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Many Miles, Many Moons: A Galileo Album

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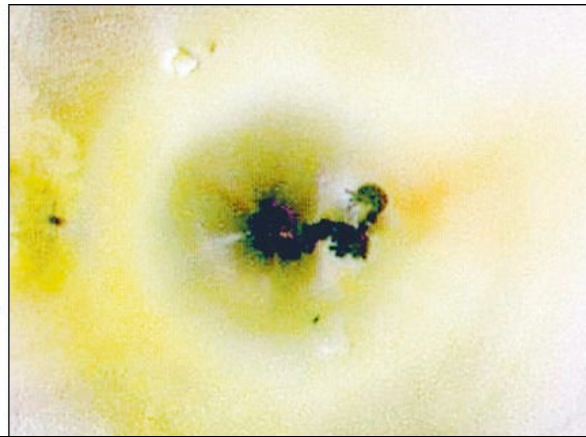
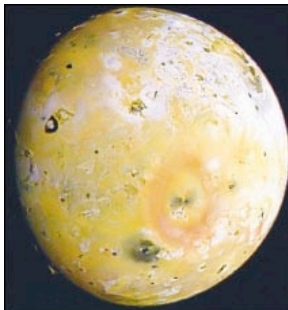
On Sunday, several hundred engineers and scientists will gather at the Jet Propulsion Laboratory in Pasadena, Calif., and await the end of the Galileo spacecraft in a suicide plunge into Jupiter's dense atmosphere.

They are the kind of professionals who try to resist anthropomorphizing their machines, even one like Galileo, which has been a longtime companion in their lives and careers. But they freely concede that they will be there at the end as an act of homage.

"It will be the equivalent of a wake," said Dr. Claudia Alexander, manager of the project.

Few flight teams have had to contend with a spacecraft more demanding of their attention and ingenuity.

Launched in 1989 after a long delay caused by the loss of the space shuttle Challenger in 1986, Galileo took six years going to Jupiter, almost half a billion miles away, by a circuitous route dictated by the limited power of its initial rocket boost.



NASA
IO At left, a composite image of the moon, photographed by Galileo in April 1997. The surface. right. bubbles with erupting volcanoes.



NASA
GANYMEDE Jupiter's largest moon; right, a close-up of its surface, with craters probably formed by a comet.

From then on, the three-ton spacecraft was tormented by as many afflictions as poor Job.

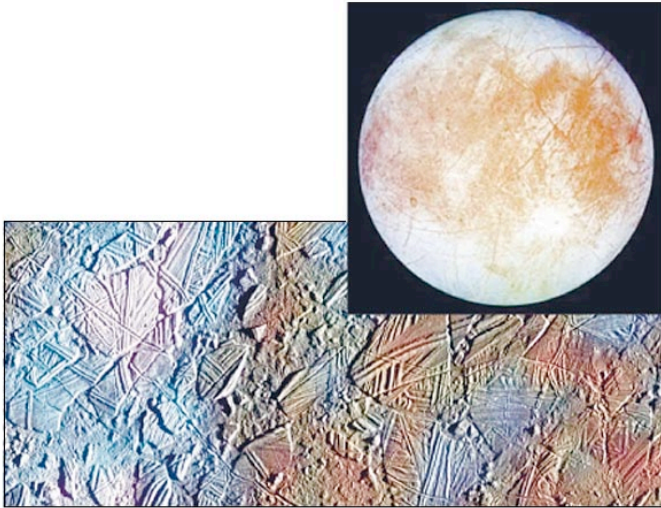
The main antenna, the one that scientists counted on for the return of pictures and data of Jupiter and its four largest moons, failed to unfurl. Engineers had to rely on a smaller antenna and an improvised system of data shorthand.

Galileo was further hobbled by an erratic tape recorder. After the craft began orbiting Jupiter in 1995, repeated zappings from the planet's intense radiation belts damaged other instruments.

In nearly all cases, engineers managed to reprogram software to overcome or work around the setbacks. As recently as last November, in its last encounter with a Jovian moon, tiny Amalthea, the spacecraft "got hammered again by radiation," Dr. Alexander said.

The spacecraft's fault-detection system came to the rescue once again, turning off nearly all operations and saving the science data from the encounter.

But the tape recorder was left stuck. Flight controllers applied electrical current to the recorder, on and off and on again, repeatedly, until the molecular structure was altered enough to unstick the recorder for transmitting



NASA
EUROPA The ice crust of this brightest moon could hide a briny ocean that harbors life.

data.

"Miracles continued to happen on this mission," Dr. Alexander said.

Indeed, in spite of everything, scientists rate Galileo as one of the most successful missions of planetary exploration. Galileo's eight-year orbit of Jupiter included several close encounters of each of Jupiter's major satellites, Ganymede, Callisto, Io and Europa. No two were found to be anything alike.

Ganymede is not only the largest moon in the solar system, but it is also larger than Mercury and Pluto. Galileo discovered that Ganymede had a strong magnetic field, "something no one thought a moon would have," said Dr. Rosaly Lopes-Gautier, a member of the project's science team.

Icy Callisto appears to be the most heavily cratered object in the solar system. Io is bubbling with erupting volcanoes, 152 by Dr. Lopes-Gautier's latest count. The phenomenon was discovered on previous flybys by Voyager spacecraft, but Galileo determined how plentiful and persistent the eruptions are. The lava flows are hotter than anything seen on Earth in two billion years.

Europa has given scientists the most reason to celebrate and speculate. In Galileo's eight flybys, the appearance of Europa's frozen crust suggested that it covered an immense ocean. And where there is so much liquid water, could there also be some forms of life?

That discovery sealed Galileo's ultimate fate. If the spacecraft, after running out of maneuvering fuel, should crash into Europa, it might contaminate that moon with stowaway microbes from Earth and confound future searchers for indigenous life. So the decision was made to vaporize the spacecraft by putting it on a collision course with Jupiter.

"The course is unalterable," Dr. Alexander said. "The last fuel was expended several months ago, to make sure we hit the planet."

Tracking data show that the craft, traveling 30 miles a second toward the end, will crash into Jupiter on its night side. At 12:50 p.m., Pacific time, the old Galileo hands in Pasadena, hearing no radio signal, will know that their spacecraft is no more.



NASA
CALLISTO This moon appears to be the most heavily cratered object in the solar system.