spot (GRS)
- Strong magnetosphere (x10 of Earth's)
- 'at least' 63 moons and a ring around
- Europa Clipper orbiter and lander (2022?) by NASA [6]

Saturn

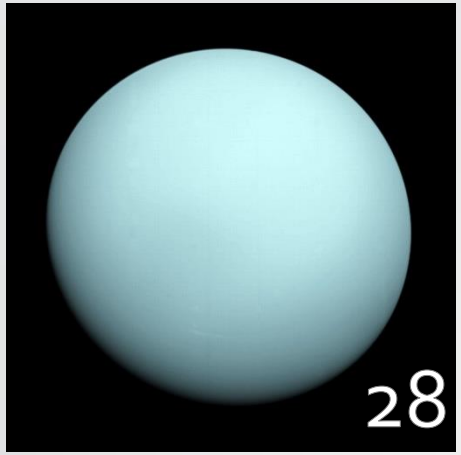


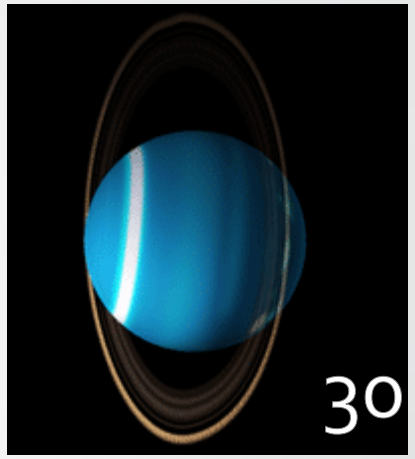


- Cassini/Huygens probe (ended in 15 Sept, 2017)
  - Especially Titan
  - Cassini orbiter (reached at 2004)
  - Huygens lander probe on Titan (2005)
- Liquid water in geysers on Enceladus
- Hydrocarbon lakes near Titan's north pole
- The ring → 6630 – 120,700 km altitude
  - Possible electromagnetic connection
- 31 officially recognized moons

