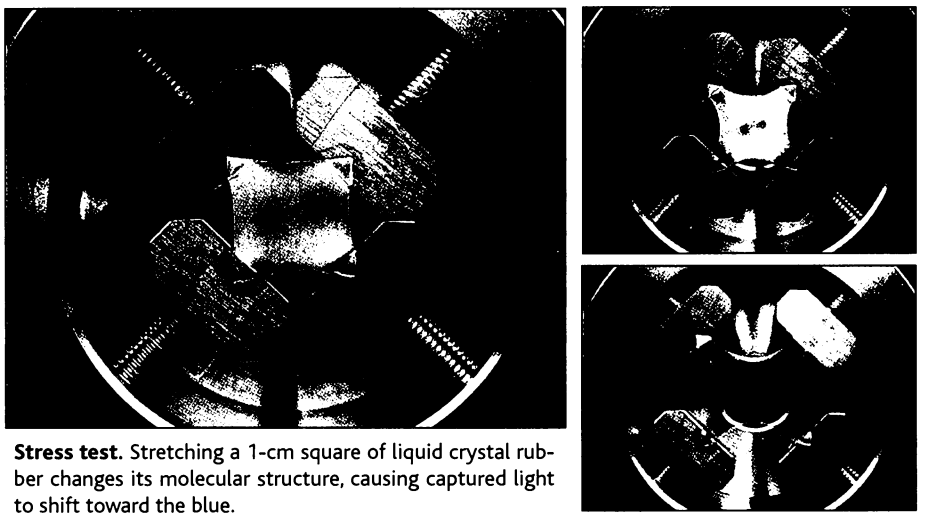


Stress test. Stretching a 1-cm square of liquid crystal rubber changes its molecular structure, causing captured light to shift toward the blue.

gineer. "Here's a hope that one can make naturally occurring bandgap materials that therefore are very inexpensive, and here they're also tunable," says Azriel Genack, a physicist at the Queens College of City University of New York in Flushing. "It's just a question of mixing the chemicals together."

The transparent rubber is about as stretchy as an office rubber band. It is also a liquid crystal, a member of a class of twilight materials whose structures lie partway between the neat ordering of a true crystal and the haphazard disorder of a liquid. In a typical liquid crystal, long, rodlike molecules spontaneously line up with one another. Finkelmann's material varies the theme: The rodlike molecules twist like the steps of a spiral staircase, a structure first observed in derivatives of the cholesterol molecule. In such so-called cholesteric liquid crystals, the helical structure is described by its pitch, the distance needed to make one complete twist.

What makes cholesteric crystals useful, Finkelmann explains, is their ability to capture light. "If light is coming in the direction of the pitch axis, light of a given wavelength is reflected," he says. That means that if light of just the right wavelength enters the liquid crystal material, the twisted molecules can trap it just as mirrors do in a regular laser. Where to get such fine-tuned light? The trick, Finkelmann says, is to impregnate the material with a fluorescent dye that, when excited by an external laser, gives off light of just the right wavelength to be trapped. If the exciting laser is powerful enough, the light emitted by the dye escapes as laser light at wavelengths both just above and just below the forbidden, trapped wavelength band.

Last year, Genack demonstrated such a fluorescent-lasing mechanism in a liquid. Finkelmann saw similar results presented at a conference by Peter Palffy-Muhoray of Kent State. Finkelmann's lab had just succeeded in creating cholesteric ordering in a rubber. "It was straightforward to transfer this concept to our rubbers," he says.

The result, as Finkelmann, Palffy-Muhoray, and three colleagues will report in an upcoming issue of the journal *Advanced Materials*, is a material with its spiral axis oriented through its thickness. Shine a laser beam on one side, and laser light of a different frequency comes out the other. Stretch the rubber in two directions at once (see figure), and the molecular spirals shorten, causing the emitted light to shift toward the blue end of the spectrum. The color of the light leaving the rubber changes before your eyes, Finkelmann says.

The new work is a "significant step" in the progress of liquid crystal lasing, says physicist Cliff Jones of ZBD Displays in Malvern, United Kingdom. Applications may be in the offing. "I can imagine that this may lead to a low-cost, tunable laser," Jones says. Genack says he is interested in using the rubber to develop practical devices for display technology. **–ANDREW WATSON**

Andrew Watson writes from Norwich, U.K.

CREDITS: (TOP TO BOTTOM) H. FINKELMANN/*ADVANCED MATERIALS*; THOMAS TUSCHL

GENE SILENCING

A Faster Way to Shut Down Genes

When scientists say a new technique ranks up there with the polymerase chain reaction (PCR), you know it's big. That's how at least one researcher is viewing a report this week of a new method for shutting off specific genes in mammalian cells. Although still in its infancy, the approach, known as RNA interference (RNAi), makes a currently arduous process much faster, much as PCR did for copying segments of DNA.

