Planetary Exploration and International Collaboration

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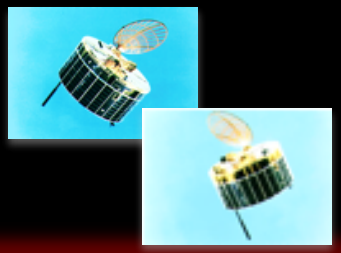
The Path
Japanese Planetary Exploration

1985

Sakigake/ Suisei

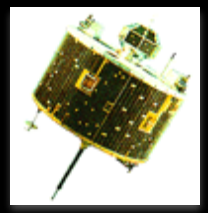
Comet flyby



1990

Hiten

Lunar probe



1992

1995

Nozomi

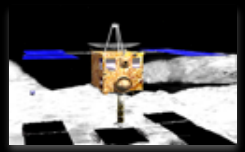
Planned and launched Mars orbiter

1998

2003

Hayabusa

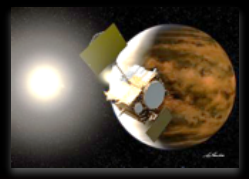
Asteroid Sample Return Mission



2010

Akatsuki

Venus Climate Orbiter



2014

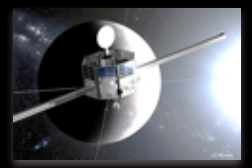
Hayabusa2

Asteroid Sample Return Mission

2018

BepiColombo MMO/MPO

Mercury Orbiter



2020s (TBD)