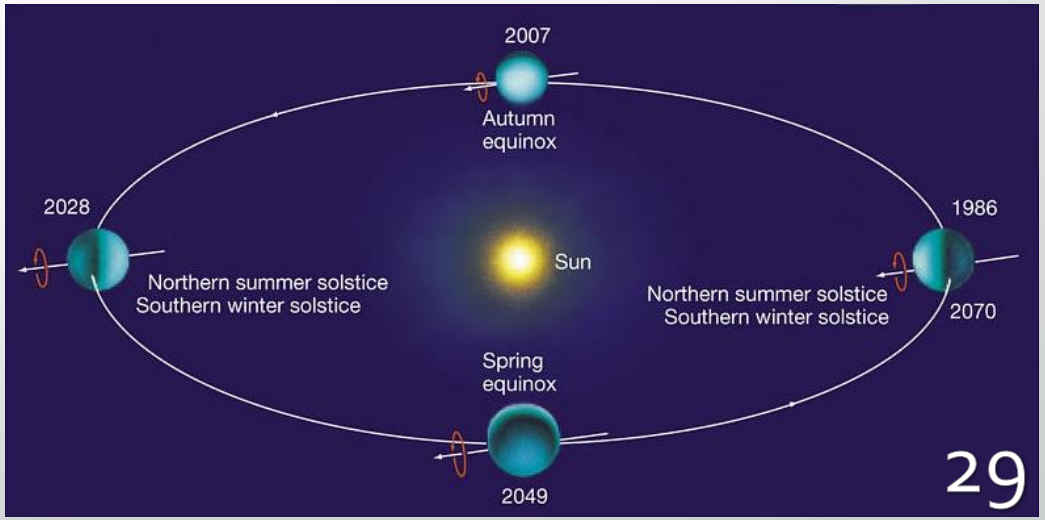


Uranus

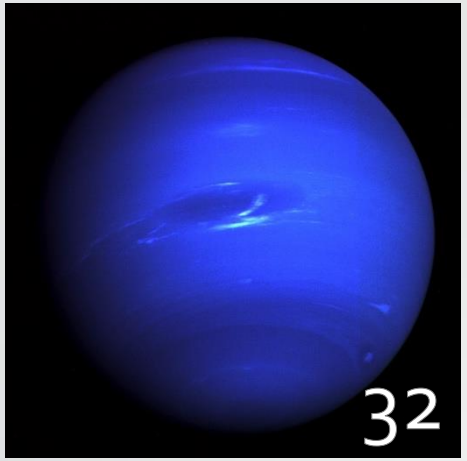


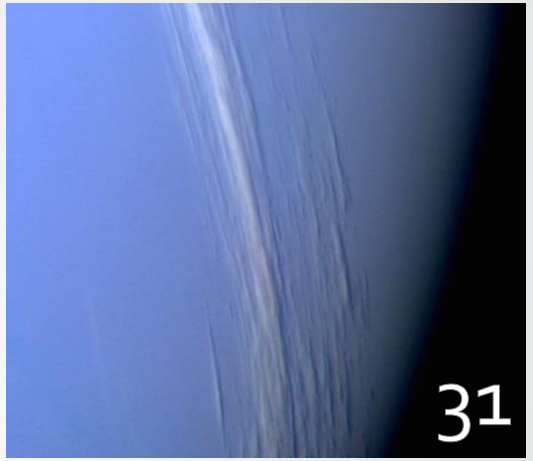


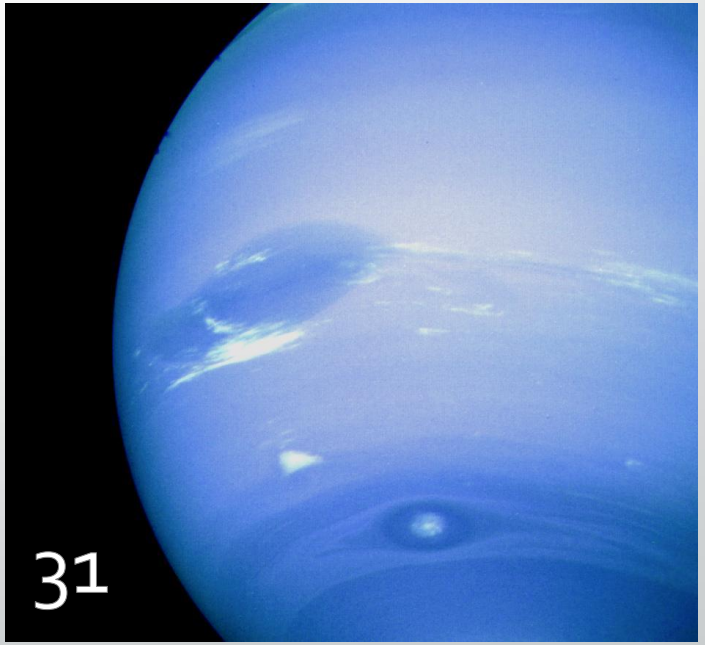
- Only Voyager-2 (Jan 1986)
- Observed from ground and by HST
- Rotation axis nearly in the ecliptic plane
- Extreme seasonal variation



