JUICE: Jupiter Icy Moon Explorer

Presentation to the Giant Planet Systems Panel of the National Academies Planetary Science and Astrobiology Decadal Survey

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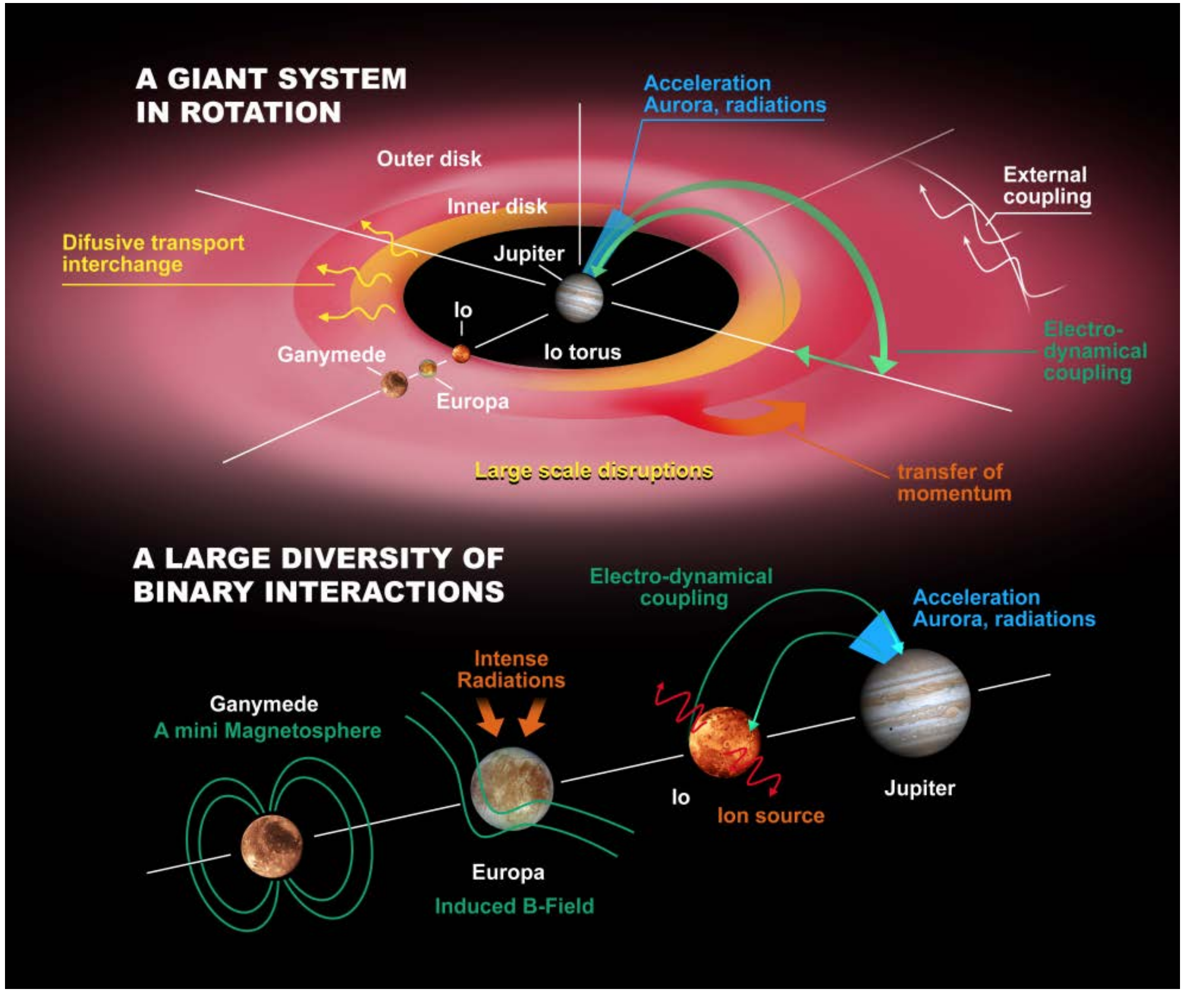
JUICE science themes

Emergence of habitable worlds around gas giants

- Ganymede as a planetary object and possible habitat
- Europas's recently active zones
- Callisto as a remnant of the early jovian system

