says, it should be possible to use parallel processors to speed up the solutions to linear programming problems to such an extent that they can be obtained in "real time"—almost instantaneously. Thus it could be used in pattern recognition problems and in computer programs that pilot airplanes, which are instances where linear programming problems were simply untouchable.

The method also should enable researchers to solve enormous linear programming problems, which have as many as a million inequalities and were long considered impossible to solve. Such problems arise in the design of traffic routing in the telephone system.

In addition, Karmarkar anticipates that his method should solve nonlinear programming problems, which resemble linear programming ones except that the functions are nonlinear and instead of having a polytope with edges, you have a multidimensional figure with curved faces. Such problems arise in models of the economy, for example.

Although the computer science and operations research communities are taken aback by Karmarkar's result, they are not entirely surprised that a practical polynomial time algorithm for linear programming problems has been found. What surprises them is that it is so efficient. As Lászlo Lovász, the researcher from the University of Budapest who helped valiate the ellipsoid algorithm and make it more efficient, says, "I would have expected that someone would have first found a polynomial time method that was comparable to the simplex and that, after a time and with refinements, it might be better." The incredibly efficient algorithm that Karmarkar found seems "spectacular", according to Lovász.

Karmarkar's algorithm is still so new, however, that its implications are yet to be fully established. He got his theoretical results last year and started implementing the method and testing it against the simplex this summer. But one thing is certain, says Graham, "People will be experimenting a lot with this method."

—**Gina Kolata**

Decision Near on *Galileo* Asteroid Flyby

Less than a year ago, the scientists in charge of the upcoming *Galileo* mission to Jupiter realized that the spacecraft would have a chance to explore a major asteroid on the way; the National Aeronautics and Space Administration (NASA) is now very near a decision on whether or not to seize that opportunity. For once the issue is not money. It is management: can the *Galileo* operations team at the Jet Propulsion Laboratory handle the extra work load without jeopardizing the mission as a whole?

The object in question is 29 Amphitrite, namesake of the legendary wife of Neptune and, at 200 kilometers diameter, one of the 30 largest objects in the main asteroid belt between Mars and Jupiter. The planetary science community is understandably enthusiastic about having a look: asteroids are thought to be relics of the formation of the solar system and thus have a very high scientific priority. Unfortunately, the first dedicated United States mission to an asteroid is not scheduled until the mid-1990's.

Aside from its relatively large size, Amphitrite is intriguing because of its composition. It is classified as an S-type asteroid, which means that the sunlight reflected from its bright, slightly pinkish surface contains absorption bands of the minerals pyroxene and olivine, as well as the signature of nickel-iron metal.

Since the asteroid belt is thought to be the source of many of the meteorites that fall to Earth, the obvious thing to do with such spectra is to compare them with the spectra of samples in the museum collections. It turns out, however, that the S-type asteroids are ambiguous. On the one hand they match the most common class of meteorites, the chondrites, which are pyroxene-olivine rocks containing millimeter-sized flecks of nickel-iron metal. If Amphitrite is a giant chondrite, then it is a mass of primitive stuff that condensed right out of the original solar nebula, and it has probably remained unaltered for 4.6 billion years.

On the other hand, S-type asteroids also match the stony-iron meteorites, which are solid chunks of metal laced with rock. The stony-irons appear to be relics of chondritic asteroids that somehow melted, allowing the molten nickel-iron to sink through the lighter, rocky magma. Later, after these asteroids had cooled and solidified, they were presumably ruptured by collisions with other asteroids, their crusts stripped away, and their metallic cores laid bare.

So perhaps Amphitrite is an exposed core. If so, a once-over by *Galileo* might help explain where the heat came from to melt the asteroid and why the S-types melted when the others stayed cool.

The *Galileo* encounter with Amphitrite would come on 6 December 1986, nearly 6 months after the May 1986 launch. From a closest-approach distance of possibly 10,000 kilometers, the spacecraft's cameras would image the asteroid with approximately the same resolution that the Voyager cameras achieved among the moons of Saturn. Unlike Voyager, however, *Galileo* also carries a Near-Infrared Mapping Spectrometer that could make a surface composition map. Ultraviolet, thermal, and polarization measurements would also be possible.

The encounter's major cost to the mission would be a 3-month delay in *Galileo's* arrival at Jupiter in 1989, which translates to an additional outlay of some $10 million on top of a total mission cost of nearly $1 billion. "It's not a serious concern," says Geoffery Briggs, head of NASA's plantary science division. "The added outlays come at the end of the mission [in the early 1990's], and *Galileo* is a good candidate for an extended mission anyway."

The real concern, he says, is that the *Galileo* team at the Jet Propulsion Laboratory is already stretched thin, with most of the current activity focused on completing the spacecraft itself. "Do we have the resources—and the management attention—to do the asteroid?" asks Briggs. "We don't want to close our eyes to the value of the science, but we don't want to jeopardize the mission by having people overlook something stupid."

On the other hand, Briggs points out that the JPL team is working hard to pin down just what Amphitrite will involve. He hopes to take a recommendation to NASA administrator James M. Beggs within a few weeks. "I hope by then, with the facts in front of us, that it will be a straightforward decision."—**M. Mitchell Waldrop**