

Icy moons: Why do we care?

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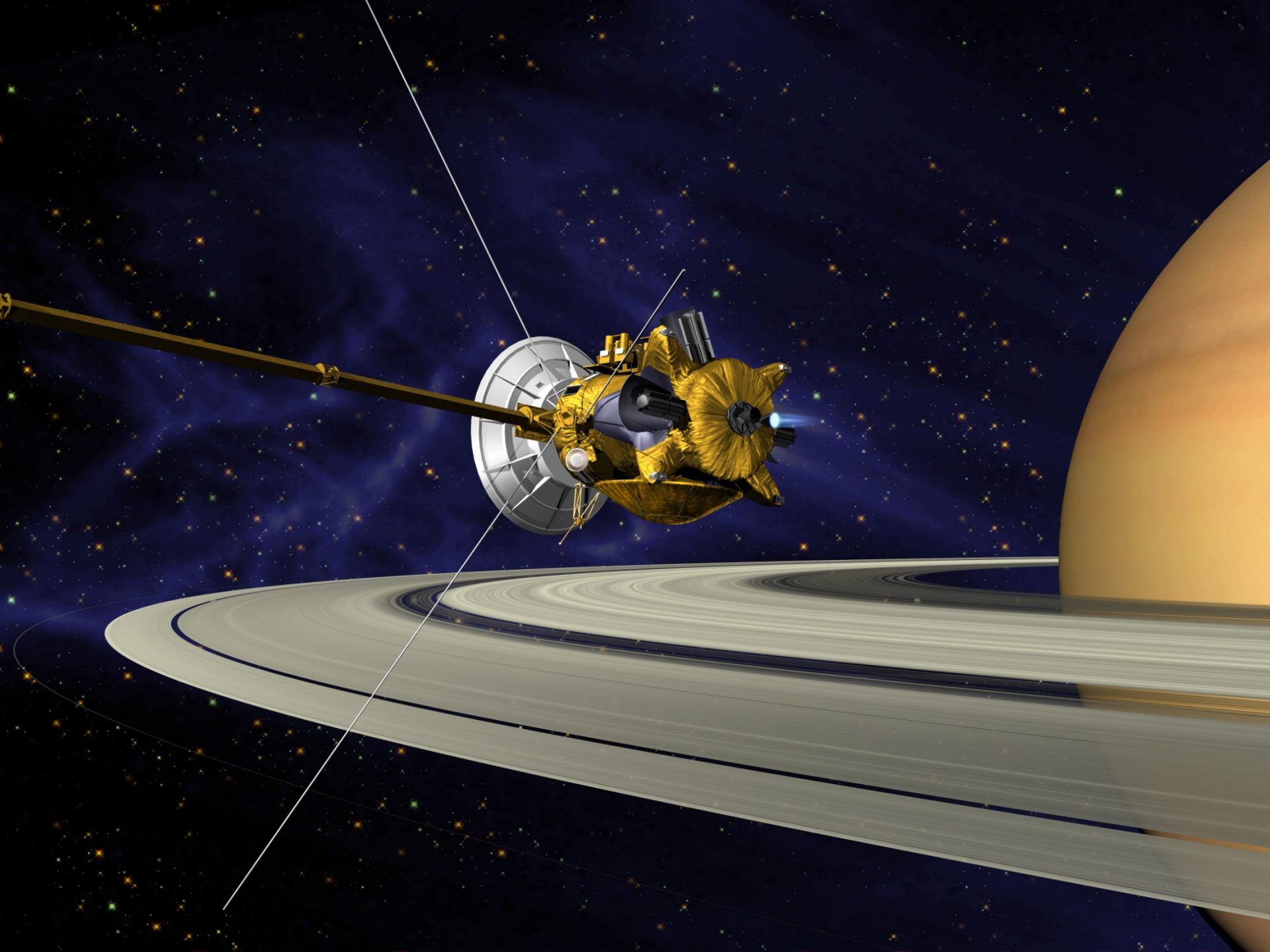
*ISAS, JAXA

