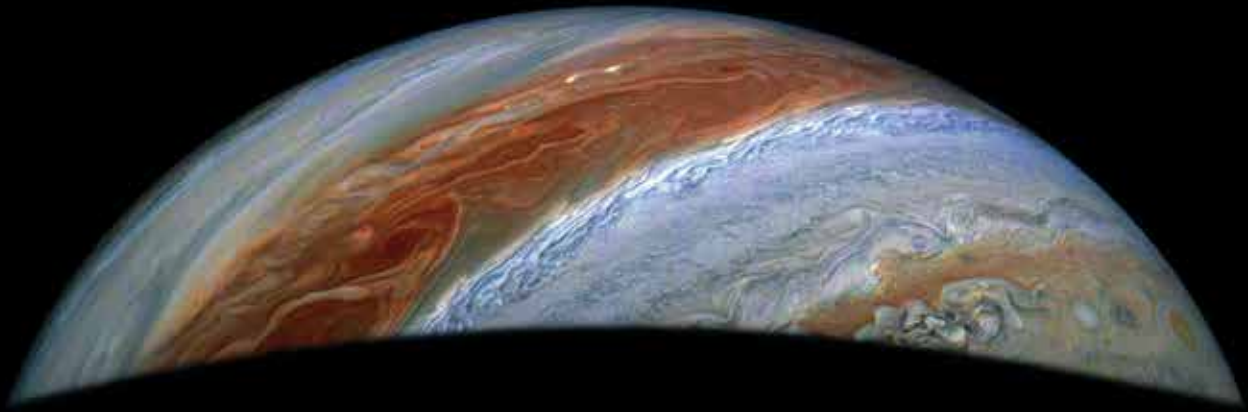




JUPITER'S GALILEAN MOON HYDRATION SET AT BIRTH

Io, the most volcanically active moon in the solar system, appears completely dry and devoid of water ice, while its neighbor Europa is thought to harbor a vast global ocean of liquid water beneath its icy crust. A new international study co-led by SwRI and Aix-Marseille University reveals that this striking contrast was established at birth, as they formed around Jupiter, not from later evolutionary processes.

Since the first missions exploring the Jovian system in the late 1970s, scientists have known that Jupiter's moons exhibit markedly different characteristics. Io and Europa provide the most striking example. While Io is a dry and intensely volcanic world devoid of water, Europa is icy and thought to conceal a vast subsurface ocean of liquid water.

"Io and Europa are next-door neighbors orbiting Jupiter, yet they look like they come from completely different families," said SwRI's Dr. Olivier Mousis, second author of an *Astrophysical Journal* paper detailing these findings. "Our study shows that this contrast wasn't written over time — it was already there at birth."

The team tested two main hypotheses to explain the differences. The first suggests that the extreme conditions prevailing close to Jupiter during satellite formation prevented water ice from being preserved, depriving Io of this component from the outset. The second hypothesis proposes that Io and Europa initially formed with similar amounts of

water, but Io subsequently lost most of its volatiles over time through atmospheric escape and erosion processes.

The international team reconstructed the earliest evolutionary stages of Io and Europa, assuming that the moons' water originated from hydrated minerals incorporated during formation. Using an advanced numerical modeling framework, the study coupled the internal thermal evolution of the moons with volatile escape processes, accounting for all major heat sources active in the young Jovian system, including accretional heating, radioactive decay, tidal dissipation and Jupiter's intense radiation.

"Io has long been seen as a moon that lost its water later in life," Mousis explained. "But when we put that idea to the test, the physics just refuses to cooperate: Io simply can't get rid of its water that efficiently."

For that matter, Europa would not lose its water either, even under extreme conditions. The findings indicate that Io and Europa were already fundamentally different at birth — Io forming from dry materials and Europa accreting from ice-rich building blocks.

"The simplest explanation turns out to be the right one," Mousis said. "Io was born dry, Europa was born wet — and no amount of late-stage evolution can change that."

