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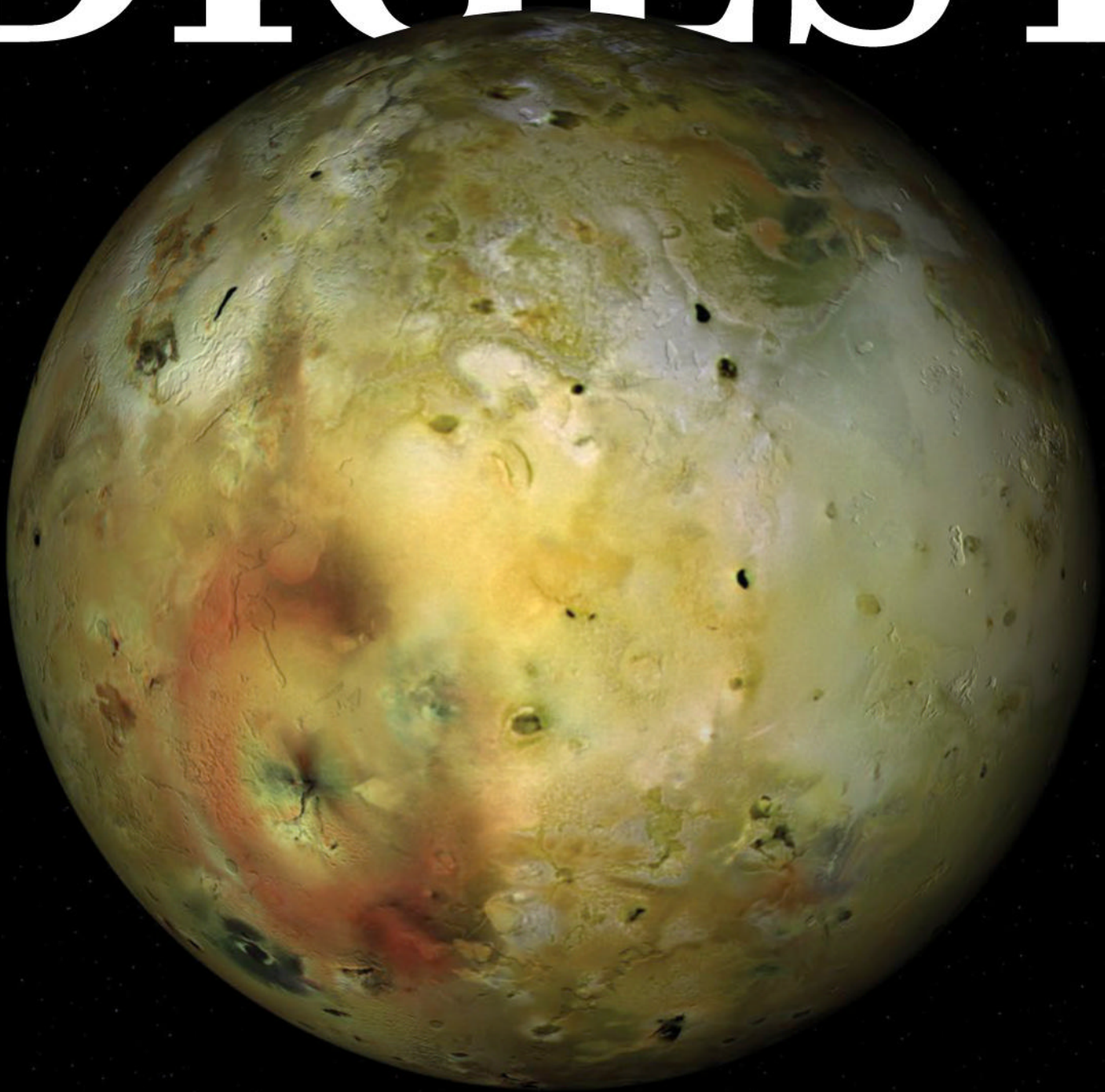