Liquid water

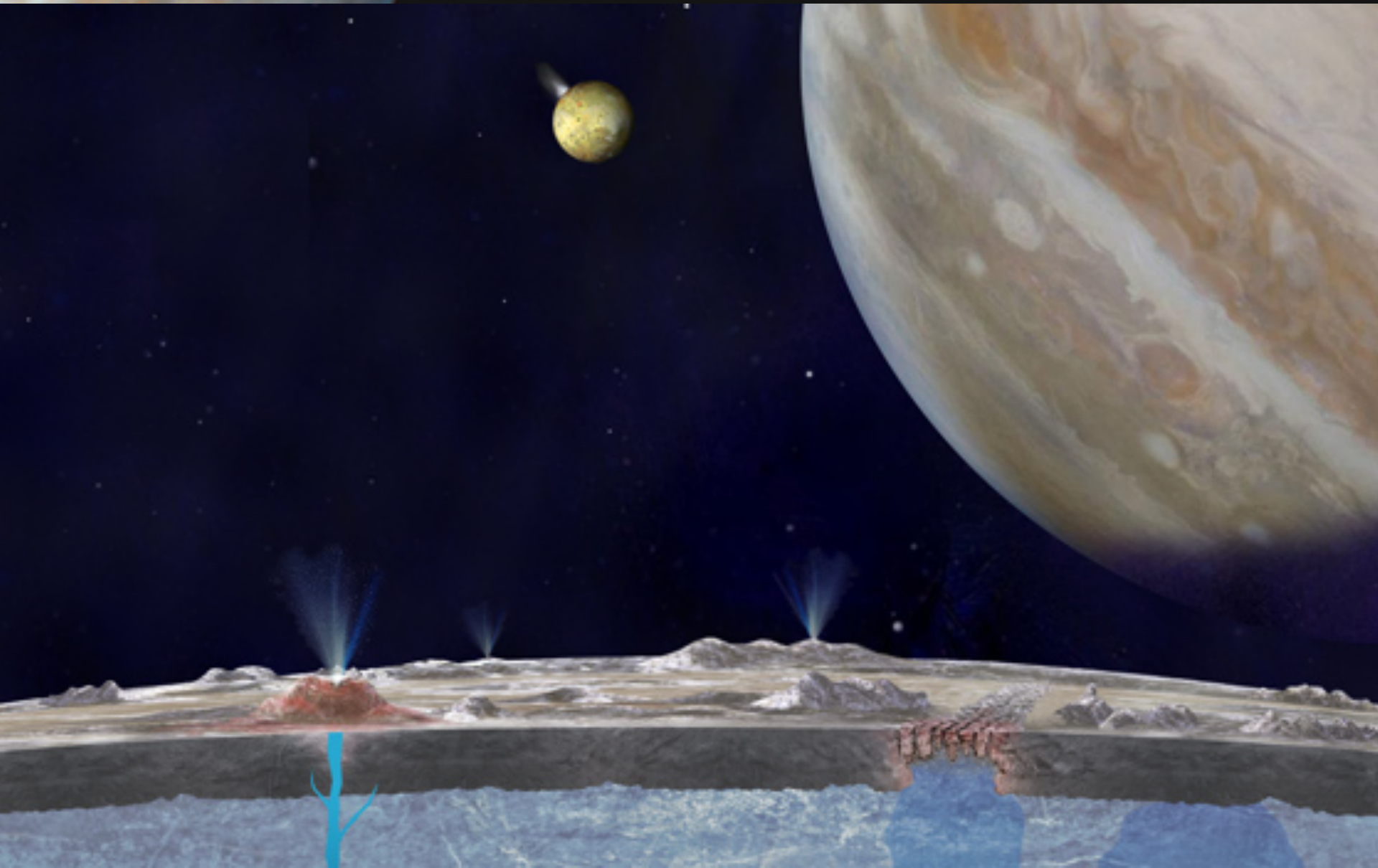
- Enigmatic, yet, we all agree that liquid water is necessary for emergence of life.
- Presence of liquid water is not an easy thing to be achieved.
- Then, every corner in the solar system (a planetary system) where liquid water is present should be studied in detail.