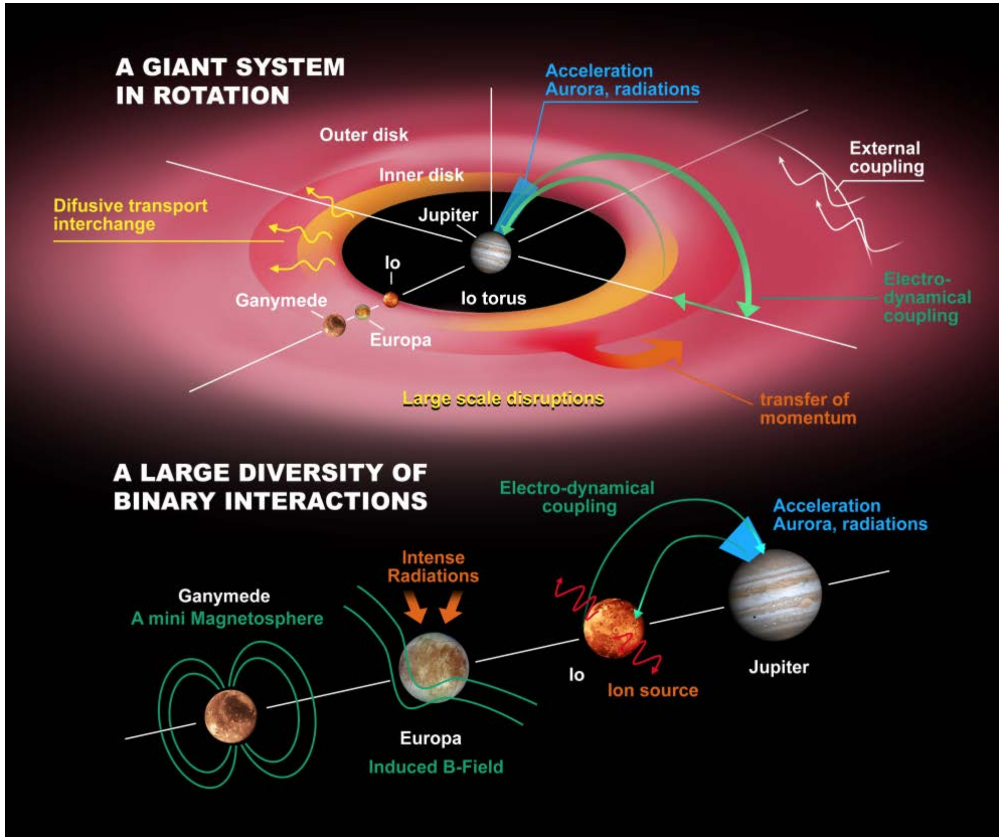


Broad and interdisciplinary science

The Jupiter system as an archetype for gas giants

- Jovian atmosphere
- Jovian magnetosphere
- Jovian satellite and ring systems

Science objectives

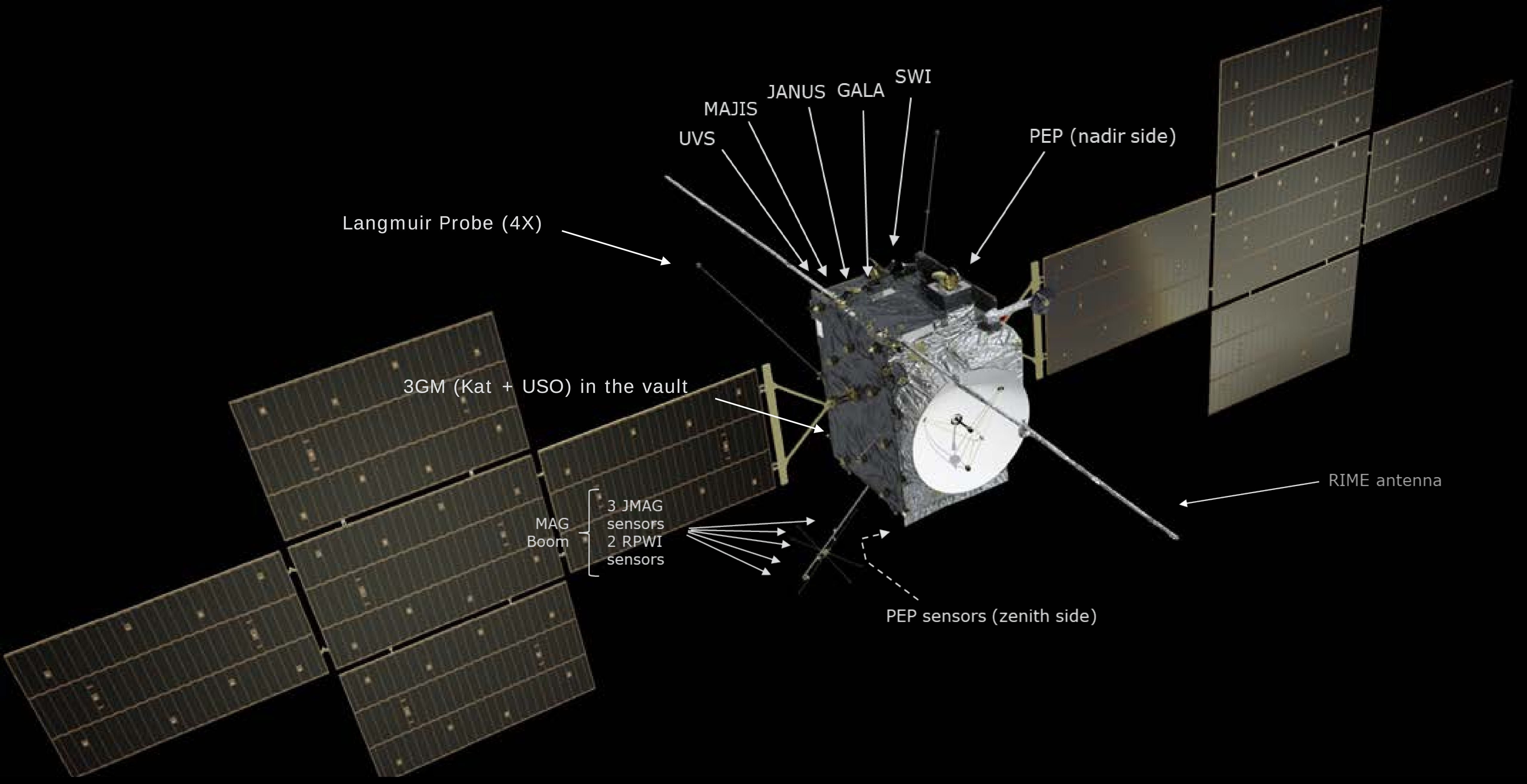


Explore the habitable zone: Ganymede, Europa, and Callisto	
Ganymede as a planetary object and possible habitat	Characterise the extent of the ocean and its relation to the deeper interior
	Characterise the ice shell
	Determine global composition, distribution and evolution of surface materials
	Understand the formation of surface features and search for past and present activity
	Characterise the local environment and its interaction with the Jovian magnetosphere
Europa's recently active zones	Determine the composition of the non-ice material, especially as related to habitability
	Search for liquid water under the most active sites
	Study the recently active processes
Callisto as a remnant of the early Jovian system	Characterise the outer shells, including the ocean
	Determine the composition of the non-ice material
	Study the past activity

Explore the Jupiter system as an archetype for gas giants	