MMX

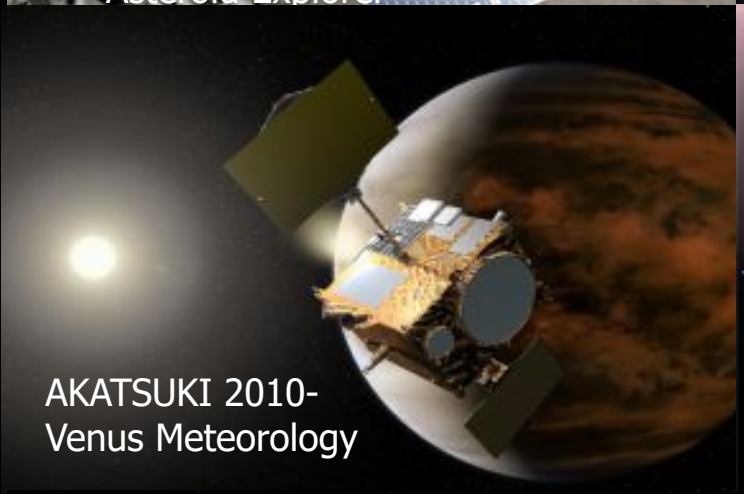
Martian Moons explorer

Recent Science Missions

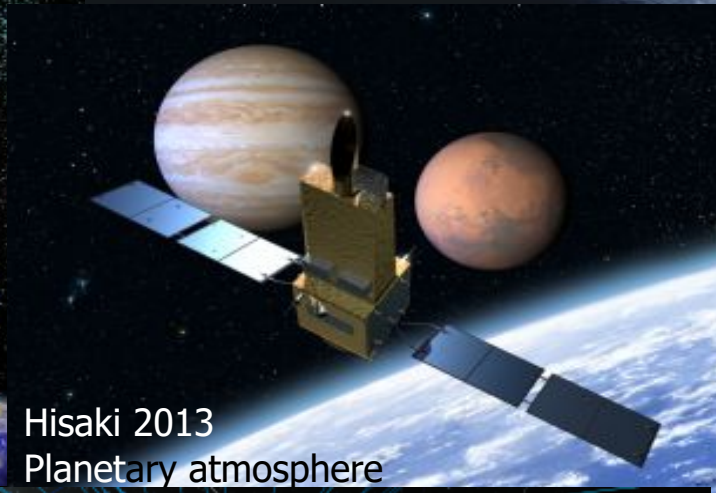

HAYABUSA 2003-2010
Asteroid Explorer


HINODE(SOLAR-B)2006-
Solar Observation


KAGUYA (SELENE)2007-2009
Lunar Exploration

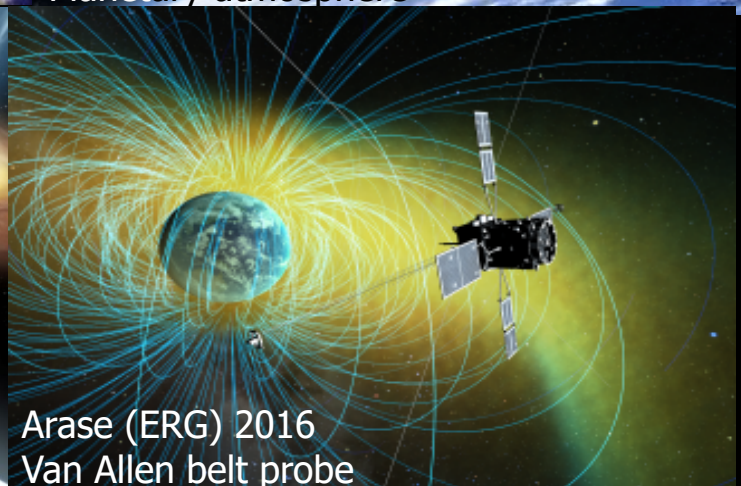

AKATSUKI 2010-
Venus Meteorology


IKAROS 2010
Solar Sail


Hisaki 2013
Planetary atmosphere


HAYABUSA2 2014-2020
Asteroid Explorer

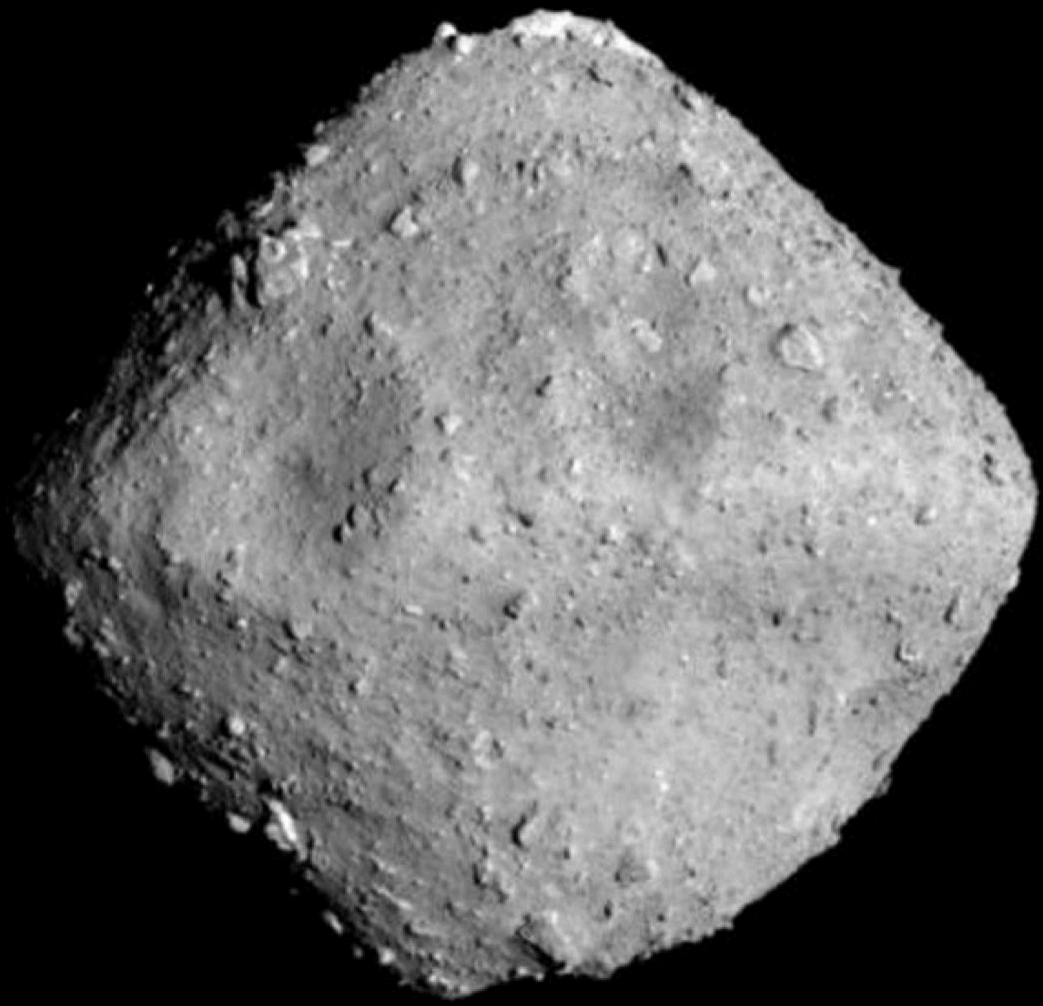

Hitomi(ASTRO-H) 2016
X-Ray Astronomy


Arase (ERG) 2016
Van Allen belt probe

Hayabusa & Hayabusa 2
Asteroid Sample Return Missions

"Hayabusa" spacecraft brought back the material of Asteroid Itokawa while establishing innovative ion engines. "Hayabusa2", while utilizing