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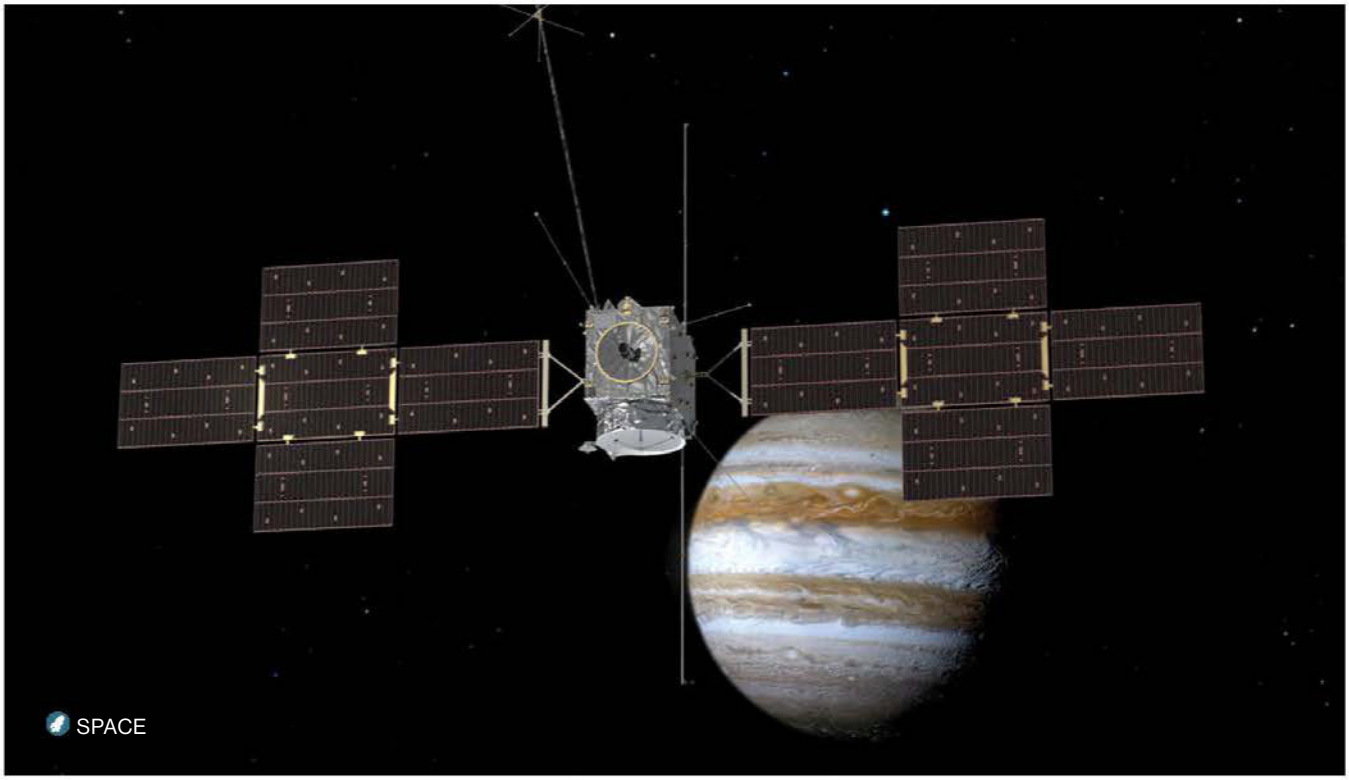
Io, as seen from Voyager.



Europe's JUICE mission is off to Jupiter – here's what you need to know

Eight-year journey to the solar system's biggest planet.

EUROPE'S JUPITER Icy Moons Explorer (JUICE) mission successfully launched on 14 April 2023, headed off to explore some of the Solar System's most mysterious ice worlds.

Over the next decade, JUICE will chart the gas giant and its interactions with three of its four largest moons, which are covered in thick ice sheets. Below these frigid surfaces, scientists expect to find potentially world-covering oceans.

The European Space Agency's mission also hopes to extend our knowledge of planet formation and how it may support the emergence of life.

It's unlikely that JUICE will find even simple lifeforms beneath the ice, but it will investigate the habitability of the moons.

"JUICE…has taken the better part of the past decade to be designed and developed and is now ready," says Alessandro Atzei, JUICE's payload system engineer.

Over 17 days after launch, the spacecraft's solar arrays, probes, antennas and booms were deployed. In total, JUICE is the size of two tennis courts and weighs about as much as an adult elephant.