Icy moons

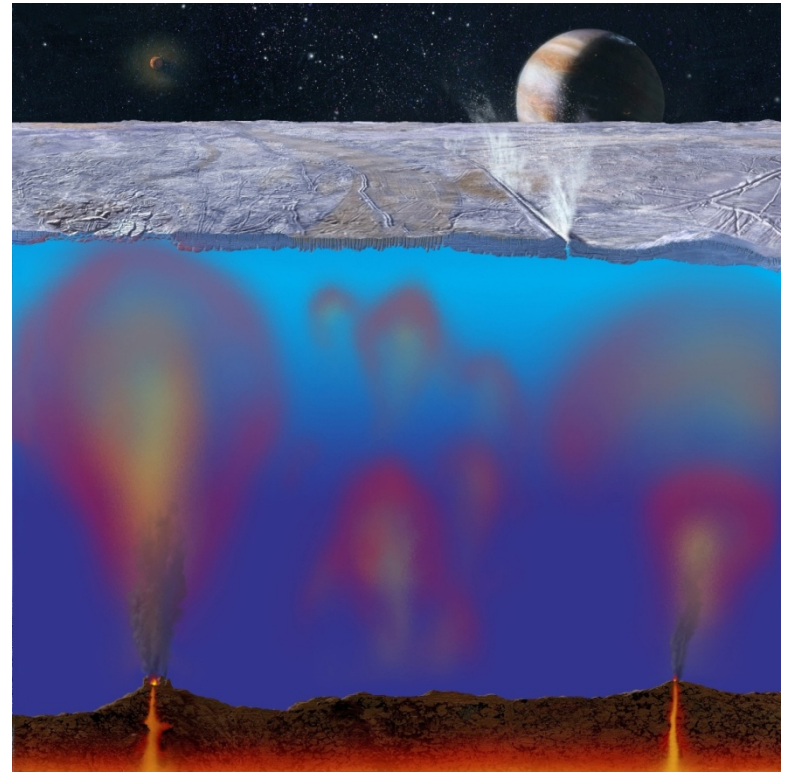
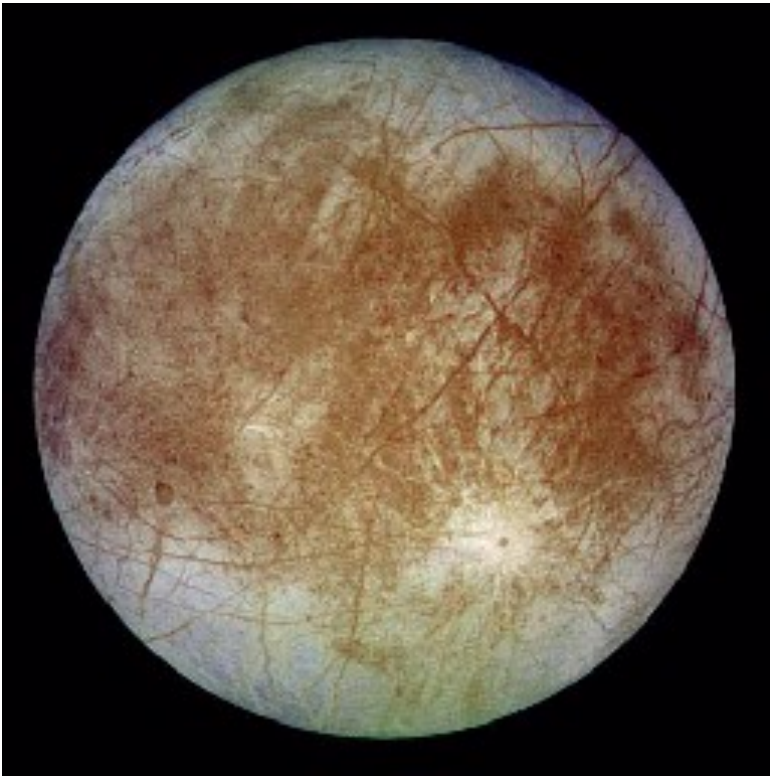
- Satellites of outer planets (Jupiter, Saturn) are covered by ice crust.
- There is diversity in their interior structures.
- Some of them are known/suggested to possess sub-surface ocean/pond (presence of liquid water).



