them a new immune system. As of December 2002, 10 of those subjects were still alive: six had major remissions of their cancer, and four had some of their tumors shrink.

Analysis of patients' blood and tumor samples showed that the TILs multiplied and then attacked the tumor tissue. "In the past when we transferred cells, maybe 1 or 2 percent survived," Rosenberg explains. "Now we have 80 percent that survive for months, and when that happens the cancer disappears."

"The good news about Rosenberg's work is that as a proof of principle, it's extraordinary," says Robert A. Figlin, an oncologist at the University of California at Los Angeles School of Medicine. "The bad news is that it's not easily extrapolated to a large group of patients." Moreover, "we are asking a lot of these T cells to treat patients with very large tumor burdens," says Cassian Yee, an immunologist who has developed a similar T cell transfer therapy at the Fred Hutchinson Cancer Research Center in Seattle. "The T cell therapy might be more effective with smaller tumors and with repeated treatments over time."

According to Figlin, the key to immunotherapy is selecting the right patients. "There will be a smaller number of patients that have a higher response, and not the other way around," he explains. "That's the reality until we understand the subtleties of the immune response."

Diane Martindale is based in Toronto.

PHYSICS

Scaled-Up Superposition

SUPERSIZING SCHRÖDINGER'S CAT—BY A BILLION TIMES BY CHARLES CHOI

Cats may have nine lives, but only Schrödinger's can be both alive and dead at the same time. The quirky laws of quantum mechanics suggest that objects can literally exist in two states or places simultaneously until perturbed in some way, after which they collapse out of this "superposition" to just one outcome. Physicists have created such Schrödinger's cats before, usually in the guise of a single particle—a photon or electron. That's because the bigger the "cat," the harder it is to keep it undisturbed, a necessary condition for preserving the superposed state.

Physicists have come up with a scheme they think will produce a Schrödinger's cat billions of times larger than before. That would make it about the size of a feline cell—still a speck to human eyes but gigantic on the quantum scale. Roger Penrose of the University of Oxford originally conceived an experiment in space involving satellites, but collaborator Dik Bouwmeester of the University of California at Santa Barbara realized that a copycat version could be done on a tabletop, perhaps in three to five years as technology improves.

The setup, a kind of interferometer, monitors two paths that a photon of light can take. A photon is directed toward a beam-splitting crystal, which gives the light an equal chance of going down one of two paths, both capped with reflective cavities. The photon travels into either cavity and bounces around inside for a while. It then eventually leaks out to head back to the beam splitter, where it is reconstituted for detection. A photon will enter a superposition of traversing both paths simultaneously.

But one of the cavities is crucially different—one of its mirrors is mounted on an oscillating arm. Similar to a cantilever in atomic force microscopes, it would be sensitive enough to detect the push felt by the mirror. The quivering mirror would end up being in a superposition for about a millisecond because it was coupled to the photon. This superposition would appear as an interference pattern formed by the photon traveling two paths.

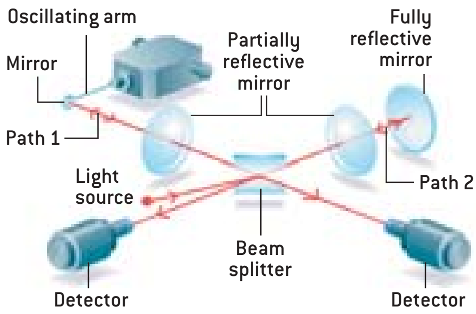
The requirements for this experiment, developed with physicists William Marshall and Christoph Simon, both at Oxford, are exquisitely sensitive. The mirror has to be minuscule to be jostled by a photon—maybe 10 microns thick (about a tenth the width of a human hair) and five billionths of a gram in weight. Temperature must be kept a few millionths of a degree from absolute zero, to keep all vibrations to a minimum. Ultrahigh vacuum must be maintained to make sure a stray atom doesn't knock the arm askew. To-

STAKING A SUPERPOSITION

Roger Penrose of the University of Oxford conceived the experiment described in the main text because he thinks that the very fabric of existence forbids large objects from remaining in superposition for long. If something exists in two places at once, it would result in two different structures of space and time, he says. Such a blister in reality represents an energy uncertainty; the larger the blister, the shorter the amount of time each can stay apart. Whereas electrons could exist in superposition for millions of years, something the size of a dust mote would exist for just a second or so.

The proposed experiment with mirrors won't settle the question: it would need 100,000 times more mass to reach the regime in which Penrose expects to see this cutoff in Schrödinger's cat size. An experiment involving long distances—such as orbiting satellites—may be needed.

day's technology can meet both temperature and vacuum conditions, but such a tiny mirror on an equally small arm challenges existing fabrication techniques. Bouwmeester suggests that in the future one could make this mirror on a carbon nanotube, a small but incredibly strong rod that researchers are still trying to perfect.



GIANT QUANTUM CAT could be made if a photon is directed to a beam splitter, giving it two paths to follow. The photon enters a superposition of traversing both paths—and takes the mirror on the oscillating arm with it. The detector records the superposition as an interference signal.

"I would be quite surprised if a decade or so from now the experiment had not been done," comments quantum physicist Paul Kwiat of the University of Illinois at Urbana-Champaign. "Technology has a wonderful tendency to improve, despite the aphorism 'They don't make 'em like they used to.'"

Bouwmeester says that creating a large superposition could improve quantum computers, which rely on particles in superposition to represent 0's and 1's simultaneously. The proposed experiment, if successful, could help solve the problem of keeping these quantum cats trapped in superposition—and without the scratches, either.

Charles Choi is based in New York City.

SECURITY

Nothing but Net

HOW NOT TO BREAK THE SAFETY BARRIER BY PHIL SCOTT

World War II footage has that familiar black-and-white scene: a heavily damaged war bird lands out of control on the stern of a straight-deck carrier and crashes into a steel cable net, which prevents it from ramming into aircraft waiting to take off. Volunteer firefighter Matthew Gelfand was watching one such documentary in 1993 when a lightbulb went on above his head. He had heard about an accident in which a car struck a train, then another vehicle whizzed past the crossing and hit a firefighter. "If a carrier could catch a plane with a net, why not a car with a net?" Gelfand wondered.

BETTER THAN A SPEED BUMP: A retractable net can stop vehicles without damaging them.

The result is GRAB, for ground retractable automobile barrier. Essentially, it is a tennis net made from Kevlar strips, with two metal stanchions on either side. Remote sensors or a manual push button shoots the net up from a two-inch-wide recess in the ground in as little as three seconds. As the vehicle hits the net, the energy is absorbed by pistons in the stanchions and the net—not unlike the barriers on the WWII aircraft carriers, whose nets had cables that folded down onto the deck and were connected to energy-absorbing stanchions.

Gelfand, who received $650,000 from the state of New York to develop GRAB through his new company, Universal Safety Response, envisions the system installed not only on railroad crossings but also at tunnels, bridges and security gates on government buildings. During tests, the net could stop a 1,800-pound automobile traveling at 45 miles an hour in just 13 feet. The quick stop did not inflict much damage to the vehicle.

Last December the first GRAB was installed at a fitting location: the security entrance to the USS *Intrepid,* a WWII-era aircraft carrier converted to a floating aviation museum docked on New York City's Hudson River.

Phil Scott is based in New York City.

SAMUEL VELASCO (*top*); UNIVERSAL SAFETY RESPONSE, INC. (*bottom*)