"It will take quite some time to arrive at Jupiter…in the distant July of '31 and then the real mission will start," Atzei says. "We'll [first] focus on Europa, then we'll go to a high latitude phase which is basically focusing on the polar areas of Jupiter itself."

WHAT'S JUICE GOING TO DO?

Jupiter is the biggest planet in the Solar System – a 142,000-kilometre-wide gaseous world that could fit more than 1,300 Earths inside it. It pulls 92 moons into its orbit, and has a magnetic field 20 times more powerful than our planet's.

JUICE will try to understand how the gas giant's unique properties have influenced the formation of its largest moons as well as the wider planetary system.

The mission will also look at the characteristics of Ganymede, Callisto and Europa, including studying their oceans; mapping the topography, geology and composition of their surfaces; studying the properties of their icy crusts; and looking deep into the moons' interiors.

GANYMEDE

The largest moon in our Solar System, (and around half the size of Earth), Ganymede is believed to possess a saline ocean under the ice, which may cover the entire celestial body. The moon is one of the oldest space bodies in the Solar

CREDIT: ESA/ MEDIALAB.

System, with a geological history stretching back billions of years.

Ganymede also generates its own magnetic field and has a tenuous atmosphere, which are of particular interest to the JUICE mission.

CALLISTO

The second-largest moon orbiting Jupiter, Callisto is a fraction smaller than Mercury and bigger than the dwarf planet Pluto. Callisto is another ancient world that appears to have ceased geological activity at least a billion years ago. Studying it will give scientists an idea of what the space environment around Jupiter might have been like during the early formation of the planet.

EUROPA

Europa's veiny surface is mainly ice, and likely also conceals an underlying liquid ocean. For this reason it has been suggested as a possible home for simple life (and was featured in classic science fiction works like Arthur C. Clarke's *Space Odyssey* series). Scientists also hypothesise that plumes of ocean and ice may erupt from the surface into space.

WHAT ABOUT IO?

Io is the most volcanically active place in the Solar System, with kilometre-high lava plumes driven by gravitational interactions with Jupiter and its neighbouring moons Europa and Ganymede.

Unsurprisingly, Io's volcanic nature keeps it ice-free and for this reason is unlikely to host life; it won't be explored in detail as part of the JUICE mission.

HOW IS JUICE GETTING TO JUPITER?

On 14 April (local time), the JUICE spacecraft blasted into space on board an Ariane 5 rocket from the European Space Agency's spaceport in Kourou, French Guiana. After launch, it will perform a series of flybys of Earth, the Moon and Venus to calibrate its course towards Jupiter. These flybys are imperative to the mission, effectively juicing (pardon the pun) the spacecraft with gravity assistance to slingshot it towards its target planet. These flybys will take place in August 2024 (Earth and Moon), August 2025 (Venus), September 2026 (Earth) and January 2029 (Earth), so JUICE will spend six years simply building up its speed to jet off to its destination.

In July 2031, it will start a three-and-a-half-year tour of Jupiter and its icy moons, before a final tour of Ganymede in December 2034; the mission will end when JUICE smashes into Ganymede's surface in September 2035.

JUICE (above, being prepared for loading onto the Ariane 5 spacecraft) will arrive at Jupiter in 2031 (opposite, artist's impression).

ESA-CNES-ARIANESPACE/ OPTIQUE VIDÉO DU CSG, S MARTIN

CLIMATE

World's ice melting five times faster than in the '90s

Polar ice is melting at an unprecedented rate and accounts for a quarter of all sea level rise.

Figures published in *Earth System Science Data* show there has been a five-fold increase in ice melt since the 1990s; seven of the worst years have occurred in the past decade.

The research – by a decade-long international collaboration between dozens of institutions called IMBIE (Ice sheet Mass Balance Intercomparison Exercise) – compiled 50 satellite surveys of Antarctic and Greenland ice sheets between 1992 and 2020.

During that time, more than 7,500 billion tonnes of ice disappeared across both locations, or about 40 Sydney Harbours.

Continuous monitoring of the ice sheets is now required to forecast their behaviour and help plan human adaptation.

Dr Diego Fernandez, head of research and development at the European Space Agency, which co-funds IMBIE, made the grim assessment that polar ice variations "have reached a scale where abrupt changes can no longer be excluded".