underlie an authentication protocol for computer communications, in which each machine would show that it is "known" to the other by submitting the answer to an instance of a problem it had transmitted during an earlier session. But so far there is no obvious way to embed secret information in randomly generated lattices.

That's not to say it can't be done at all. Inspired by Ajtai's breakthrough, Goldwasser and her colleagues at MIT have a scheme for creating a code based on lattice problems. However, she points out that the extra structure required to incorporate useful code into the lattice problem alters the problem itself, so that Ajtai's theorem may not automatically carry over. "We have a lot of experimental results that seem encouraging," she says, but not the kind of confidence that comes from theory.

IBM researchers are also looking for ways to put Ajtai's discovery to work, but they see it mainly as a fundamental advance in the theory of hard problems. "It's been sort of a Holy Grail of cryptography, to do what [Ajtai] has done, for any sort of problem whatsoever," says IBM's Ron Fagin. An eventual payoff is both certain and unpredictable, adds IBM's Ashok Chandra: "As with all foundational discoveries, it can go in unexpected ways." Guessing the future of computational codes may be no easier than cracking them.

–Barry Cipra

PLANETARY SCIENCE

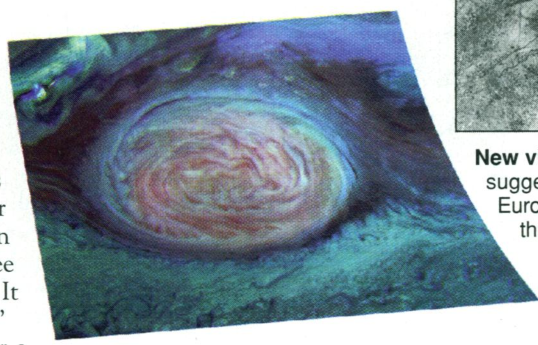
Galileo Gazes at Jupiter and Its Moons

With the public still dazzled by the possibility of life on Mars, NASA last week unveiled images that point to surprisingly Earth-like processes on other heavenly bodies. The new data come from the Galileo spacecraft, which is now touring Jupiter's vast system of moons and catching much-improved views of features that planetary scientists had only glimpsed in the 1979 flybys by the Voyager spacecraft. Among other things, it has revealed thunderstorms on the giant planet itself and suggestive evidence of a water ocean—the first on any planetary body outside Earth—on another moon, Europa.

These results not only offer new insights into the workings of alien worlds; they may even enhance scientists' understanding of weather systems on Earth, researchers say. "That's one of the reasons we do comparative planetology," says James Head of Brown University, a member of the Galileo imaging team. "When you leave the neighborhood, you see things back home in a different way. It never fails to give a new perspective."

Galileo gathered these images after a close encounter in late June with another of Jupiter's moons, Ganymede, which revealed hints of a magnetic field (*Science*, 19 July, p. 311). The spacecraft then swept within 155,000 kilometers of Europa, a body about the same size as Earth's moon—close enough to provide "just sensational" images, says Steven Squyres, a planetary scientist at Cornell University in New York. The Voyager missions had showed a cracked, icy crust on this moon, raising the possibility that a liquid water ocean was sloshing under its icy shell, perhaps heated by the friction of massive tides caused by Europa's proximity to Jupiter. Galileo's closer look strengthens the idea of an ocean, revealing a jigsaw puzzle of ice pieces that appear to have cracked apart, moved slightly, and then frozen together again.

The simple patterns are the telltale sign, says Head, a planetary geologist. "You can put the jigsaw pieces back together by moving them laterally and simply," he says. "Qualitatively, it just screams at you that it might have been a relatively thin layer that broke up and moved," presumably as it rode on a lubricating layer of slush or even liquid water. The width of the cracks—as much as 10 kilometers—is more evidence for a semiliquid layer, Head argues, because only a "pretty mobile interior" would allow so much crustal movement. But whether the layer is truly liquid—and conceivably hospitable for life—is uncertain. "Whether it's like a daiquiri or a margarita, we're not sure," Head says.



New views. Refrozen cracks suggest liquid water beneath Europa's ice (*above*); a Jovian thundercloud (red and white) towers over other clouds (blue and black, *left*).

The issue could be settled late this year or early next year, when Galileo passes within 600 kilometers of Europa's surface. But the only convincing proof would be to catch a geyser of liquid water in the act of erupting through the icy crust, which would require a great stroke of luck, says Squyres. The problem is that Galileo doesn't carry an instrument aimed specifically at detecting water, because its instruments were selected before Voyager—and before anyone had any thoughts of an ocean on Europa. A definitive answer will probably have to wait for another mission carrying instruments able to penetrate ice, such as long-wavelength radar, says Squyres.

But Galileo does have the right equipment to solve another mystery of the Jovian system. Voyager had detected lightning flashes on the night side of the planet, and planetary scientists have been seeking thunderstorms, complete with rain, in Jupiter's thick atmosphere ever since. But "Voyager had the wrong camera," says Andrew Ingersoll of the California Institute of Technology. And Galileo's probe, which plunged into Jupiter's atmosphere late last year, found less water than expected, although the probe may have fallen into an especially dry spot (*Science*, 2 February, p. 593).

But in the latest work, team scientists used Galileo's three near-infrared filters, which can detect the difference in light reflected from clouds of varying heights. That allowed them to map cloud heights around Jupiter's great red spot. They found several patches of cumulus clouds that tower 50 kilometers above their neighbors and seem to cluster together—characteristics typical of thunderheads on Earth.

These thunderclouds are consistent with the idea that there is indeed some moisture on Jupiter, says Ingersoll. And they suggest that the heat-driven vertical circulation patterns called convection, which drive thunderstorms on Earth, also take place on Jupiter, says Timothy Dowling, a meteorologist at the Massachusetts Institute of Technology. On Jupiter, however, the heat moves upward from the depths of the planet (*Science*, 14 June, p. 1589).

The three-dimensional data on the thunderclouds will help scientists better model the Jovian weather. In fact, says Dowling, Jupiter could offer valuable insights into the forces that drive weather on Earth, by providing a simplified model of wind and weather patterns uncomplicated by land masses or mountains. "Jupiter is giant and roomy," Dowling says. "Earth is crowded and chaotic." If scientists can understand how the cumulus towers work on Jupiter, he says, it may improve models of cloud behavior on Earth—and add an earthly bonus to results from other worlds.

–Gretchen Vogel