the experience cultivated in "Hayabusa", has arrived at the C type Asteroid Ryugu in order to elucidate the origin and evolution of the solar system and primordial materials that would have led to emergence of life.

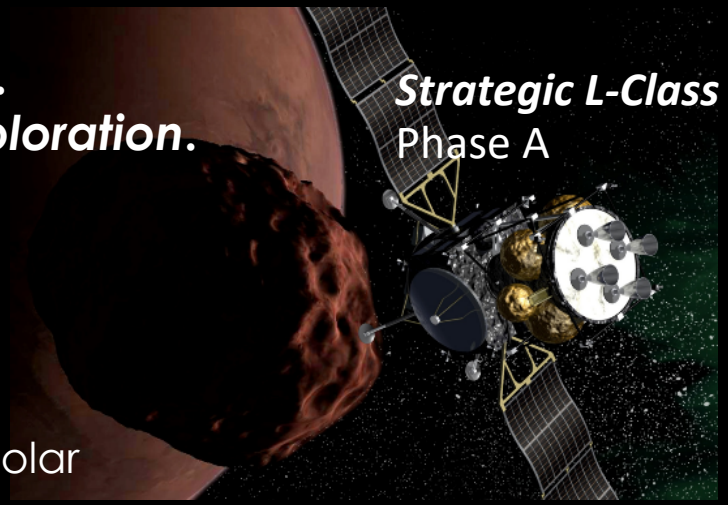
	Hayabusa	Hayabusa2
Target	Itokawa	Ryugu
Launch	2003	2014
Arrival	2005	2018
Return	2010	2020



Asteroid Ryugu

Martian Moons eXploration (MMX)

Sample return from Marian moon for detailed analysis.
A key element in the ISAS roadmap for small body exploration.



Strategic L-Class
Phase A

■ Science Objectives

1. Origin of Mars satellites.
   - Captured asteroids?
   - Accreted debris resulting from a giant impact?
2. Preparatory processes enabling to the habitability of the solar system.