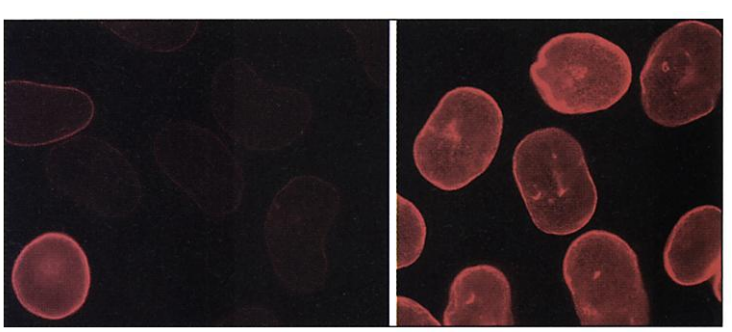
"It's going to totally revolutionize somatic cell genetics in mammals," predicts Phillip Zamore of the University of Massachusetts Medical Center in Worcester. "Instead of devoting 6 months to a year figuring out how to turn off expression [of a mammalian gene], people will be able to go in and in a week turn off the expression of 10 genes."

RNAi is a process in which double-stranded RNA (dsRNA) molecules turn off, or silence, the expression of a gene with a corresponding sequence (*Science*, 26 May 2000, p. 1370). A variety of organisms, including plants, fruit flies, the roundworm *Caenorhabditis elegans*, and likely mammals, seem to enlist RNAi to fight off viruses and restrain the movement of transposons, pieces of DNA that can hop around and disrupt a genome.

Recently scientists have also harnessed this process as a research tool, injecting dsRNA into cells to turn off specific genes, thereby garnering clues about their function. That work has yielded some stunning results; last year, for instance, scientists used the technique to systematically block expression of nearly all the genes on two *C. elegans* chromosomes. But so far, silencing genes using RNAi has not worked well in mammalian cells; although successful in mouse embryos, dsRNA triggers a global shutdown of protein synthesis in other mammalian cells.

Now scientists at the Max Planck Institute for Biophysical Chemistry in Göttingen, Germany, report in the 24 May issue of *Nature* that they have finally overcome this barrier: By using specially constructed dsRNA molecules that are shorter than those tried to date, they have shut down target genes in several different cultured mammalian cells lines. The technique won't replace gene knockout strategies, but RNAi does offer some advantages. It is faster and less labor intensive than making a knockout, and genes that are lethal when knocked out in embryos can be analyzed with RNAi in cell culture.

The new work grew out of studies of RNAi in *Drosophila*. Although much of the RNAi mechanism is mysterious, researchers know that dsRNA triggers the degradation of the messenger RNA (mRNA), blocking



Running interference. An siRNA stops its target from making protein *(left)*; siRNAs to other genes have no effect *(right)*.

synthesis of the protein product. Earlier this year, Thomas Tuschl and his Max Planck coworkers discovered that an RNAi intermediate, called siRNA (small interfering RNA), instigates degradation of an mRNA in the fruit fly. Tuschl wondered whether that intermediate, a 21-base dsRNA with two bases overhanging on each end, would be better than longer dsRNAs at silencing genes in cultured mammalian cells.

In the new work, Tuschl and his team tested synthetic siRNAs that matched the sequence of four different genes that express cytoskeletal proteins. In four different cell lines derived from human and monkey, expression of three of the four genes was lowered substantially—by as much as 90%. The fourth gene is highly expressed, which may make silencing it more difficult, say the authors. Control genes not targeted by the siRNAs were not affected. The team has subsequently tried RNAi on other genes, and according to co-author Klaus Weber, nine out of 10 genes can be "knocked down" with the method.

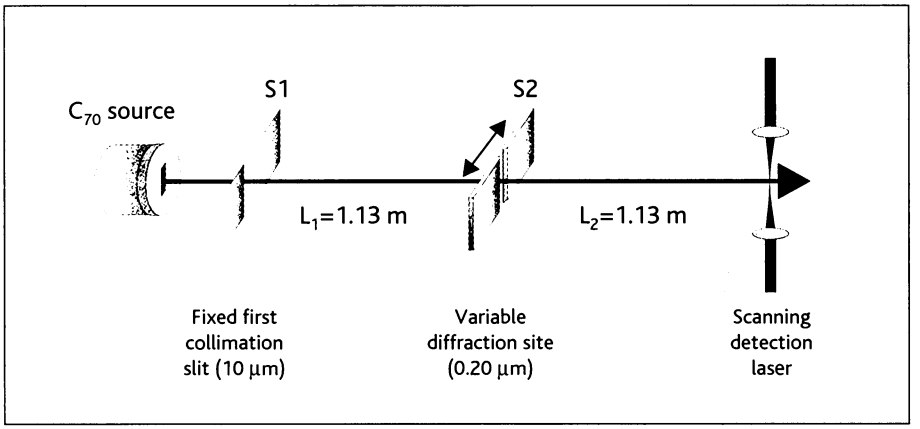
This targeted silencing in mammalian cells appears to work by circumventing a global cellular process not present in lower organisms. Injection of long dsRNAs into mammalian cells (which probably mimics invasion by a virus) induces a broad interferon response that reduces the translation of many genes and can even trigger cell suicide. siRNAs appear to be short enough to sneak under the radar of the interferon system but long enough to specifically target single genes.

