Communications

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News Release

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High-temperature superconductors: magnetic glue may be the clue

Striking pictures of magnetic waves inside advanced ceramics may be the clue to understanding how they can transmit electricity without losing energy, according to results obtained by two teams of scientists using the UK's world-leading ISIS neutron source in Oxfordshire and published this week in the journal *Nature*.

The ceramics, known as high-temperature superconductors, lose all resistance to the flow of electricity when cooled below a critical temperature. Wires made from the ceramics can conduct up to 140 times more power than conventional copper wires of the same dimension, carrying current with 100% efficiency. Yet despite their growing use in applications ranging from medical imaging scanners to revolutionary propulsion systems, just exactly how they work remains a mystery.

What is astonishing in the results of the two research teams led by Professor Stephen Hayden at the University of Bristol in the United Kingdom, and Dr. John Tranquada at the US Department of Energy's Brookhaven National Laboratory, is the almost identical data obtained

…more (HTsuperconductors)

from their two different ceramics. Electric current is carried most efficiently in the materials when the electrons are 'glued' into pairs. Both teams believe they have observed the fingerprint of what might be the binding glue.

"Without the unique capabilities of the MAPS experiment at the ISIS neutron source these observations would have been impossible," said Dr Toby Perring, Project Scientist for the MAPS instrument at the Rutherford Appleton Laboratory, and a co-author on both of the Nature papers. ***"The 100 million detector pixels gives an unmatched clarity of vision into the interior world of superconductors."***

"The results suggest that the glue may be due to very weak magnetism associated with embedded copper atoms. The electrons appear to be bound together by a sort of magnetic glue," explained Stephen Hayden.

Whilst the results will cut a swathe through the huge number of competing explanations in existence, each team is currently backing their own favourites, and the impact of their results will certainly be intensely debated.

"We definitely expect some controvers," says John Tranquada from the Brookhaven team, ***"because our data suggest that some popular ideas are wrong."***

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Notes for editors

1. MAPS is a revolutionary instrument for neutron spectroscopy at the ISIS neutron source, at the CCLRC Rutherford Appleton Laboratory. Using the technique of neutron scattering, an intense beam of neutrons is scattered from samples of research material and collected by 100 million detector pixels located over an area of 20 square metres. By measuring changes to the neutron speeds as they travel through the instrument, exchanges of energy between the neutrons and the research material can be measured and related to changes occurring at an atomic level.
2. ISIS, the world's leading pulsed neutron source, is located at CCLRC Rutherford Appleton Laboratory in Oxfordshire. ISIS supports an international community of around 1600 scientists, who use neutrons for research in physics, chemistry, biology, materials science, geology and engineering. A £100 million expansion of ISIS through the building of a Second Target Station was announced in April 2003 by the Science Minister Lord Sainsbury, and is scheduled for completion in 2008. On December 16th 2004, ISIS will celebrate 20 years of world-leading science.
3. CCLRC (Council for the Central Laboratory of the Research Councils) owns and operates three research laboratories in the UK – the Rutherford Appleton Laboratory in Oxfordshire, the Daresbury Laboratory in Cheshire and the Chilbolton Observatory in Hampshire – with science research programmes spanning a wide range of topics in science, engineering and technology. It is the UK's strategic agency for large scale neutron, muon, synchrotron and high power laser facilities.

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