edited by CONSTANCE HOLDEN

Opening Window on Quantum Weirdness

In Joseph Heller's *Catch 22* one of the officers—Army major Major M. Major—was notoriously hard to catch in his office. Whenever the protagonist, Yossarian, didn't need him, he was in; whenever he did, he was out. Yossarian might have wondered if he really existed; instead, he trapped the major slipping out his back window just at the moment when a visit had been scheduled.

That's not far from the classic conundrum in quantum mechanics. For decades, physicists have predicted that subatomic particles and certain macroscopic objects occupy several "states" at once, but only when no one's looking—a condition called a superposition of states. Indeed, theory says that the very act of observation locks the system into one of its possible states, rendering the superposition unobservable. This contention has been accepted as proved, but the evidence is only indirect.

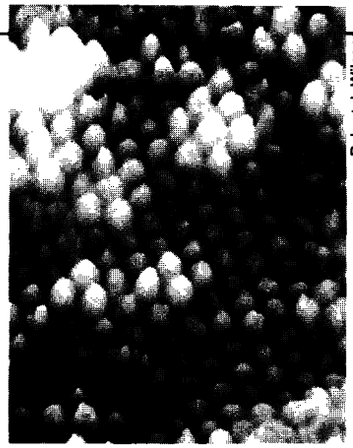
Now, a group of English physicists at Sussex University is claiming it has found a way to "see" a superposition of states. The group, led by Terry Clark, does this with a small ring of superconducting metal called a Superconducting Quantum Interference Device (SQUID). Although it contains billions of atoms, under the right circumstances a SQUID behaves like a single quantum particle, remaining in a superposition of magnetic flux states. The researchers say they can read the SQUID's magnetic superpositions by measuring the frequency shifts they induce in a nearby resonant circuit.

Although physicists have been familiar with the findings for several years, most remain unconvinced. Says Anthony Leggett, a SQUID expert at the University of Illinois: "The argument necessary to go from the raw data to their conclusions is extremely indirect and makes many assumptions along the way." He says the Sussex group may be misinterpreting a classical effect such as a magnetic resonance.

Clark and his collaborators are hoping to sway the doubters with an upcoming paper, to be published in the Italian journal *Il Nuovo Cimento*, that is based on a completely rebuilt apparatus. But experiments in quantum dynamics tend to have many conflicting interpretations, and it may be a long time before physicists agree on what the Sussex group is actually seeing.

Buckyballs for Sale

There's good news for scientists who have been dying to experiment with buckyballs, the newest sensation in chemistry. If you don't have the equipment to synthesize your own, you can now order a batch of the soccer-ball-shaped C_{60} molecules from a Tucson firm, Materials and Electrochemical Research (MER).



Robert J. Wilson

Portrait of buckyballs. *Direct image of soccer-ball-shaped molecules made with scanning tunnelling microscope at IBM.*

Researchers in dozens of labs around the world have been racing to study the unusual chemical and physical properties of buckyballs since September, when Donald Huffman of the University of Arizona and Wolfgang Krätschmer at the Max Planck Institute for Nuclear Physics in Heidelberg announced a relatively simple way to make pure samples of the material (*Science*, 12 October 1990, p. 209). "We've had dozens of orders since the first of the year," says James Withers, chief executive officer of MER, which has licensed the rights to make buckyballs from the University of Arizona.

The price tag: $1250 per gram, or $250 for 100 milligrams. Not much for a product unavailable at any price less than a year ago.

Search for ETs Gets Fiscal Reprieve

Exactly 30 years after the first attempt to detect radio signals from alien civilizations, the search for extraterrestrial intelligence (SETI) got its biggest birthday present ever. Not only did NASA stave off Congress's attempt to ax the program (*Science*, 20 July 1990, p. 249), but it also got a tripling of the annual budget to $12.1 million. Things are back on track for an October 1992 start of a search that will be more than a million times more capable than all previous efforts combined.

SETI prospects looked dim last summer, with one irate congressman waving banner headlines about little green men already being on Earth and another warning against squandering good money on "curiosity." The House responded by zeroing out SETI's fiscal 1991 budget.

That activated the seasoned SETI lobby—including science teachers, astronomer Carl Sagan, and one-time Shuttle passenger Senator Jake Garn (R–UT)—which went to work on the Senate. The outcome surprised even the enthusiasts: The Senate restored the full amount requested by NASA and added language to protect it from reallocation to other NASA programs. These provisions were included in the House-Senate conference report. If the program can continue to weather the lengthy budget process, the 500th anniversary of Columbus' discovery of America will mark the opening of a new age for SETI. Little green men, call soon.

Canada Sacrifices for Middle East

Canada will probably temporarily stop compiling statistics on its scientific research and development in order to finance its contributions—supply ships and fighter planes—to the war in the Persian Gulf. Statistics Canada, one of a number of government departments taking cuts for this purpose, is losing $4.5 million ($3.87 million U.S.) from its budget this year. Sources say that there may be no Canadian R&D statistics collected for 1990, 1991, or 1992. That's a further blow to Canadian science: Statistics in recent years have documented a decrease in R&D spending as a proportion of gross domestic product, despite government promises to the contrary.