The Jovian atmosphere	Characterise the atmospheric dynamics and circulation
	Characterise the atmospheric composition and chemistry
	Characterise the atmospheric vertical structure
The Jovian magnetosphere	Characterise the magnetosphere as a fast magnetic rotator
	Characterise the magnetosphere as a giant accelerator
	Understand the moons as sources and sinks of magnetospheric plasma
The Jovian satellite and ring systems	Study Io's activity and surface composition
	Study the main characteristics of rings and small satellites

Mission parameters

- Launch: 2022-2023
- Arrival: 2030-2032
- End of mission: 2034-2036
- Impact on Ganymede at the end
- 59-68 orbits around Jupiter
- 9 months in orbits around Ganymede – 500 km circular orbit at the end.
- 2 Europa flybys 400 km altitude
- 11-15 Ganymede flybys (various altitudes at closest approach)
- 12-21 Callisto flybys – 200 km altitude

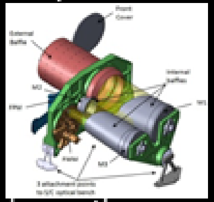

SWI
GALA
JANUS
MAJIS
UVS
PEP (nadir side)
Langmuir Probe (4X)
3GM (Kat + USO) in the vault
RIME antenna
MAG
Boom
3 JMAG
sensors
2 RPWI
sensors
PEP sensors (zenith side)

The payload (1)

JANUS: Visible Camera System

PI: Pasquale Palumbo, Parthenope University, Italy.

