Confining superfluid helium to a new state

Superfluid helium-3 represents one of the more exotic forms of matter created in the laboratory. At temperatures below 2.5 millikelvins, this liquid can flow without friction (SN: 10/19/96, p. 247).

When liquid helium-3 is allowed to soak into a highly porous glass sponge, known as an aerogel (SN: 11/17/90, p. 316), its characteristics change. The cobweblike silica filaments of the aerogel interfere with the coordinated movement of the helium-3 atoms, and the liquid must be cooled to even lower temperatures before it begins to act as a superfluid.

Now, researchers have discovered that a magnetic field further depresses the superfluid transition temperature of helium-3 and facilitates the formation of a new type of superfluid phase. "This was totally unexpected," says physicist William P. Halperin of Northwestern University in Evanston, Ill. Halperin and his coworkers report their findings in the Nov. 25 PHYSICAL REVIEW LETTERS.

The researchers used a cylindrical sample of aerogel 1 centimeter long and 4 millimeters in diameter. Only 1.8 percent of the sample's volume consisted of silica, in the form of thin, randomly interconnected strands. The rest was open space into which a liquid could soak.

Immersed in helium-3, an aerogel's open network of glass threads serves as a means of introducing disorder into the confined liquid. Last year, both Halperin's group and the team of Jeevak M. Parpia and James V. Porto at Cornell University reported that such confinement substantially reduces the temperature at which helium-3 becomes a superfluid.

However, researchers had expected the superfluidity to disappear completely. "That doesn't happen," Parpia says. The atomic pairing responsible for superfluidity is much stronger than anyone had anticipated.

Physicists had also previously found that a magnetic field has little effect on the superfluid transition temperature of pure helium-3. So when Halperin and his colleagues subsequently discovered that a magnetic field strongly influences the superfluidity of helium-3 in an aerogel, they were again surprised. "It was a large effect," Halperin says.

"Having so much [aerogel] surface in close proximity to the liquid can clearly do odd things when you apply a magnetic field," Parpia comments.

Halperin now suspects that the sensitivity of helium-3 to a magnetic field is due to interactions between a solid layer, one atom thick, of helium-3 coating the glass filaments of the aerogel and the remaining helium-3 atoms wandering about in the liquid phase between the coated strands.

The ordered atoms of the surface coating have individual magnetic fields. When atoms in the liquid phase bump into surface atoms, the interaction can reverse the magnetic orientation of the rebounding helium-3 nuclei, disrupting the usual pairing of atoms in the superfluid. An applied magnetic field enhances the effect.

Halperin and his group tested the proposed model by introducing a small amount of helium-4, which displaces helium-3 atoms from filament surfaces. Because helium-4 and helium-3 atoms have different magnetic behavior, collisions between surface helium-4 atoms and wandering helium-3 atoms no longer cause the same spin-flipping effect. The helium-3 superfluid transition temperature goes back to what they expect it would be in the absence of a magnetic field.

"I think the helium-3–aerogel system is very important," Parpia notes. He adds that studies of this system's unusual behavior are bound to provide new insights into the mechanisms underlying both superfluidity and superconductivity in a variety of materials. *— I. Peterson*

Colorectal cancer: To screen or not?

A simple, widely available blood test for colorectal cancer could save nearly 10,000 lives a year in the United States and thousands more worldwide, two new studies show—but only if more people use it.

Although the test is painless, many people find it repugnant because it requires them to supply a fecal sample for lab analysis. Still, doctors say, a little unpleasantness beats risking an untimely, agonizing death.

Colorectal cancer kills 55,000 people in the United States each year. The fecal occult blood test, often ordered by physicians for people over age 50, detects traces of blood shed by malignant bowel tissue. This enables doctors to diagnose and remove some tumors early, boosting a person's odds of survival. Still, because the test detects just one of every four tumors, doctors have questioned whether mass screening would improve overall survival.

Until now, just one controlled trial had addressed the effectiveness of large-scale screening. In that study of 46,551 people, Jack S. Mandel and his colleagues at the University of Minnesota in Minneapolis reported that screening reduces colorectal cancer mortality by one-third. But the study, published in the May 13, 1993 NEW ENGLAND JOURNAL OF MEDICINE, had a drawback. The researchers used a highly sensitive test that misses fewer cases of colorectal cancer, but yields more false positives, than the one generally available. Doctors then had to perform the more expensive, more invasive colonoscopy to confirm the presence of cancer.

The new studies, done in Nottingham, England, and Funen, Denmark, assessed the blood test now in common use, the researchers report in the Nov. 30 LANCET.

Jack D. Hardcastle and his colleagues at the University Hospital of Queens Medical Centre in Nottingham tested 44,838 symptomfree men and women age 45 to 74 at least once between 1981 and 1991. The researchers compared the percentage of deaths from colorectal cancer in this group with that in a group of 74,998 untested people. They found that 15 percent more people in the untested group died of the disease—and recommended that the United Kingdom consider routine screening for colorectal cancer.

In Funen, Ole Kronborg and his team at Odense University Hospital studied 30,966 people who had not been tested and 30,967 people who had. The volunteers ranged in age from 45 to 75. The researchers found that 18 percent more unscreened than screened people died of the disease. Kronborg also concludes that mass testing could be beneficial.

The American Cancer Society estimates that just one in four U.S. adults has had the test. To expand this pool, the nation should begin mass screening without waiting for "perfect tests," argue David Lieberman of the Oregon Health Sciences University in Portland and Marvin H. Sleisenger of the University of California, San Francisco in a LANCET editorial. The cost of such testing, however, would work out to $200,000 for each life saved, they note.

Efforts to develop more accurate tests are under way. Bert Vogelstein of Johns Hopkins Medical Institutions in Baltimore is working on a way to detect an altered version of the *ras* gene, which is shed in the feces of people with colorectal cancer. "Its mutations are particularly easy to detect," he says.

David Shibata of Harvard Medical School in Boston and his colleagues report in the Dec. 5 NEW ENGLAND JOURNAL OF MEDICINE that people whose tumors express the *DCC* (deleted in colon cancer) gene are more likely to survive than those whose tumors do not. Ultimately, they say, patients with better prospects might benefit most from aggressive therapy. *— S. Sternberg*