■ Timelines

FY2024 Launch
2025 Mars Arrival
2029 Return to Earth

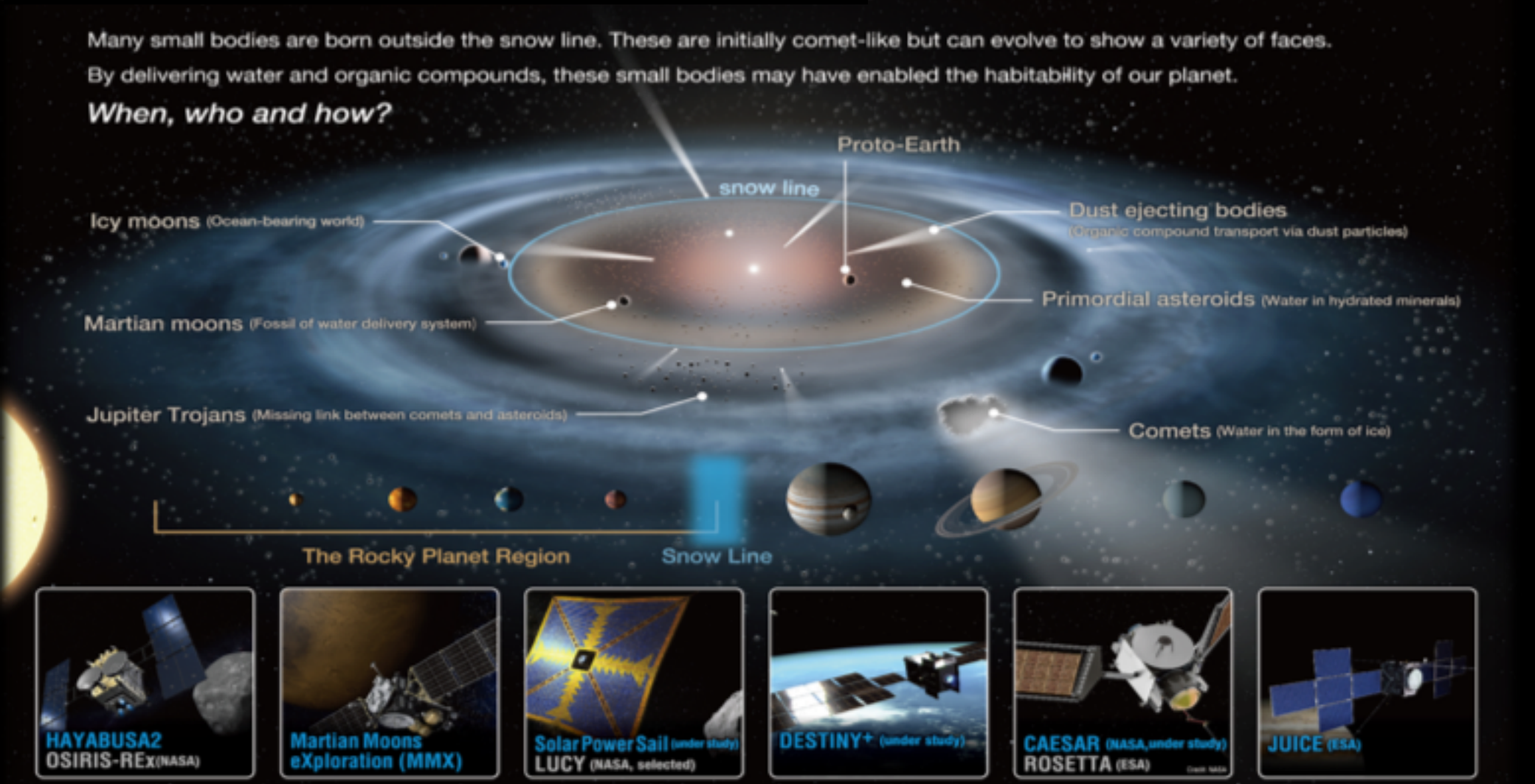
■ Launch Mass : 3400kg

Three stages system.
Return module: 1350kg
Exploration module: 150kg
Propulsion module: 1900kg

■ International collaboration

- CNES
  - Near-infrared Spectrometer
  - Flight Dynamics
  - Joint Rover with DLR
- NASA
  - Gamma-ray and Neutron Spectrometer
  - Use of DSN, Test Facilities, etc.
- ESA, DLR : under coordination

Small Body Exploration Strategy



The fleet of ISAS small body missions explores these questions

Promotion Strategies for Space Science & Exploration Projects

Based on strategies for execution of future projects in the space science and engineering fields amid harsh resource limitations, rather than the large-scale projects that have been strived for in the past, we will mainstream smaller projects in 3 categories: Large-scale satellites/explorers (launched on H2-class or larger rockets), medium-scale satellites/explorers (launched on Epsilon rockets), and various other small-scale projects.

