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What's New in the World of Superconductivity (June)

Shinya Hasuo, Director
Superconductivity Research Laboratory, ISTEC

Medical

Luvata (June 28, 2011)

Luvata has announced the expansion of its Magnetic Resonance Imaging (MRI) superconducting wire and cable business in Zhongshan, China. The new facility will be housed in a newly leased 50,000 square foot building dedicated to the manufacture of superconducting wire and cable for MRI applications. Equipment installation in the new facility should be completed before the end of 2011, and production is expected to being during the first quarter of 2012. John Peter Leesi, CEO of Luvata, commented, "Luvata's superconductor expansion in Zhongshan, China is one more example of our strategy to focus on emerging markets and technology-driven, high value-added products and solutions. We are committed to our partners and to growing the availability of the latest MRI technology worldwide. Over the next five years, we plan to double our sales of MRI superconducting wire." Luvata expects the global MRI market to grow by 6 % annually, with a significant proportion of sales originating in developing countries and in India and China.

Source:
"Luvata announces plans to double its sales of MRI superconducting wire and cable"
Luvata press release (June 28, 2011)
http://www.luvata.com/en/News-Room/Press-Releases/Luvata-announces-plans-to-double-its-sales-of-MRI-superconducting-wire-and-cable/

Quantum Computer

Columbia University and Consiglio Nazionale delle Ricerche (June 7, 2011)

Researchers from Columbia Engineering, the Italian National Research Council, Princeton University, the University of Missouri, and the University of Nijmegen (Netherlands) have developed an artificial semiconductor structure with a superimposed pattern created on a nanometer scale using advanced fabrication methods. The pattern is similar to the honeycomb lattice that occurs in graphene, and the device has consequently been named "artificial graphene" (AG). The device can be used to simulate the quantum behavior of strongly interacting electrons and may be a first step towards the realization of an innovative class of solid-state quantum simulators that could be used to explore fundamental quantum physics, including the complex interactions that underlie superconductivity. In a "first run" trial of the AG device, an unexpected peculiar quantum state was generated; this trial produced promising data and suggested the

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great potential of the device. The group's work has been reported in Science.
Source:
"Innovative device for quantum simulations"
Columbia University press release (June 7, 2011)
http://engineering.columbia.edu/innovative-device-quantum-simulations
"Nuove soluzioni per la simulazione quantistica"
Consiglio Nazionale delle Ricerche press release (June 7, 2011)
http://www.cnr.it/cnr/news/CnrNews?IDn=2240

Accelerator

CERN (June 5, 2011)

CERN has reported the successful trapping of antimatter atoms for longer than 16 minutes—long enough to begin studying their properties in detail. The trapping of the antimatter atoms was part of the APLHA experiment that is presently being conducted at CERN. Approximately 300 antiatoms were trapped for 1000 seconds; this trapping will enable antihydrogen to be mapped precisely using laser or microwave spectroscopy and compared to hydrogen atoms. The present results were published online in Nature Physics.

The trapping of antiatoms may also provide a complementary approach to measuring the influence of gravity on antimatter, a topic that will soon be investigated using antihydrogen in the AEgIS experiment. Additionally, the trapping of antiatoms for long periods, allowing the antiatoms to relax into their ground state, will enable precise measurements necessary to investigate a symmetry known as CPT.

The next step in the ALPHA experiment will be to begin performing measurements on trapped antihydrogen.

Source:
"CERN experiment traps antimatter atoms for 1000 seconds"
CERN press release (June 5, 2011)
http://press.web.cern.ch/press/PressReleases/Releases2011/PR05.11E.html

CERN (June 17, 2011)

CERN has announced that the ATLAS and CMS experiments underway at the LHC have achieved an important milestone: the collection of 1 inverse femtobarn of data. The number signifies a quantity physicists call "integrated luminosity", which is a measure of the total number of collisions produced. One inverse femtobarn is equivalent to around 70 million million collisions. The collection of one inverse femtobarn of data was set as the target for 2011; its achievement after only three months of operation indicates how well the LHC is running. Fabiola Gianotti, spokesperson for the ATLAS experiment, commented, "This is a superb achievement, which demonstrates the outstanding performance of the accelerator and of the operation team. It's really great to have such a large amount of data in time for the main summer conferences. The ATLAS physicists, in particular students and post-docs, are working hard and with great enthusiasm to produce exciting results, from precise measurements of the known particles to searches for the Higgs boson and other new phenomena."

