Future nanoelectronics may face obstacles

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(PhysOrg.com) -- Combining ordinary electronics with light has been a potential way to create minimal computer circuits with super fast information transfer. Researchers at Umeå University in Sweden and the University of Maryland in the U.S. are now showing that there is a limit. When the size of the components approaches the nanometer level, all information will disappear before it has time to be transferred.

“Our findings throw a monkey wrench in the machinery of future nanoelectronics. At the same time, it’s a fascinating issue to address just how we might be able to prevent the information from being lost,” says Mattias Marklund, professor of theoretical physics at Umeå University in Sweden.

The electronics we know in our computers today is, as the name suggests, based on the transfer of information with the help of electrons. Using electrons has allowed us to shrink the size of computer circuits without losing efficacy. At the same time, communication with the help of electrons represents a rather slow means of transmission.

To alleviate this problem, light can be used instead of electrons. This is the basis of so-called photonic components. While the transfer speed in photonics is extremely high, the size of the components cannot be shrunk to the same level as ‘ordinary’ electronics.

For a number of years, so-called plasmonic components have proven to be a possible way around the dilemma of electronics and photonics. By combining photonics and electronics, scientists have shown that

information can be transferred with the help of so-called plasmons. Plasmons are surface waves, like waves in the ocean, but here consisting of electrons, which can spread at extremely high speeds in metals.

The findings now being presented by the Swedish-American research team show that difficulties arise when the size of such components is reduced to the nanometer level. At that point it turns out that the dual nature of electrons makes itself felt: the electrons no longer act like particles but rather have a diffuse character, with their location and movement no longer being clearly defined. This elusive personality leads to the energy of the plasmon being dissipated and lost in the transfer of information. For nanocomponents, this consequence is devastating, entailing the loss of all information before it can be transferred.

“The effects we have discovered cannot be fully avoided, but the behavior of the plasmons might nevertheless be controlled by meticulous component design that takes into consideration the quantum nature of the nanoscale. It’s our hope that continued research will provide a solution to this problem,” says Mattias Marklund.

Citation: The findings are presented in the September issue of the journal *Europhysics Letters*. New quantum limits in plasmonic devices; M. Marklund, G. Brodin, L. Stenflo and C. S. Liu. See also arxiv.org/pdf/0712.3145 .

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