Finding Superconductors That Can Take the Heat

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By studying how superconductors interact with magnetic fields, Pitt researchers advance quest for higher-temperature superconducting materials.

Superconductors are materials with no electrical resistance that are used to make strong magnets and must be kept extremely cold-otherwise, they lose their superconducting abilities. Even the "high-temperature" superconductors discovered in the 1980s must be kept at around -300°F.

The search for superconductors that function at higher temperatures has taken a step forward with new findings from University of Pittsburgh professor of physics and astronomy Yadin Y. Goldschmidt and former Pitt postdoctoral associate Eduardo Cuansing that were published in the Oct. 21 issue of the journal *Physical Review Letters*.

When a superconductor is exposed to a magnetic field, the field penetrates it in the form of thin tubes, called vortices. Around each tube circulates an electric current. These vortices arrange themselves into patterns and melt when the temperature of the material is raised.

“This melting transition of the vortices is important, because it usually causes superconductivity to disappear,” said Goldschmidt. “It is thus beneficial to delay the full melting as much as possible.”

In addition to confirming previous experimental results, Goldschmidt and Cuansing used computer simulations of the vortex melting process to find, for the first time, direct evidence of new vortex patterns.

“Experimentalists can hardly see individual vortices,” said Goldschmidt. “But with our simulations, we can actually see a picture of what's going on inside the material.”

Since the vortices tend to attach to long, thin holes in the material, called columnar defects, the Pitt researchers suspected that the vortices would behave differently in the presence of such defects. And they did: When there were more vortices than holes, the vortex matter melted in two stages instead of one as the temperature was raised.

“Once physicists understand these melting mechanisms, they may be able to design materials that remain superconductors at higher temperatures,” Goldschmidt said.

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Source: