Research reveals vital insight into spintronics

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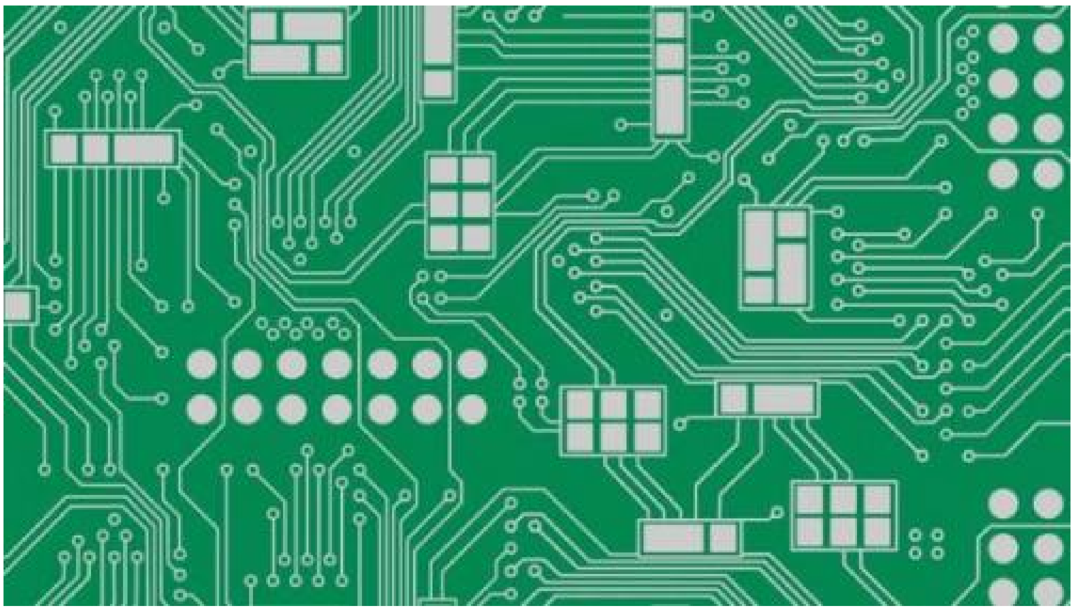

(PhysOrg.com) -- Progress in electronics has relied heavily on reducing the size of the transistor to create small, powerful computers. Now spintronics, hailed as the successor to the transistor, looks set to transform the field.

Scientists have taken one step closer to the next generation of computers. Research from the Cavendish Laboratory, the University of Cambridge's Department of Physics, provides new insight into spintronics, which has been hailed as the successor to the transistor.

Spintronics, which exploits the electron's tiny magnetic moment, or 'spin', could radically change computing due to its potential of high-speed, high-density and low-power consumption. The new research sheds light on how to make 'spin' more efficient.

For the past fifty years, progress in electronics has relied heavily on the downsizing of the transistor through the semiconductor industry in order to provide the technology for the small, powerful computers that are the basis of our modern information society. In a 1965 paper, Intel co-founder Gordon E. Moore described how the number of transistors that could be placed inexpensively on an integrated circuit had doubled every year between 1958 and 1965, predicting that the trend would continue for at least ten more years.

That prediction, now known as Moore's Law, effectively described a trend that has continued ever since, but the end of that trend—the moment when transistors are as small as atoms, and cannot be shrunk any further—is expected as early as 2015. At the moment, researchers are seeking new concepts of electronics that sustain the growth of computing power.

Spintronics research attempts to develop a spin-based electronic technology that will replace the charge-based technology of semiconductors. Scientists have already begun to develop new spin-based electronics, beginning with the discovery in 1988 of giant magnetoresistance (GMR) effect. The discovery of GMR effect brought about a breakthrough in gigabyte hard disk drives and was also key in the development of portable electronic devices such as the iPod.

While conventional technology relies on harnessing the charge of electrons, the field of spintronics depends instead on the manipulation of electrons' spin. One of the unique properties in spintronics is that spins can be transferred without the flow of electric charge currents. This is called "spin current" and unlike other concepts of harnessing electrons, the spin current can transfer information without generating heat in electric devices. The major remaining obstacle to a viable spin current technology is the difficulty of creating a volume of spin current large enough to support current and future electronic devices.

However, the new Cambridge researchers in close collaboration with Professor Sergej Demokritov group at the University of Muenster, Germany, have, in part, addressed this issue. In order to create enhanced spin currents, the researchers used the collective motion of spins called spin waves (the wave property of spins). By bringing spin waves into interaction, they have demonstrated a new, more efficient way of generating spin current.

Dr Hidekazu Kurebayashi, from the Microelectronics Group at the Cavendish Laboratory, said: "You can find lots of different waves in nature, and one of the fascinating things is that waves often interact with each other. Likewise, there are a number of different interactions in spin waves. Our idea was to use such spin wave interactions for generating efficient spin currents."

According to their findings, one of the spin wave interactions (called three-magnon splitting) generates spin current ten times more efficiently than using pre-interacting spin-waves. Additionally, the findings link the two major research fields in spintronics, namely the spin current and the spin wave interaction.

More information: "Controlled enhancement of spin-current emission by three-magnon splitting" by H. Kurebayashi et al. *Nature Materials* (2011).

Provided by University of Cambridge