Icy moons of Jupiter



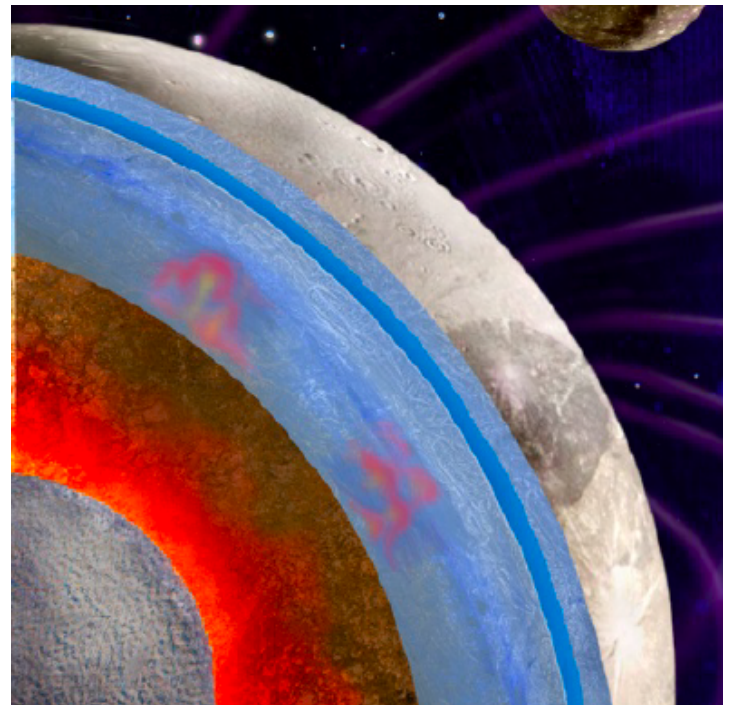
Europa: Sub-surface ocean with a rocky sea-floor



