leagues—as university-based, publicly funded scientists—could not keep secrets. "A decision to accept public funding and the use of nonprofit university facilities is inconsistent with efforts to keep data secret," Siskind argues. The only way to protect intellectual property in these circumstances, according to Siskind, is to file a patent. (Cistron did, but the patent wasn't issued until 1988.) Even if an academic discovery is awaiting a patent, Siskind argues, "it would be unreasonable to extend protection to the review process."

As for the complaints of unethical conduct raised by Cistron, Siskind argues that standards vary from journal to journal, making it hard to label anyone as being out of line. "There are no codes, standards, or rules governing journal peer review which are generally accepted by all groups in the biomedical community," Siskind argues, adding that "Immunex, Dr. Gillis, and Dr. Henney acted within the range of commonly accepted norms of behavior in their use of the Auron manuscript. Their conduct was ethical and violated no rules and no uniformly accepted standard of conduct at the time."

Indeed, Siskind continues, the "use of data in a manuscript to facilitate further research is a practice followed by many scientists," and "some scientists believe it is unrealistic and even unethical not to use whatever information is available to them." Siskind believes that "a substantial number of scientists would have made use of the knowledge they obtained from reviewing the Auron manuscript." And he notes that Bogorad and Fischer conceded, when questioned by an Immunex attorney, that it would be all right for a reviewer to drop a project after reading a manuscript claiming to have completed the same work.

Many of the witnesses in this case—including Maddox—have conceded that there are no uniform standards governing peer review. But they argue passionately that the standards of conduct are genuine and that all scientists know what they are. Cistron's attorneys go further, arguing that these standards are so widely understood that the alleged violation of them by the Immunex staffers was a violation of fair business practices. This argument could be worth a lot to Cistron, should it hold up in court. But Immunex's lawyers are confident that it will not.

If there is no further delay in the trial or a pretrial settlement—which sources close to the case say is unlikely—a Seattle jury will soon cast its vote on Cistron's allegations and, by extension, on the sanctity of peer review. Its verdict will be extensively peer-reviewed throughout the scientific community.

–Eliot Marshall

INFORMATION SCIENCE

All Together for Quantum Computing

More than 10 years ago, the late physicist Richard Feynman planted a dream: harnessing the weird ambivalence of quantum-mechanical states to compute at a pace that would outstrip the fastest possible classical computer. Since then physicists have made great strides in the theory of quantum computers and even in their hardware, going as far as making simple quantum logic gates (*Science*, 7 July 1995, p. 28). What they haven't done is show that quantum computers will ever really work. "When you go from the mathematics to the engineering," says Caltech physicist Hideo Mabuchi, "the prospects don't look so great."

BOB PAZ/CALTECH

QUIC mover. Caltech's Jeff Kimble.

Now a consortium of researchers from Caltech, the Massachusetts Institute of Technology (MIT), and the University of Southern California (USC) has founded an institute for Quantum Information and Computing (QUIC) at Caltech to test the promise of quantum computing and see how, short of a full-fledged computer, quantum mechanics might be harnessed to manipulate information. Starting this month with a 5-year, $5 million grant from the Defense Advanced Research Projects Agency (DARPA), the institute-without-walls will unite researchers who will work on different pieces of the quantum-computing puzzle. The aim is to answer a few simple but profound questions about quantum information processing, says Caltech theorist and provost Steve Koonin: "What good is it? What class of problems might it be good for if it existed? And how perfect does a [quantum computer] have to be for it to work?"

The phenomenon at the heart of a potential quantum computer is the ability of a microscopic system, say an atom or a single photon, to be in more than one quantum mechanical state at the same time—a superposition of states. As USC computer scientist and QUIC researcher Alvin Despain explains, a laser can excite an atom into a superposition of both its ground and its excited states. If those two states represent a binary 1 and 0, then calculations on the superposition act on both values at once. A quantum computer containing n atoms in superposed states, says Despain, could do a calculation on 2^n numbers at once—a degree of parallelism that is inconceivable for classical computers.

Quantum computing suffers two handicaps, however. First, says Mabuchi, the laws of quantum physics and the subtleties of a quantum-mechanical measurement limit the amount of information that can be extracted from a quantum computer. As a result, researchers have so far figured out only two applications for which they might use a quantum computer: factoring large numbers, and simulating other quantum systems such as high-temperature superconductors. Second, quantum superpositions are extraordinarily fragile: Any contact with the environment sets off a process known as decoherence, and the quantum superposition collapses to a mundane classical one. "It appears the main advantages of quantum computation are lost if you really have any significant degree of uncontrolled interaction with the environment, and if you're not able to perform manipulations of the computer with a high degree of accuracy," says Mabuchi.

DARPA put out a call for proposals to study quantum computing and its limits last year, after the agency decided to look at research somewhat beyond the cutting edge of technology, says Despain. The QUIC researchers, led by Caltech's Jeff Kimble, responded with a proposal for a many-faceted research program. Seth Lloyd of MIT will work on algorithms for quantum calculations, while Kimble and his colleagues, who have already built a primitive logic gate, will develop data storage registers and better logic gates. Despain's own group will simulate various quantum architectures to see which have the most tolerance to errors and decoherence, and Caltech theoretical physicist John Preskill will develop means of correcting those errors to see, as he puts it, "how long you can do a quantum computation in a noisy environment before your quantum computer crashes." Finally, Koonin will study the quantum-mechanical theory on which all these dreams are founded.

With much to be gained from studying quantum information processing, even without achieving a working quantum computer, all of the research will be exploratory as well, says Kimble: "in the spirit of a 'bold new frontier' and not so much just a better widget." Then again, the widget is a pretty appealing prospect, says Despain: "Quantum computing isn't something one would do unless we thought the payoff would be incredible."

–Gary Taubes