Co-PI: Ralf Jaumann, DLR, Germany

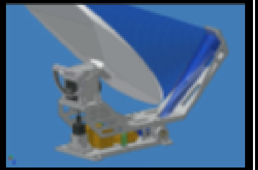


- ≥7.5m/pixel
- Multiband imaging, 380 - 1080 nm
- Icy moon geology
- Io activity monitoring and other moons observations
- Jovian atmosphere dynamics

SWI: Sub-mm Wave Instrument

PI: Paul Hartogh, MPS, Germany

- 600 GHz / 1200 GHz
- Jovian Stratosphere
- Moon atmosphere
- Atmospheric isotopes



MAJIS: Imaging VIS-NIR/IR Spectrograph

PI: Yves Langevin, IAS, France

Co-PI: Guiseppe Piccioni, INAF, Italy

- 0.9-1.9 µm and 1.5-5.7 µm
- ≥62.5 m/pixel
- Surface composition
- Jovian atmosphere

GALA: Laser Altimeter

PI: Hauke Hussmann, DLR, Germany

- ≥40 m spot size
- ≥0.1 m accuracy
- Shape and rotational state
- Tidal deformation
- Slopes, roughness, albedo

UVS: UV Imaging Spectrograph

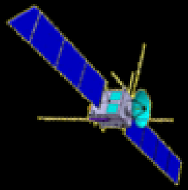
PI: Randy Gladstone, SwRI, USA

- 55-210 nm
- 0.04°-0.16°
- Aurora and Airglow
- Surface albedos
- Stellar and Solar Occultation

RIME: Ice Penetrating Radar

PI: Lorenzo Bruzzone, Trento, Italy

Co-PI: Jeff Plaut, JPL, USA



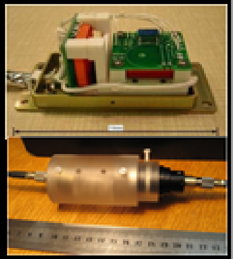
- 9 MHz
- Penetration ~9 km
- Vertical resolution 50 m
- Subsurface investigations

The payload (2)

JMAG: JUICE Magnetometer

PI: Michele Dougherty, Imperial, UK

- Dual Fluxgate and Scalar mag
- ±8000 nT range, 0.2 nT accuracy
- Moon interior through induction
- Dynamical plasma processes



3GM: Gravity, Geophysics, Galilean Moons

PI: Luciano Iess, Rome, Italy
Co-PI: David J. Stevenson, CalTech, USA

- Ranging by radio tracking
- 2 µm/s range rate
- 20 cm range accuracy
- Gravity fields and tidal deformation
- Ephemerides
- Bi-static and radio occultation experiments

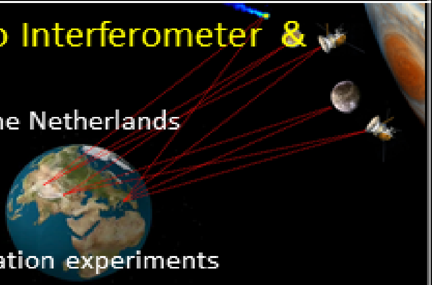
PEP: Particle Environment Package

PI: Stas Barabash, IRF-K, Sweden
Co-PI: Peter Wurz, UBe, Switzerland

- Six sensor suite
- Ions, electrons, neutral gas (in-situ)
- Remote ENA imaging of plasma and torus

PRIDE: Planetary Radio Interferometer & Doppler Experiment

PI: Leonid Gurvits, JIVE, EU/The Netherlands



- S/C state vector
- Ephemerides
- Bi-static and radio occultation experiments

RPWI: Radio and Plasma Wave Investigation

PI: Jan-Erik Wahlund, IRF-U, Sweden

- Langmuir Probes
- Search Coil Magnetometer
- Tri-axial dipole antenna
- E and B-fields
- Ion, electron and charged dust parameters

Broad science and interdisciplinary

SWI, PEP, RPWI, J-MAG, MAJIS, UVS, 3GM, PRIDE

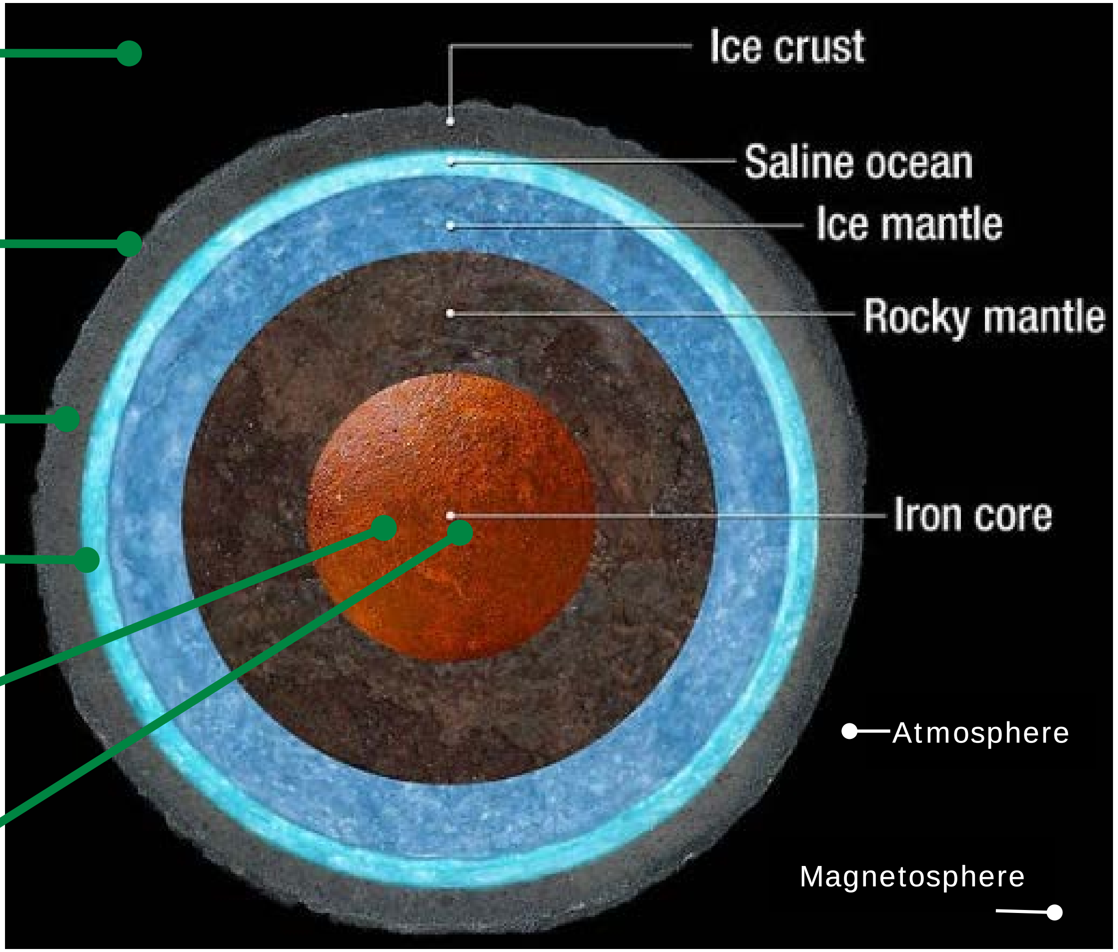
Remote sensing instruments, GALA, RIME

RIME, GALA

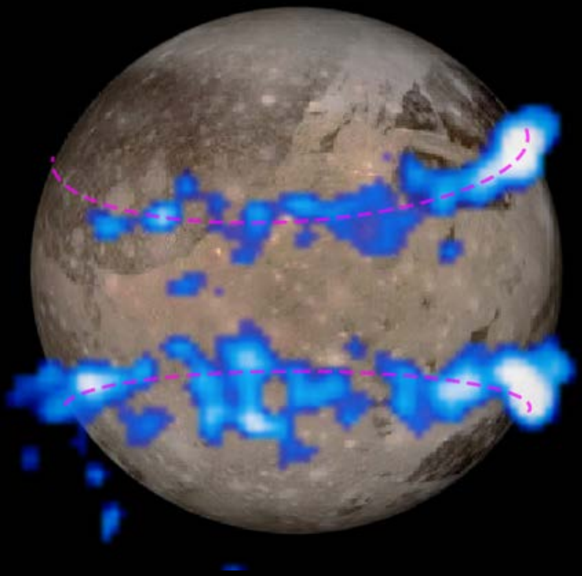
3GM, J-MAG, RPWI, GALA, passive radar?