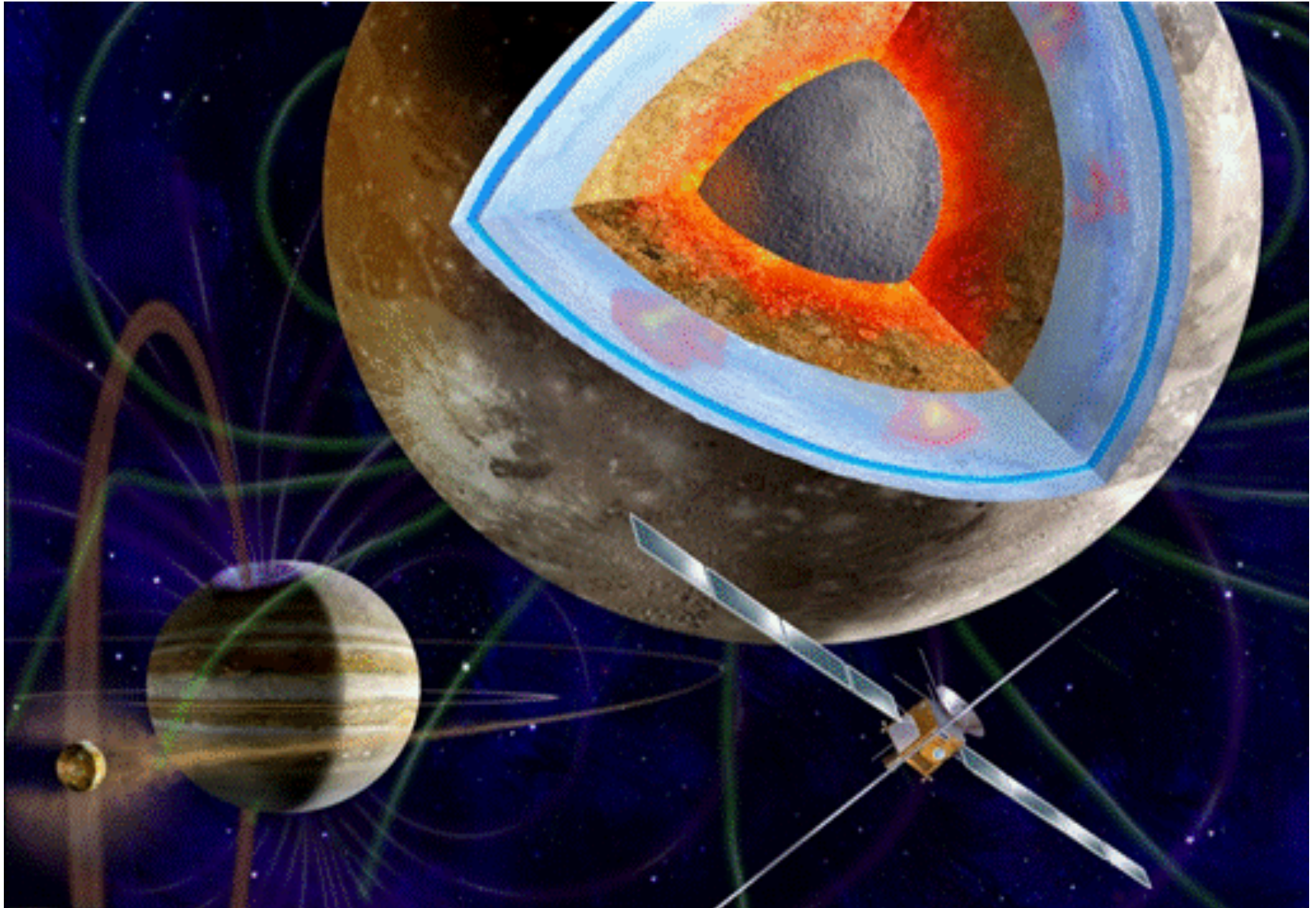
Deep habitat?

Ganymede: The largest moon in the solar system with rich features

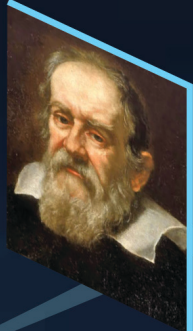
- Potential sub-surface ocean (with an ice-floor?), variety of tectonic features recored on the surface, dynamo in action to maintain intrinsic magnetic field



