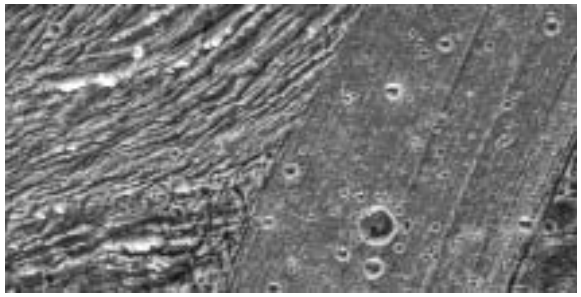
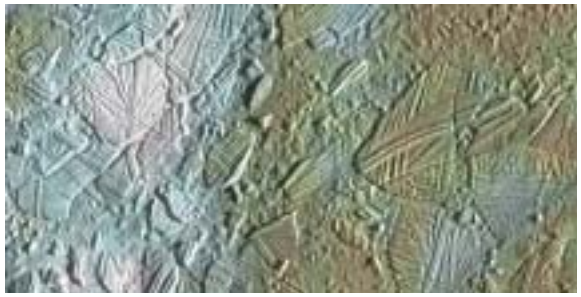
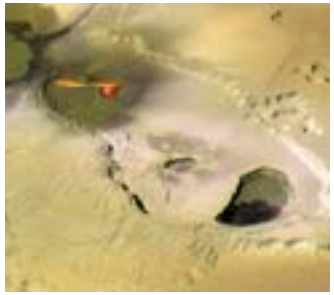
National Aeronautics and
Space Administration

Moons of Jupiter







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Moons of Jupiter

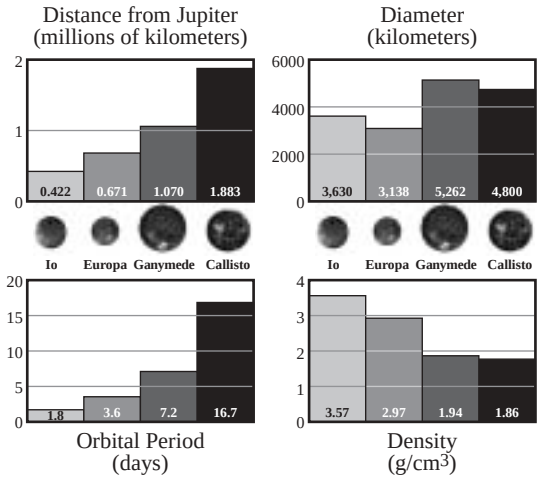
The planet Jupiter's four largest moons are called the Galilean satellites, after Italian astronomer Galileo Galilei who observed them in 1610. The moons were also observed then by German astronomer Simon Marius. These moons, named **IO**, **EUROPA**, **GANYMEDE**, and **CALLISTO**, are particularly intriguing since each has its own amazing distinction in our solar system. Io is the most volcanically active body in the solar system, and parts of its surface change within weeks. Europa's cracked surface is mostly water ice, and there is strong evidence that it may be covering an ocean of water or slushy ice. Ganymede is the largest moon in the solar system (larger than even the planet Mercury), and it is the first moon known to have its own magnetic field. Callisto is extremely heavily cratered but has surprised scientists with its lack of very small craters that should be visible in *Galileo*'s closeup images—they appear to be covered with fine dust.

Though distinctive, the Galilean moons also have much in common. The surfaces of the outermost three moons are mostly water ice, mixed with rocky, probably carbon-rich, material. Io's surface is mainly sulfur in different colorful forms including sulfur dioxide. As Io travels in its slightly elliptical orbit, Jupiter's immense gravity causes tides in the solid surface 100 meters high on Io, generating enough heat to drive the volcanic activity and drive off any water. Io's volcanoes are driven by hot silica, not water. Io, Europa, and Ganymede all have a layered interior structure (as does Earth). Europa and Ganymede both have a core; a rock envelope around the core; a thick, soft ice layer; and a thin crust of impure water ice. Io has a core, and a mantle of at least partially molten rock, topped by a crust of solid rock coated with sulfur compounds. On the other hand, Callisto appears to be an ice-rock mix both inside and out. Under the influence of Jupiter's and each other's gravity, the Galilean moons all keep the same face towards Jupiter as they orbit (as does our moon towards Earth). This means that each of the moons turns only once on its axis for every orbit about Jupiter.