Assessing High School Achievement

Standardized high school achievement tests—with their heavy emphasis on multiple choice questions—have long been criticized for their failure to reflect student resourcefulness and problem-solving capacities. Now, two educational research centers, in what they call "a major departure" from current practices, are developing an alternative national system of "performance-based" assessment.

The core of the plan, designed by the National Center on Education and the Economy in Rochester, New York, and the University of Pittsburgh's Learning Research and Development Center, involves three types of assessments: individual "performance examinations" where students respond to questions from examiners, individual and group projects, and portfolios of student work. Assessments will be tied to a syllabus and set of standards devised by

an independent National Education Standards Board.

According to a press release: "Students would be able to accomplish tasks set by the assessment process over time much as scouts accumulate merit badges." Local assessment instruments would not be thrown out, but would be calibrated to the national standards.

The 18-month development stage is being funded by $2.45 million from the MacArthur Foundation and the Pew Charitable Trusts. Pilot testing of what organizers envisage as a 10-year effort will begin next year.

Final Word on Agent Orange?

Key members of Congress have reached agreement on the nagging quandary concerning Agent Orange—namely, should the government provide compensation to servicemen who were exposed to the defoliant during the Vietnam War? Their answer: if the National Academy of Sciences says so.

Representatives Lane Evans (D–IL) and G. V. (Sonny) Montgomery (D–MS), long at odds over this issue, agreed 2 weeks ago on a bill under which the NAS will review all the available evidence on health risks and recommend to the Department of Veterans Affairs (VA) whether any more diseases should be linked to Agent Orange. (The VA has already granted such recognition to a severe skin condition and two rare cancers.) The VA is required to accept the recommendations or explain why it won't within 60 days.

The scientific arguments over Agent Orange seemed closed in 1987, when the Centers for Disease Control said troop records were inadequate to determine what ailments might be linked to exposure. But last year, a congressional committee accused the Reagan Administration of mounting a cover-up to avoid potentially massive disability payments (*Science*, 31 August 1990, p. 982).

The latest move may place the academy in the position of writing the closing chapter in the Agent Orange story. A panel of the Institute of Medicine, its sister organization, unofficially endorsed the CDC's decision when it cancelled its Agent Orange study. And a recent study in *The New England Journal of Medicine* suggests that the health risks associated with dioxin—an active ingredient in Agent Orange—are much lower than previously thought.

New Audit at Stanford

Stanford University, under siege for its indirect cost accounting practices (*Science*, 21 December 1990, and 11 January, p. 157), made a peace offering last week: the university will return $500,000 from government research funds received since 1981 as reimbursement for expenditures in running the university-owned homes of its president, provost, and vice president for public relations. In addition, Stanford has hired the accounting firm of Arthur Andersen and Co. to review its accounting methods, and has assembled a panel of outside advisers to help carry out any changes Andersen may recommend. All this, university officials hope, will mollify Representative John Dingell (D–MI), who is currently investigating Stanford's indirect cost accounting practices.

Investigators from Dingell's Subcommittee on Oversight and Investigations have argued that money spent on things such as flowers and a cedar closet have nothing to do with research. Stanford officials initially responded that some of the expenditures were legitimate since the houses often host research-related events. But now Stanford has decided to remove all the house-related charges.

The university is making much of the fact that its newly appointed auditors and advisory committee—which includes former National Security Agency director Bobby Inman—are free to scrutinize Stanford's accounting system "from top to bottom."

But Dingell's investigators are not impressed. One staffer said he is not sure the Andersen team will go through the accounts on the kind of voucher-by-voucher basis needed to "get the garbage out."

The Case Against Crop Chemicals

"Organic" farming is not some luxury pursued by fuzzy-minded counterculturists and health-obsessed yuppies. Rather, it's a matter of hard-nosed economics, says a new, wide-ranging study led by Cornell University agricultural scientist David Pimentel.

Agricultural chemicals have become increasingly counterproductive, argues Pimentel: the tonnage of chemical pesticides applied to U.S. croplands has grown thirty-three-fold since the 1940s, and their toxicity has grown roughly tenfold. Yet crop losses to insects, fungi, and weeds have actually increased in that time, from 31% to 37%. This is due in part to insects' ability to develop resistance to every new pesticide that comes along. But government commodity price supports are even more to blame, says Pimentel, because they encourage farmers to specialize in single crops instead of rotating them to keep down the pest population.

If U.S. farmers could cut their use of chemical pesticides in half—which could be done easily by employing such well-proven alternatives as crop rotation and biological pest control—then food prices would rise by less than 1%, or about $1 billion per year, according to the report. And the benefits would be overwhelming: The nation would save from $4 billion to $10 billion per year in terms of decreased damage to fish and water supplies, decreased costs of pesticide regulation, and decreased health care costs for the 20,000 people a year who are poisoned by pesticides.

"The study should have been done a long time ago," says Pimentel. Although agriculture critics have been saying the same things for years, he says that this is the first really comprehensive cost-benefit analysis of pesticide use. Published in a new edition of the *Handbook on Pest Management in Agriculture*, from CRC Press, it is a synthesis of more than 300 previously scattered research reports.

David Lynch-Benjamin

David Pimentel. ***Pennies more at the supermarket could save billions in pollution, health, and regulation costs.***