Source:
"LHC achieves 2011 data milestone"

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CERN press release (June 17, 2011)
http://press.web.cern.ch/press/PressReleases/Releases2011/PR06.11E.html

Basic

Brookhaven National Laboratory (June 10, 2011)

Researchers at the U.S. Department of Energy's Brookhaven National Laboratory, in collaboration with the Paul Scherrer Institute (Switzerland), have reported that in ultrathin slabs of copper oxide materials at low temperatures, the thinnest, isolated layers lose their long-range magnetic order and behave like a "quantum spin liquid"—a state in which electron spin orientations fluctuate widely. This unexpected discovery may support the hypothesis that this novel condensed state of matter is a precursor to high-temperature superconductivity. Ivan Bozovic, a physicist at Brookhaven, explained the research as follows: "The crystal structure of lanthanum-copper-oxide is layered; it consists of parallel copper-oxide and lanthanum-oxide sheets. The interaction among the spins within one copper-oxide plane is strong, while their interaction with the spins in the nearest copper-oxide plane (about 0.66 nanometers away) is ten thousand times weaker. Still, this weak interaction between layers may be sufficient to suppress fluctuations and stabilize the anti-ferromagnetic order." The group used a specialized atomic-layer-by-layer molecular beam epitaxy method to assemble lanthanum-copper-oxide samples with varying numbers of layers of precisely controlled thickness. These samples were then examined using low-energy muon spin spectroscopy to detect and investigate magnetism in the ultrathin layers. The results showed that samples with four or more copper-oxide layers exhibited anti-ferromagnetic ordering but that thinner slabs containing only one or two copper-oxide layers produced unexpected results: "While the magnetic moments, or spins, were still present and had about the same magnitude, there was no long-range static anti-ferromagnetic order, not even on the scale of a few nanometers. Rather, the spins were fluctuating wildly, changing their direction very fast." This effect was stronger at lower temperatures, indicating that the fluctuations were of quantum origin, not a thermal origin. Bozovic concluded, "Altogether, this experiment indicates that once a copper-oxide plane is well isolated and not interacting with other such layers, it in fact seems to behave, at low temperature, like some sort of quantum spin liquid." The group's research, which was published online in Physical Review Letters, may lead to a deeper understanding of the physics of high-temperature superconductivity and contribute to the quest for new and better superconductors.
Source:
"Ultrathin copper-oxide layers behave like quantum spin liquid"
Brookhaven National Laboratory press release (June 10, 2011)
http://www.bnl.gov/bnlweb/pubaf/pr/PR_display.asp?prID=1294

University of Buffalo (June 13, 2011)

Two chemists at the University of Buffalo have proposed an alternative to shock-wave methods for the metallization of hydrogen: by adding sodium to hydrogen, it may be possible to convert the compound into a superconducting metal under significantly lower pressures. Using an open-source computer program (XtalOpt) to determine stable geometries or crystal structures for solids, the two chemists have been searching for sodium polyhydrides that would be viable superconductor candidates under pressure. As a result, NaH9 was predicted to become metallic at about 250 gigapascals (an experimentally achievable pressure). Eva Zurek, an assistant professor at the University of Buffalo and one of the two chemists

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involved in the research, commented, "…if one could potentially metallize hydrogen using the addition of sodium, it could ultimately help us better understand superconductors and lead to new approaches to designing a room-temperature superconductor." The present theory was published in the June 10 issue of Physical Review Letters.

Source:
"Under pressure, sodium, hydrogen could undergo a metamorphosis, emerging as superconductor"
University of Buffalo press release (June 13, 2011)
http://www.buffalo.edu/news/12644

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