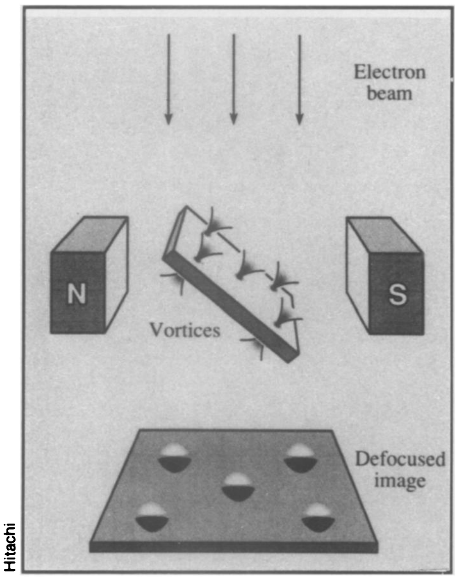
Capturing the motion of magnetic vortices

Applying a new imaging technique, researchers in Japan have for the first time directly observed the movement of tiny whirlpools of magnetism trapped in a superconducting material. Their observations help settle a long-standing debate concerning the behavior of these vortices as the temperature of an oxide superconductor — placed in a magnetic field — is varied.



To observe vortices, researchers sent an electron beam through a sample of bismuth strontium calcium copper oxide placed in a magnetic field.

Akira Tonomura and his co-workers at the Advanced Research Laboratory of Hitachi, Ltd. in Saitama, Japan, report their findings in the Nov. 15 PHYSICAL REVIEW LETTERS.

"To those in the superconductivity business, these images are nothing less than spectacular," comments David J. Bishop of AT&T Bell Laboratories in Murray Hill, N.J., in the Nov. 18 NATURE. "It is a truly outstanding piece of experimental physics."

A superconductor normally shields itself from the effects of magnetic fields in which it is placed by preventing such fields from penetrating its interior. For oxide superconductors, however, once this external magnetic field exceeds a certain value, it begins to enter the material. This penetrating magnetic field exists within the superconductor in the form of separate vortices — whirlpools of electric current. At low temperatures, the vortices arrange themselves into a distinctive pattern, or lattice.

The behavior of these vortices has a great influence on how well a superconductor carries electricity, particularly at high currents, when the vortices get in the way. But researchers have been unsure whether a vortex lattice remains intact below a certain temperature and "melts" into disarray above this temperature (SN: 4/1/89, p.197).

The Hitachi team confirmed that at low temperatures, the vortices form a lattice. As the researchers raised the temperature, the vortices moved a little with each temperature step but eventually settled again into a stationary pattern. However, once a certain temperature — a critical point — was reached, the lattice melted. A previous result indicated vortices start moving well below this temperature.

"Many of us have been consumed for the past six years by the issue of whether magnetic flux lattices could indeed melt," Bishop says. Now, "seeing is believing."

— *I. Peterson*

Agent from the sea has antitumor promise

A very preliminary human trial of a compound extracted from a marine animal hints that this agent may have a future as an antitumor drug.

While the rain forest is commonly thought of as a source of novel drugs, this study shows that the sea also may provide oncologists with a rich source of cancer-fighting compounds, comments Andrew S. Kraft of the University of Alabama at Birmingham. The agent, bryostatin 1, is obtained by grinding and purifying a small sea creature called *Bugula neritina*.

A raft of studies had previously demonstrated bryostatin 1's cancer-killing muscle in the test tube or in laboratory animals. For example, scientists have shown that it can halt the proliferation of human leukemia cells growing in a petri dish. In addition, the compound has been shown to shrink skin tumors in mice.

"This study is the first to use the drug in humans," says Philip A. Philip, formerly at Churchill Hospital in Oxford, England, who coauthored the report in the Nov. 17 JOURNAL OF THE NATIONAL CANCER INSTITUTE.

Before they can test its efficacy in humans, Philip and his colleagues must show that bryostatin 1 is safe. So the team designed a trial in which they gave various doses of the drug to 35 people with a variety of advanced malignant tumors. Not all recruits were candidates for or had failed conventional anticancer treatments, Philip notes.

The most notable side effect of the new drug seems to be muscle pain, which was severe enough to necessitate stopping treatment in six patients, Philip reports. Patients did not experience the nausea or vomiting associated with the all-out blitz of chemotherapy, he says.

Although this trial is not designed to determine efficacy, bryostatin 1 did show a glimmer of effectiveness in two people suffering from malignant melanoma, a deadly type of skin cancer that is very resistant to treatment, says Philip, now at the University of Texas M.D. Anderson Cancer Center in Houston. After experimental treatment with bryostatin 1, the patients' tumors shrank by at least 50 percent, a remission that lasted up to 10 months in one case.

Bryostatin 1's mechanism of action is likely to be complex. For example, laboratory studies have demonstrated that this compound stimulates the activity of protein kinase C, an enzyme that regulates cancer cell growth, notes Kraft, who wrote an accompanying editorial. What's more, Philip adds, bryostatin 1 may trigger the immune system's attack on malignant cells. — *K.A. Fackelmann*

Ancient Maya trade: Tracing salty swaps

Underwater excavations off the coast of Belize have uncovered a site where the Classic-era Maya produced salt from seawater more than 1,000 years ago, both for local use and as a valued item for trade with nearby communities.

"What we're seeing is evidence of regional trade of salt from coastal to inland sites in southeastern Belize," says project director Heather McKillop of Louisiana State University in Baton Rouge. "This shows that there has been an overemphasis [by scientists] on long-distance trade in Classic Maya civilization."

McKillop described the ongoing research last week in Washington, D.C., at the annual meeting of the American Anthropological Association.

The discovery of short-range salt trading by the Maya during the Classic period, which extended from around A.D. 250 to A.D. 900, occurs as other investigators explore the remnants of mountain settlements where the Maya simultaneously exploited various minerals to support another regional trading network (SN: 8/7/93, p.84).

Classic Maya towns clustered in the lowlands of Central America, where salt proves difficult to obtain, McKillop notes. The closest salt flats lie in northern Yucatán, several hundred miles away from ancient Maya cities. Coastal Belize offered easier access and thus stoked interest in extracting salt from seawater, she asserts.

Ironically, water now covers several Classic-era salt-production sites. Geological surveys of the coast along Belize have documented a dramatic rise in sea level that occurred in the last 100 years of the Classic period, coinciding with the abandonment of many coastal settlements, according to McKillop.