Neptune

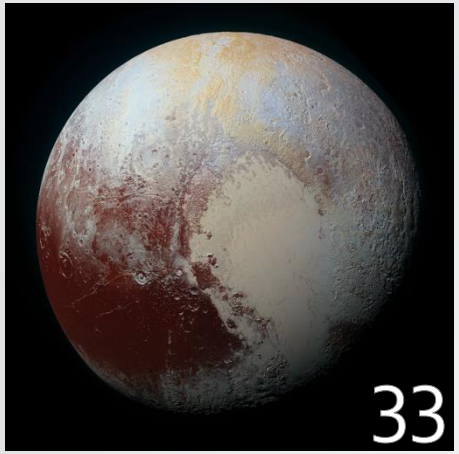






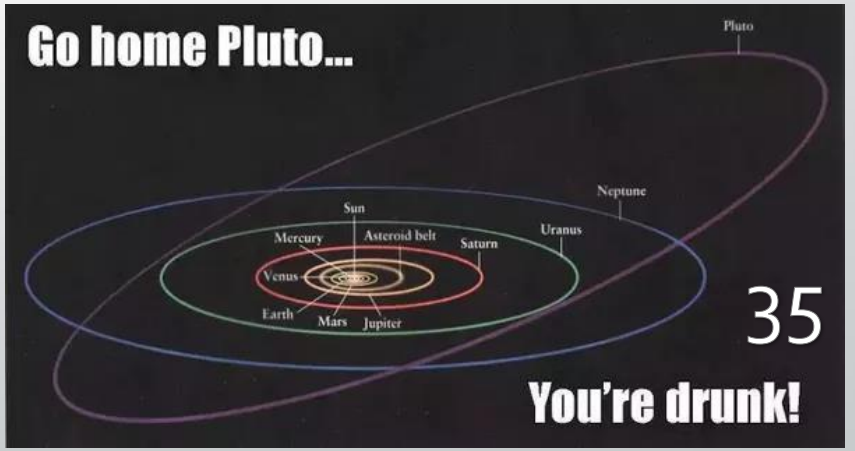
- Only Voyager-2 (August 1989)
- Several dark spots like Jupiter's GRS
- Great Dark Spot (size of the Earth)
- Dynamic atmosphere
- Neptune Orbiter mission of NASA – Cancelled
- NASA & ESA collaboration for Ice Giants investigation [7]
  - 1 Neptune, 3 Uranus probe offers are being considered.

Pluto



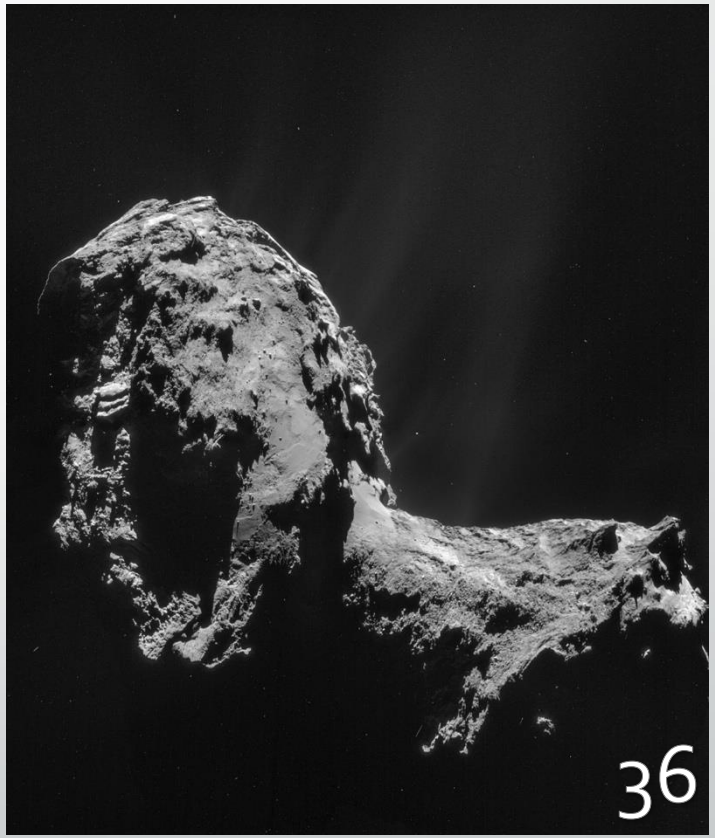
Pluto's moon Charon (July 14, 2015)

- Dwarf Planet
- New Horizons (2015) [8]
  - 1,000-kilometer-wide heart-shaped nitrogen glacier
    - informally called Sputnik Planum
  - Past presence of running or standing liquid volatiles on its surface
    - Earth, Mars and Titan
  - Blue sky
  - Regional, red water ice
  - High surface activity than expected, lower atmospheric escape rate than estimated
  - Charon's frozen water