Still, Zamore cautions that although the technique is promising, it is too soon to know whether it will deliver. Genes are not always turned completely off, for instance, and RNAi may not be effective for genes whose protein products are unusually stable or highly abundant. Fifteen years ago, antisense methods for gene silencing and gene therapy offered similar hopes, but that has largely been a bust. Unlike antisense, however, RNAi seems to take advantage of an existing biological pathway, which just might give it a leg up. **–R. JOHN DAVENPORT**

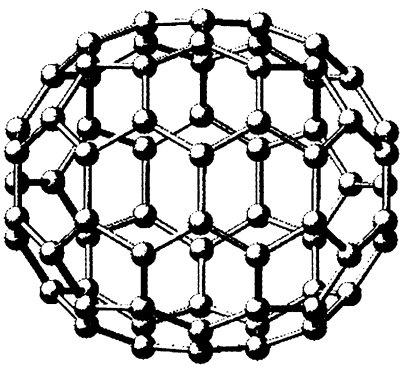
QUANTUM PHYSICS

Microscale Weirdness Expands Its Turf

Schrödinger's pipe dreams aside, no sane physicist would try to do a quantum-mechanical experiment with a cat. A cat is a large object, which tends to follow the classical laws of prequantum physics; quantum mechanics tends to hold sway over small objects, such as atoms. But physicists in Austria are breaking down the tidy distinction between large objects and small ones. In a paper that has been posted on the Los Alamos preprint archives (arXiv.org/abs/quant-ph/0105061) and submitted to *Physical Review Letters*, they show that a cluster of 70 carbon atoms—a veritable monster by quantum-theory standards—is governed by the archquantum law known as the Heisenberg Uncertainty Principle. These clusters are the largest, hottest, and most complicated objects that have been shown to obey Heisenberg's law, and they are helping scientists understand the increasingly fuzzy divide between the quantum and the classical.



Rim shot. In a large-scale test of the Uncertainty Principle, narrowing a beam of C_{70} molecules *(right)* made their momenta more varied—just as Werner Heisenberg predicted.



"It's a very good idea to try to cross that boundary," says Christopher Monroe, a physicist at the University of Michigan, Ann Arbor. "I think these are wonderful experiments."

Decades ago, experimenters showed that very small things such as neutrons and protons obey Werner Heisenberg's dictum that the better you understand an object's position, the less you are able to predict its momentum. For example, when you increasingly constrict a beam of neutrons by forcing it through smaller and smaller slits, the particles take on a greater and greater range of possible momenta. As objects get larger, though, the Heisenberg Uncertainty Principle and other quantum effects such as interference become harder to measure. Some physicists, including Roger Penrose of the University of Cambridge, U.K., argue that quantum effects break down as objects get larger, causing big objects to behave classically while small ones behave quantum mechanically. Anton Zeilinger of the University of Vienna in Austria disagrees. "A transition from quantum to classical as you go from micro- to macroscopic ... is not going to happen in my expectation," says Zeilinger. "It's just a question of the skill of the experimenter and how much money [there is] to perform the experiment."

Zeilinger and his colleagues decided to probe the hazy border between quantum mechanical and classical by looking at an object that lies between both worlds: the C_{70} molecule. The ungainly bigger brother of C_{60} (buckminsterfullerene), C_{70} is much more massive than the particles that physicists usually use to test the laws of quantum mechanics. At the same time, C_{70} is much smaller than a cat, so it can be stuffed through a small slit with a lot less difficulty. "You don't usually think of looking at such a complex system as quantum," says Monroe, who calls the massive molecule "a nice middle ground."

Zeilinger's team shot a beam of C_{70} through an adjustable slit whose size ranged from 20 micrometers to 70 nanometers. Using a sensitive laser detector, the researchers measured the range of momenta of the C_{70} molecules that had passed through the slit. When the slit got smaller than 4 micrometers, the C_{70} began to behave like quantum objects: As the slit size decreased, the range of the molecules' momenta got broader and broader. In other words, the more that was known about the molecules' positions, the less was known about their momenta. Despite its size, the C_{70} was behaving "very, very precisely" as a quantum-mechanical object should, says Zeilinger. And although he notes that C_{70} is still too small to disprove Penrose's breakdown theory, it has extended the quantum domain farther than before. "We can work upwards slowly," he says. Cat lovers beware. **–CHARLES SEIFE**

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