all of it could stay back home. Like a ping-pong ball pushed along by a jet of water, the probe could be driven towards the stars by a beam of energy from a power source in the inner solar system. For example, Belbruno and Gregory Matloff of NYU suggested a beam of charged particles, which could propel a small spacecraft made of light, heat-resistant titanium.

Of course, particle beams or lasers powerful enough to drive even a small probe don't exist, and the energy requirements are staggering. According to Curt Mileikowsky, a retired ASEA power plant engineer from Sweden, as much as 650 billion watts of power—more than the total output of all the nuclear plants in the world today—would be needed to accelerate a 10-kilogram probe to three-tenths of the speed of light.

One way around that discouraging calculus is to shrink the probe still further. But Kare notes that there are limits. "The optical apertures [of cameras and sensors] are set by the laws of physics. ... You can do pretty respectable things in a kilogram or so, but I'm not sure what you can do in a gram, even with nanotechnology." And the demands of communicating with the home planet also set a minimum size for a stellar probe.

For now, lasers rather than radio transmitters offer the most efficient means of sending data back home, said Robert Cesarone, a Jet Propulsion Laboratory Deep Space Network manager. Cesarone speculated that on the Pluto Fast Flyby, a 0.5-watt laser and a 10-centimeter telescope could return data 50 times faster than the 3-watt radio transmitter currently planned. But again there's a catch: Phoning home from even a nearby star could require an onboard telescope with an aperture of 3 meters—a burden far greater than any of the visionaries at the conference know how to propel. And a 10-meter mirror in Earth orbit would be required to collect the data.

In the meantime, several speakers advocated embarking on a "precursor" mission well beyond the planets. Such a mission would serve as a test of the technologies needed for a true star mission and a chance to study the interstellar environment. It could also yield an early close-up of nearby stars, said Claudio Maccone of Alenia Spazio–Italy, who advocated a trip to the solar focus—the point 550 times Earth's distance from the sun where the sun's gravity, acting as a lens, brings light from distant stars to a focus.

Even such first steps toward the stars may sound visionary, but that doesn't faze Kare: "We could clearly do some of those missions, and we are very close to where they are the next sensible thing to do."

–Larry Krumenaker

Larry Krumenaker is a free-lance science writer in Hillsdale, New Jersey.

LABORATORY WASTES

Toxic Dispute Costs Stanford $1 Million

Stanford University has agreed to pay the state of California nearly $1 million to settle a protracted dispute over charges that the university has mishandled hazardous wastes, the bulk of which is chemicals from its research laboratories. The university has admitted some violations, but it says many charges were trivial, and it is complaining that the state's Department of Toxic Substances Control (DTSC) is holding the school to standards set for industry—standards that are far higher than other research institutions have to meet.

The settlement, announced by Stanford officials on 27 September, involves a payment of $460,000 to cover more than 1600 alleged violations of hazardous-waste regulations over the past 6 years. As part of the deal, Stanford will give an additional $300,000 to three groups that focus on environmental education, and it will pay DTSC another $235,000 for the costs of investigating the school and enforcing the regulations.

As stipulated by the settlement, Stanford has put its researchers on notice that they will face increased scrutiny for the next 2 years. In addition to attending training programs for handling hazardous wastes, researchers now must also be stricter about labeling chemicals. Abbreviations, such as "EtOH" for ethanol, are no longer acceptable. "It is really hard to comply in such detail," says Stanford Vice Provost Charles Kruger, stressing that the regulations were designed for oil refineries and the like: "I wouldn't wish it on other schools." That concern was echoed by Lawrence Gibbs, head of Stanford's Environmental Health and Safety Program. Gibbs, who came to Stanford from Yale University, says "I've not seen another state that looked this closely at the laboratory level."

In fact, however, Stanford brought such close inspection on itself. In 1983, it received a permit to store hazardous wastes for longer than 90 days in a central storage facility (other universities store wastes for less than 90 days). This long-term storage was supposed to save the school money by reducing the number of trips outside contractors must make to remove the wastes. But it also subjected Stanford to routine monitoring by the state agency; other schools typically are monitored by county health departments.

Stanford officials stress that none of the alleged violations involved environmental damage or injury to people. And while they admit to 40% of the 1600 violations they were charged with, they branded the rest "personal and idiosyncratic" readings of the regulations. A full 75% of the DTSC citations they received were "technical," contends a Stanford press release announcing the settlement, focusing on "process and record keeping, labeling issues, and failure to report to the agency."

DTSC spokesperson Allan Hirsch says his agency is pleased with the settlement but is "a little disappointed" about how Stanford has downplayed the seriousness of the violations. "They've been telling the public that we've been nitpicking," says Hirsch. "Stanford is not paying $995,000 because of some picayune violations that we found. ... These problems are as serious as any industrial site we've investigated." Hirsch ticked off a long list of problems found at Stanford, including illegal dumping of mercury, improperly trained staff, open containers of chemical wastes, and overly crowded storage facilities.

Cart it away. Overcrowded storage was one reason for Stanford's recent settlement.

Gibbs concedes that before he took over in 1992, the university had "operational deficiencies" in its hazardous-waste handling. Gibbs says those problems mainly had to do with the school's central storage facility, and they were corrected by the time he took over. Gibbs said that if other schools were inspected with equal rigor, they would be learning the same painful and expensive lesson that Stanford is. Perhaps, but when the University of California, Berkeley's, hazardous-waste disposal program was inspected recently by the DTSC after a complaint, little was found beyond labeling problems. "By and large, the UC Berkeley hazardous-waste handling program is pretty good," says Hirsch.

Given the headaches caused by the long-term storage program, Stanford has decided it is more trouble than it is worth. The school recently asked DTSC to de-permit its long-term storage facility, and on 6 October it received permission to do so. But that won't end Stanford's headaches: DTSC still plans to conduct routine inspections of the school's labs for the next 2 years.

–Jon Cohen

With reporting by Marcia Barinaga.