Typical scientific satellite mission through the early 2000s, were launched by M-V rocket

Strategic Large-scale missions

With the goal of attaining first-class achievements, Japan will lead flagship missions in each field, assuming international cooperation in various forms.

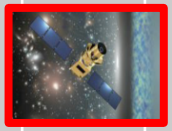
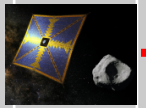
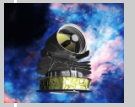
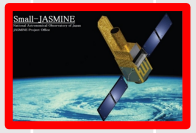
Competitively-chosen Medium-scale missions

Aiming to create high-frequency results through flexibly implemented, challenging medium-scale missions. Flexibly implemented Earth-orbiting and deep-space missions. Taking advantage of experiences gained from current small-satellite projects, we will work on making lightweight and advanced functions through advancement of satellites and probes. Includes various projects of equivalent scale.

Various small-scale projects

Maximize opportunities and generation of results through participation as a junior partner in overseas missions, domestic and international participation in flight opportunities such as satellites, small rockets and balloons, creation of small-scale flight opportunities, scientific research utilizing the ISS, etc.

Mission Roadmap for ISAS Space Science and Exploration Projects

Category	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029	FY 2030
Strategic Large Class		 Bepi Colombo			 XRISM			 MMX		 LiteBIRD  OKEANOS			 SPICA
Competitive Medium Class					 SLIM	 Destiny+		 Small JASMINE		scheduled Launch		scheduled Launch		scheduled Launch
Participating as a junior partner in overseas missions						 JUICE				Candidates: • SOLAR-C EUVST • HiZ-GUNDAM <Under Study> ATHENA WFIRST Dragonfly etc  				

JAXA's Overall Scenario for International Space Exploration

Mars, others

Human Presence Expansion

Pin Point Landing Technology
Gravitational Body Exploration Technology

MMX: JFY2024

★ Initial Exploration

- Search for life
- Science exploration

Asteroid Sample return

★ Full Fledge Exploration

- Utilization feasibility exam
- Long term scientific exploration

Moon

Kaguya

SLIM
(JFY2021)

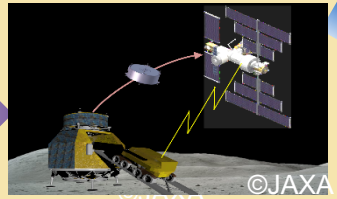
Pin-point Landing Technology

Pin-point Landing Technology

Gravitational Body Exploration Technology

Traversing exploration (prox.2023～)

- Science exploration
- Water prospecting



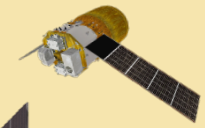
Sample Return (prox.2026～)

- S/R from far side
- Technology demo for human mission

Full-fledged Exploration & Utilization

- Cooperative science/resource exploration by robotic and human
- Diverse entity's moon activities

Deep Space Rendezvous and Docking Technology



HTV-X der.
(prox. 2026～)

- Small probe deploy
- Data relay, etc

Support

Habitation technology

Gateway Phase 1
(2022-)

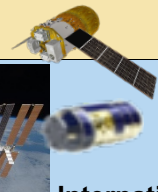
- Support for Lunar science
- Science using deep space environment

Support

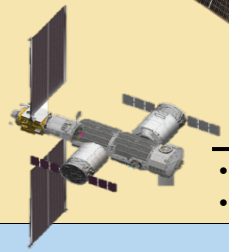
Gateway Phase 2

- Technology demo for Human Mars mission

Earth



Habitation Technologies



Promote Commercialization

International Space Station

For Future Diverse Missions -Frontloading

- Focusing efforts and cost in the earlier stages of the projects
- Advancing and prioritizing technologies common to future missions
- Capitalizing on strength of Japanese technologies;

e.g.

- Microsatellites
  - Micro miniaturization of satellite systems
  - Enhancing energy conservation
- Space transportation system
  - Re-entry flight technologies
- Lunar and planetary exploration
  - Deep space navigation system
- Cryogenic cooling system.
  - Sample return capsule
  - Rover technologies

THANK YOU FOR LISTENING.