We care so much as to send a mission to these icy moons: ESA JUICE



JUICE is a mission built upon past assets



1610

Discovery



1974

Insight



1985

Deep habitats on Earth



1995

Exploration



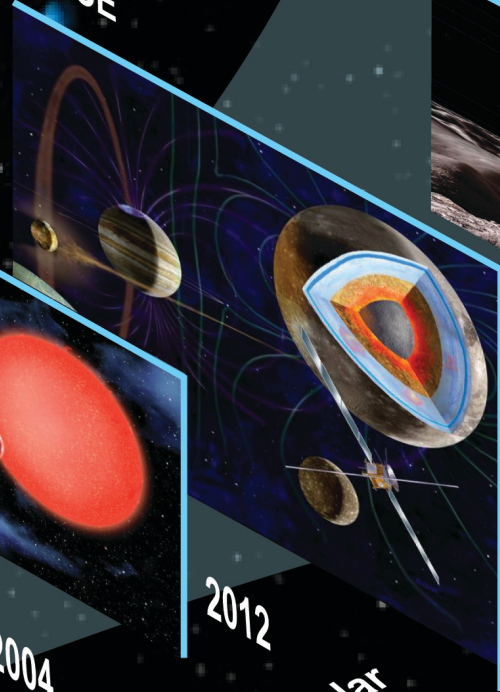
2004

JUICE



2012

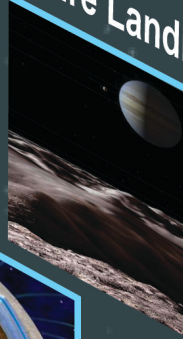
First extra-solar waterworld



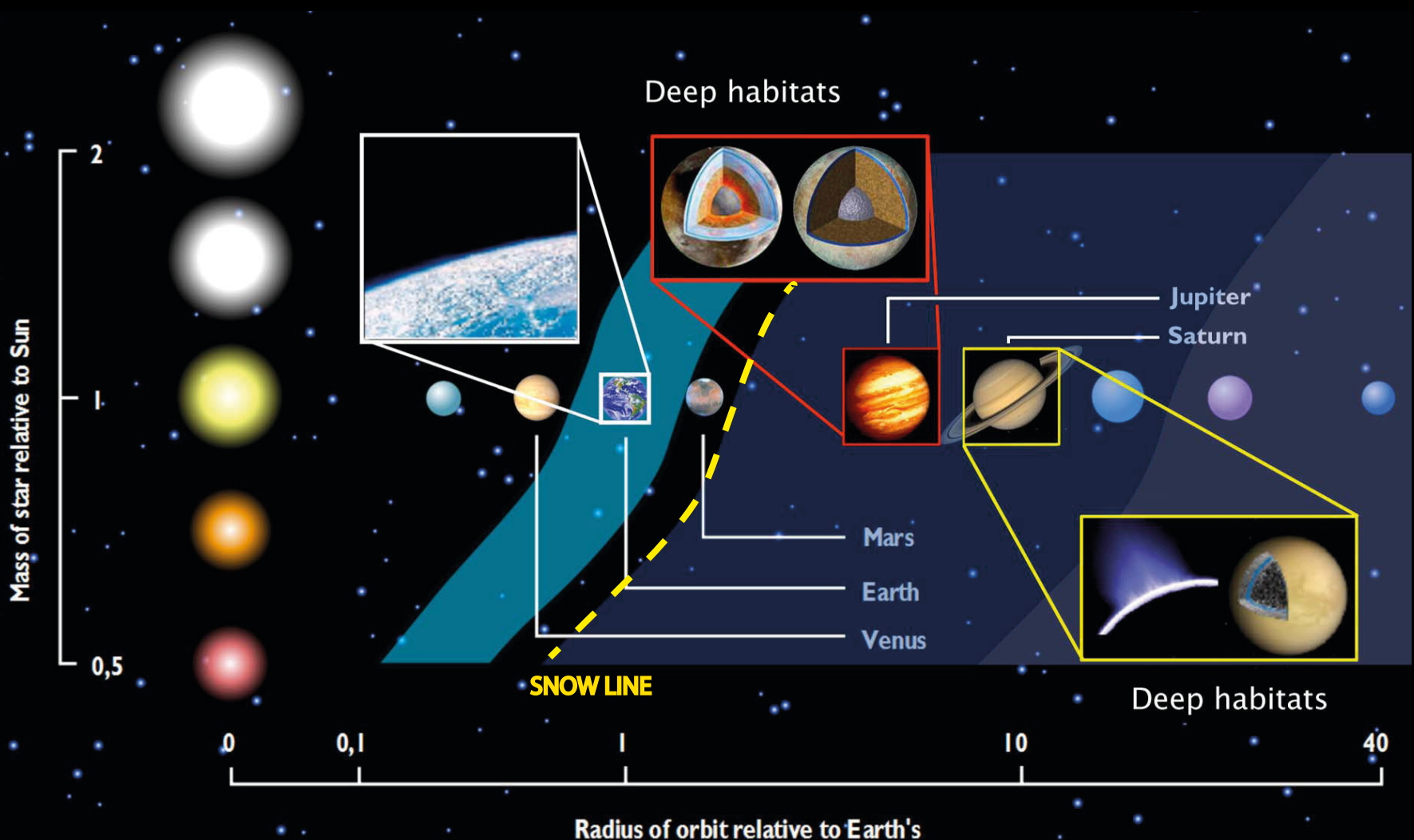
2030

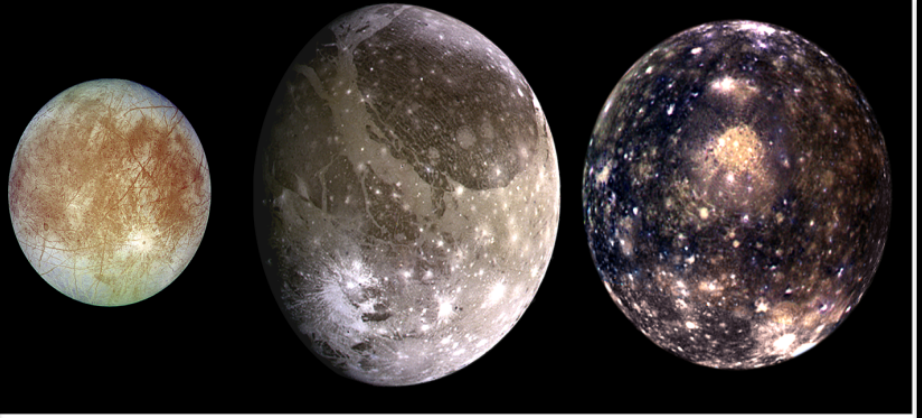
Characterisation

Future Land



With a future perspective on astrobiology





JUICE mission profile

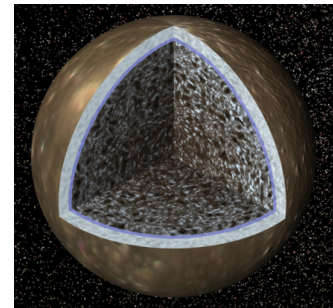
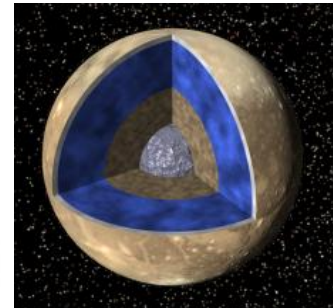
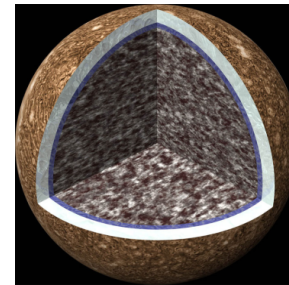
- Launch in 2022 by Ariane 5
- Arrival to Jupiter in 2030
- Cruise in the Jovian system to study Jupiter itself and its space environment
- Multiple flybys of Europa and Callisto (another icy moon)
- In 2032, start orbiting around Ganymede

Contribution from Japanese community

- Teaming-up with the European proposer team since 2006
- Hardware contribution to four instruments onboard
- One of them is GALA (Ganymede Laser Altimeter), which is the key instrument to look into the interior of Ganymede.
- ELSI will promote the science of icy moons among Japanese community members, with the deep habitat concept somewhere in mind all the time.

Research plan of the team at ELSI

- A new model for origin and evolution of icy moons: What makes Ganymede to have an intrinsic magnetic field? What makes Ganymede and Callisto so different while their settings are not so different?



- The key issue: Accretional energy during formation of icy moons is not large enough to drive differentiation of an interior.
- The decay heating of long-lived radioactive elements and dehydration of the rocky component should be taken into account.

