UCSD physicist pushes ahead in describing the "Pairing Glue' in novel superconducting materials

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UCSD PHYSICIST PUSHES AHEAD IN DESCRIBING THE 'PAIRING GLUE' IN NOVEL SUPERCONDUCTING MATERIALS

Dimitri Basov of the Department of Physics at the University of California, San Diego, along with collaborators J.P. Carbone of McMaster University and E. Schachinger of the University of Graz, has shed new light on one of the cornerstones of contemporary physics: finding ways to describe the fundamental mechanisms behind superconductivity in oxide superconductors, the materials that lose resistance to electricity at unusually high temperature.

Superconductors hold the alluring ability to conduct electrical currents without resistance, in contrast to currently used metallic wires, and hence offer a unique ability to conserve energy and money.

"High-temperature" superconductors, discovered 12 years ago, were hailed as a more viable technology because they lose resistance at temperatures well above the levels of ordinary superconducting metals, such as lead and aluminum. High temperature superconductors are complex intermetallic compounds based on the oxide of copper, or cuprates. They exhibit the ability to conduct electrical current without losses at temperatures approaching the coldest temperatures on Earth and well above the temperatures of the ordinary elemental superconductors. Over the last 12 years scientists have actively pursued the mechanisms behind high-temperature superconductivity, publishing more than 44,000 articles on this subject in refereed journals.

In the September 23 issue of the journal Nature, Basov and his collaborators describe a novel approach towards the analysis of the optical properties of high-temperature superconductors. The approach provides clues about the nature of electron pairing the basis for loss-less conduction.

In superconductors, electrons bind in pairs that are capable of propagating without resistance. On the contrary, unpaired electrons in wires made out of ordinary metals are subject to scattering.

The search for the mechanisms behind superconductivity has become the search for the strong "glue" that keeps electrons bonded in pairs.

Furthermore, the possibility of studying the pairing phenomenon through optical means was unclear.

"It had been unclear whether one could obtain this particular information about the coupling through optical experiments, but this paper proves that we can," said Basov, an assistant professor of physics at UCSD. "Now that we know that we can derive information from optics, we can begin to look at different types of high-temperature superconductors. If this is a generic effect, then it should be repeatable."

Basov's experiments employed state-of-the-art optical instruments that he and his students have developed at UCSD. The researchers were able to observe the coupling behavior by studying optical properties in frequencies that spanned from microwave through the infrared range to ultraviolet light.

Basov hopes that by pinpointing the mechanisms responsible for high-temperature superconductivity, scientists may be able to develop novel materials for specific purposes, including satellite communications and other areas.

The history of superconductivity goes back to earlier this century when Dutch physicist Haike Kamerlingh Onnes discovered the phenomenon by cooling metallic mercury to minus 452 degrees Fahrenheit. High-temperature superconduction has been achieved at nearly minus 170 degrees Fahrenheit.

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