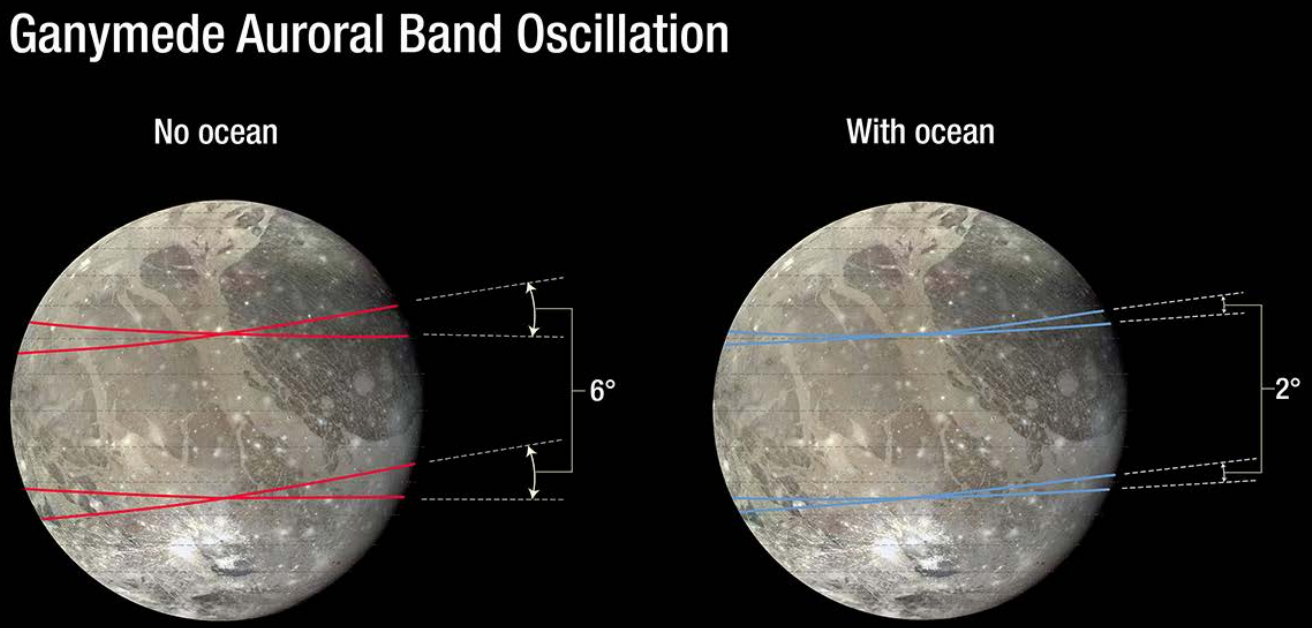
3GM, J-MAG

3GM, PRIDE, JANUS



Plasma physics (auroras) and interior science (magnetic field + ocean)