The right question

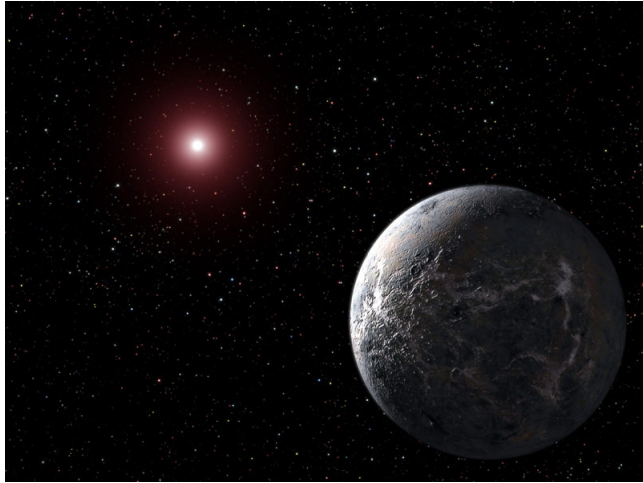
- Is the deep habitat inhabitable?

The right question

- Is the deep habitat inhabitable?
- Is the habitability of icy moons sustained for a long enough time?

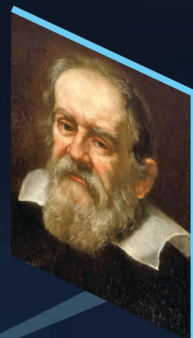
Is the energy supply and the material circulation sustained long enough for life to emerge?

Research plan of the team at ELSI



- In exo-solar systems, larger icy bodies (super-Ganymede) would be discovered in a near future. This expectation drives us to extend the above model to exo-"icy" bodies and make it as a guideline in investigating its interior structure:
We care about every corner in a planetary system where liquid water is present.

JUICE



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Deep habitats on Earth



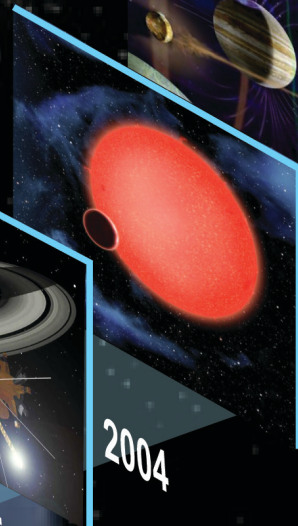
1995

Exploration



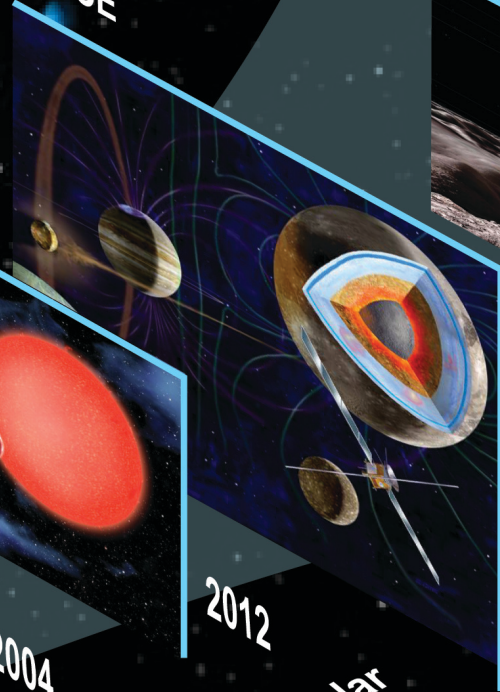
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JUICE



2012

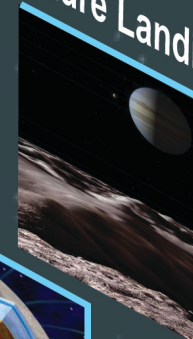
First extra-solar waterworld



2030

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JAXA's space missions from ELSI's perspective

- JUICE: Icy moons
- HAYABUSA-2: Sample from a primordial body
- *Kaguya: JAXA's lunar mission*

