Physicists Solve Vortex Problem in Superconductors

Released: July 23, 1999
From: Cynthia Day

Latest headlines

Grad Student Earns Aquatic Scholarship

ND to Award 180 Degrees at Summer Commencement

Civil Engineering Receives Two Awards

Three Appointed to New Posts in College of Engineering

Longtime Laundry Director Retires

All news

A serious obstacle impeding the application of superconductor devices can be overcome by employing a common mechanism, the so-called "ratchet effect," according to a report by a team of in the July 22 publication of Nature.

According to Albert-Laszlo Barabasi, associate professor of physics at the University of Notre Dame and principal investigator, vortices - lines of trapped magnetic flux - dissipate energy and generate internal noise in superconductive devices. And unfortunately, they can be induced in such devices by fields as small as the Earth’s magnetic field.

Until now, many methods have been used to attempt to overcome the problem. But Barabasi argues that the most desirable method would be to remove vortices altogether from the bulk of the superconductor. Previously, though, there was no known way to do this. In the Nature article, Barabasi and his team propose applying an alternating current to a superconductor that has been patterned asymmetrically in a kind of sawtooth or ratchet-like pattern. The pattern, working in concert with the alternating current, directs the vortex away from the superconductive device.

According to Barabasi, the ratchet effect has been studied mainly in biological contexts, such as molecular motors, but other previous applications have included particle separators and smoothing surfaces in molecular beam epitaxy. In the report, Barabasi’s team demonstrates theoretically how this would work in low-temperature superconductors although the effect would be the same as well in high-temperature superconductors.

This solution is attractive because it does not require sophisticated material processing to make it work. "The patterning technology is rather standard," Barabasi says. "Similar patterning is done regularly during mass production conditions, such as in computer chip fabrication."

When AC current is not desired for specific applications AC current can be used to flush out vortices before the actual application begins, Barabasi explains. Otherwise, if the superconducting device is driven by alternating current for the desired application, the vortices will be eliminated continuously during the normal operation of the device.

Barabasi is traveling overseas for the remainder of the month but can be reached by email at alb@nd.edu. For information on how to reach Barabasi by telephone, call Cynthia Day at (219) 631-7367.