Galileo proposed that these moons be called the "Medicean stars" in honor of his patron, Cosimo II de Medici; Marius named the moons Io, Europa, Ganymede, and Callisto after the lovers of the Roman god Jupiter (who was known to the Greeks as Zeus). They continued to be studied from Earth through telescopes until the two *Pioneer* (in 1973–74) and two *Voyager* (in 1979) spacecraft offered striking color views and a global perspective from their midrange flybys while surveying parts of the outer solar system. At present, the *Galileo* spacecraft flies in repeated elliptical orbits around Jupiter, flying as low as 261 kilometers over the surface of the Galilean moons. That's lower than the average Space Shuttle orbit over Earth, and much lower than most communications satellites. These close approaches result in images with unprecedented detail of selected portions of the moons' surfaces.

Close-up images taken by the *Galileo* spacecraft of portions of Europa's surface show places where ice has broken up and appeared to float apart, and where liquid seems to have come from below and frozen smoothly on the surface. The low number of craters on Europa leads scientists to believe that the ocean existed in recent geologic history and may still exist today. The heat needed to melt the ice in a place so far from the Sun is thought to come from inside of Europa, from a milder form of the tidal forces that drive Io's volcanoes.

Fast Facts



Significant Dates

1610 Italian astronomer Galileo Galilei and German astronomer Simon Marius independently discover four moons orbiting Jupiter.
1973 *Pioneer 10* is the first spacecraft to cross the asteroid belt and fly by Jupiter.
1974 *Pioneer 11* flies by Jupiter.
1979 *Voyagers 1* and *2* discover Io's volcanoes and Jupiter's ring.
1995 *Galileo* spacecraft drops probe into Jupiter's atmosphere and begins orbiting Jupiter.
2000–01 *Cassini* and *Galileo* spacecraft jointly observe Jupiter.

About the Images

(Left) In this composite of images, Jupiter's four largest moons are shown to scale, in order of increasing distance away from Jupiter (from bottom, Io, Europa, Ganymede, and Callisto). The limb (edge) of the gaseous giant planet in the region of the Great Red Spot is shown for comparison.

(Right) The insets of the surfaces of the moons show that each is unique.
(Bottom) On **Io**, a volcanic plume of cold sulfur dioxide gas and "snow" rises 140 km above the moon's surface. The closeup shows Tvashtar Catena, a chain of volcanic calderas, in enhanced color with the bright lava curtain (a chain of lava fountains) and surface flows added by the *Galileo* scientists, based on their knowledge of the area. Fountains of lava rise to heights of up to 1.5 km above the surface. The elongated caldera in the center of the image is almost surrounded by a mesa that is about 1 km high.
(Bottom, middle) On **Europa**, ice rafts the size of small towns (up to 13 km long) appear to have broken apart and "rafted" on soft ice or ice-crusted water. This suggests the presence of an ocean underneath Europa's icy surface.
(Top, middle) Ganymede has many diverse types of terrain, including this area of Nicholson Regio and Arbela Sulcus. The bright terrain of Arbela Sulcus is the youngest terrain here, slicing through the center of the image. It is finely striated and relatively lightly cratered. To the east (right) is the oldest terrain in this area, rolling and relatively densely cratered Nicholson Regio. To the west (left) is a region of highly deformed grooved terrain, intermediate in relative age. In this area of grooved terrain, stretching and normal faulting of Nicholson Regio has deformed it beyond recognition.
(Top) Callisto is famous for its numerous and varied craters. This multi-ringed impact crater named Asgard is surrounded by concentric rings up to 1,700 km in diameter. Newer craters, such as Burr in the upper right, are brighter because they expose fresh ice.
(All images by NASA/JPL/*Galileo*.)

References

1) *Galileo* Journey to Jupiter *http://galileo.jpl.nasa.gov*
2) NASA Planetary Photojournal *http://photojournal.jpl.nasa.gov*
3) Stardate: *http://stardate.org*

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