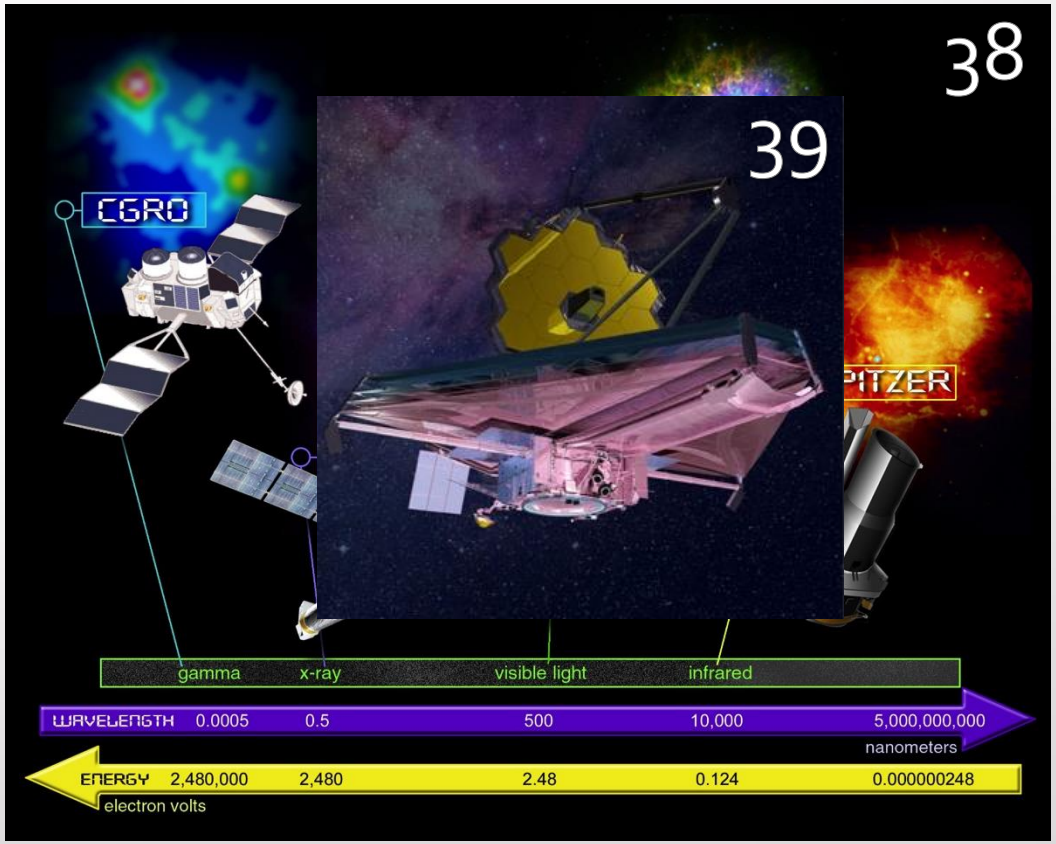
Comets

- Mixture of nonvolatile grains and frozen gases
- HST, ROSAT, DS-1, Vega-1 and -2… etc.
- Stardust (2004) → particle collection from coma
  - Returned samples in 2006
- Rosetta (2004) [9]
  - Philae lander on Comet 67P/Churyumov-Gerasimenko (2014)
  - Composition of coma (ROSINA)



Missions Beyond the Solar System

- NASA's Great Observatories Program
- Launched 1990-2003
- Still in operation besides CGRO
  - HST
    - Visible, near UV, near IR
    - Black holes in the core of the galaxies
    - Accelerating universe
    - James Webb Space Telescope (JWST) in Spring 2019 [10]
  - Compton gamma ray observatory (CGRO)
    - 1991-2000 (de-orbited due to an attitude motor malfunction)
    - Terrestrial gamma-ray sources that came from thunder clouds
  - Chandra X-ray observatory
    - Stellar coronas
    - Supernova remnants
    - Far away stars
  - Spitzer space telescope (SST) in 2003 for IR



Concluding Comments

- Findings and recent scientific satellite missions regarding the celestial bodies besides Earth are presented.
  - Improvement of the resolution sensors and image compression techniques
  - Micro-nano-pico scale satellites in the future
  - Manned missions and colonization ideas
- New challenges to improve technological developments further and to understand more about our universe

Kyutech

Thank you for listening!

Any questions?

La SEINE

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