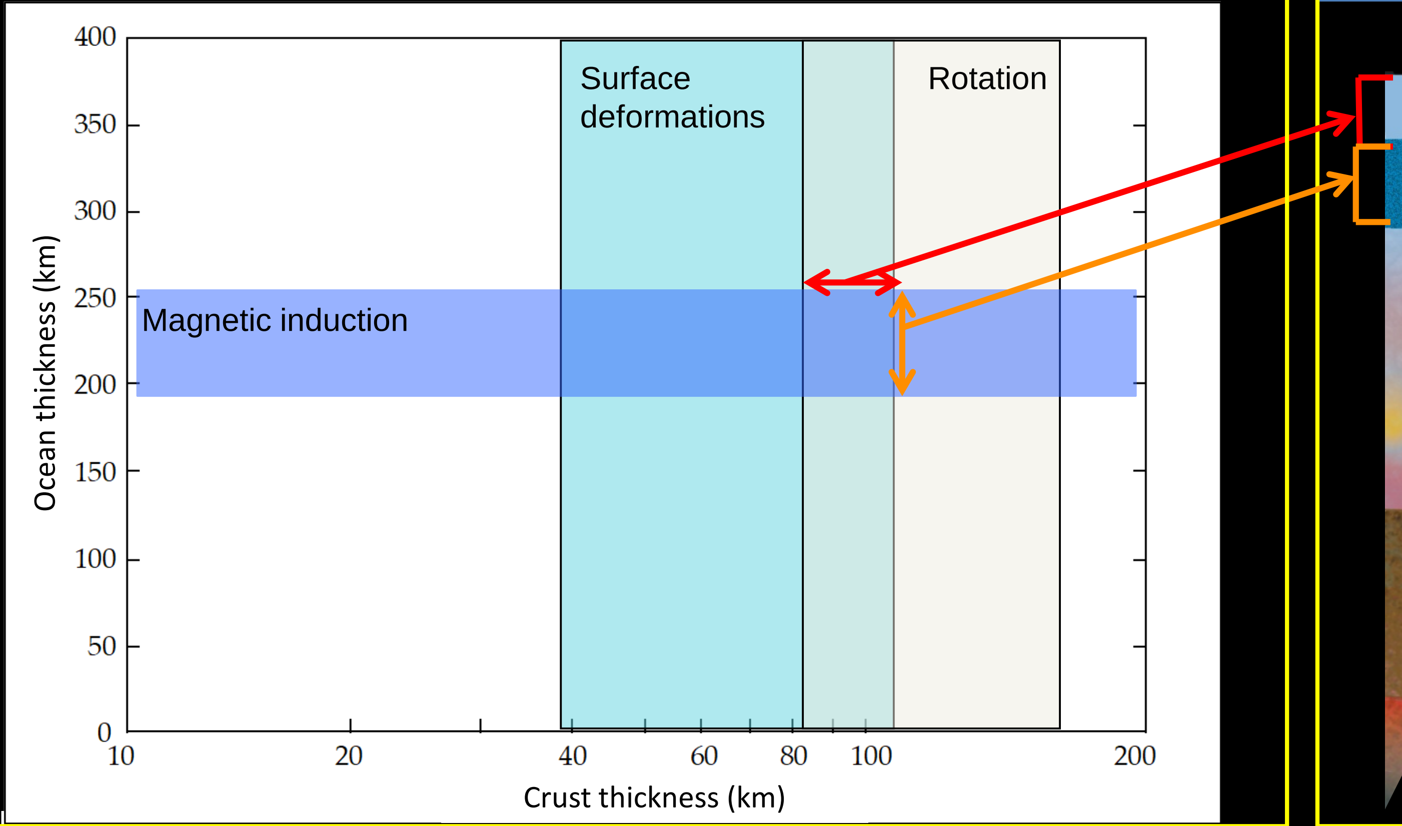


- Auroras and plasma environment observed by remote-sensing and in-situ instruments
- Information on interior from geophysics package and field instruments

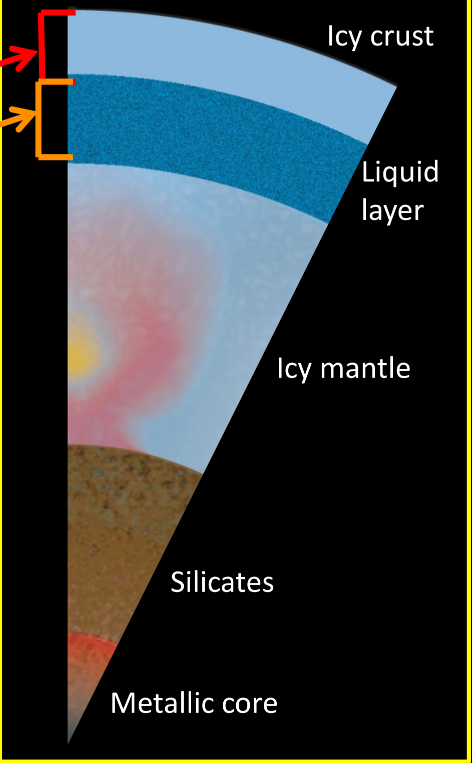
Saur et al. 2015

Characterise Ganymede as a planetary object and possible habitat

1. Extent of the ocean and its relation to the deeper interior



Internal structure



JUICE measurements

- Surface deformations
- Rotation
- Magnetic induction

Instrument Packages

- In situ Fields and Particles
- Imaging
- Sounders and Radio Science

Spacecraft flight model