Published online 9 October 2007 | Nature | doi:10.1038/449643a

News

# The physics prize inside the iPod

**Giant magnetoresistance secures Nobel.**

Geoff Brumfiel

Spin doctors: Peter Grünberg (left) and Albert Fert.

*TORU YAMANAKA/AFP/Getty Images*

Two researchers who discovered an effect that has dramatically shrunk the size of magnetic storage devices have won the 2007 Nobel Prize in Physics.

Albert Fert of the University of Paris-South in France and Peter Grünberg of Jülich Research Centre in Germany split the prize for their 1988 discovery of an effect called giant magnetoresistance (GMR). The Royal Swedish Academy of Sciences announced the award on 9 October in Stockholm.

The effect has been heralded as one of the first major applications of the fields of nanotechnology and 'spintronics'.

"I am so proud and so happy," Fert said in a press conference via telephone from France. "Science is something marvellous."

At the heart of GMR are the spins of electrons, which generate a magnetic field and can be aligned either up or down. An electron can easily pass through a material whose electrons are similarly aligned, but will encounter resistance when it passes through one with electrons aligned in the opposite direction.

Fert and Grünberg discovered the effect independently of each other using multiple layers of magnetic and non-magnetic materials only tens of nanometres thick. When all the layers were aligned in the same direction, say 'up', electrons with the same alignment passed through the material easily, whereas those with the opposite alignment struggled. But when the layers were organized in an alternating 'up-down' alignment, all electrons encountered resistance. The net effect was a rise in resistance that was much bigger than any seen before — hence 'giant'.

This led to devices that are very sensitive to tiny magnetic fields. A hard disc drive stores bits on its surface as a pattern of magnetic fields. Until the discovery of GMR, hard discs used metal induction coils to read out the data. But the laws of induction meant that the coils, and thus the bits, had to be quite large. GMR opened up a way to build much smaller magnetic heads, says Claude Chappert of the University of Paris-South. The discovery revolutionized consumer electronics. "I think this triggered the common use of MP3 players," he notes.

By the end of the 1990s, the technology had become standard across the electronics industry, thanks partly to the work of physicist Stuart Parkin at IBM's Almaden

Research Center in San Jose, California, who came up with a simple way to create the thin multilayers. Although Parkin has shared physics prizes for GMR with Fert and Grünberg in the past, he was not included in the Nobel announcement. Parkin conducted vital work that allowed the effect to be commercialized, but Fert and Grünberg were the ones who discovered it, says Tony Bland, from the University of Cambridge, UK. "I think the field will generally see this as fair," he adds.



Storing information is not the only application, says Fert. The discovery has also opened the door to the possibility of 'spintronics', the idea of using electrons' spins, as well as their charge, in electronic devices. Spintronics could soon lead to random-access memory that remains stable even without power, securing data and allowing some computers to start up more quickly, says Bart van Wees of Groningen University in the Netherlands. It could also create new ways for fibre-optic systems and conventional semiconductors to talk to each other.

Even further out is the possibility of processing information using spin, rather than electrical current. Although still highly speculative, Chappert says, such a computer could run faster and on much lower power than existing devices. "Spintronics could bring a lot."

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Posted by: **Jutta Hoffmann** | 09 Oct, 2007

Dual-element magnetoresistive (MR) heads (not GMR) began replacing single-element inductive coils for the read-sensor function in commercial hard-disk drive heads in 1991. (A 1-gigabit/inch**2 demonstration of an MR head was made public by IBM Reseeach in late 1988.) Making the MR element smaller -- to achieve higher data-storage densities -- began to reach practical limitations at about 5 gigbits/inch**2, and multilayer GMR elements began replacing the MR sensor in late 1997. The GMR head has enabled the tremendous increases in data-storage capacities that we enjoy today -- many gigabytes (and beyond) rather than mere megabytes. The creativity and doggedness of Stuart Parkin and his many IBM colleagues turned Fert and Gruenberg's wonderful discovery from a cryogenic, high-field, slow-and-expensive-to-make (i.e. molecular beam epitaxy) lab phenomenon into the room-temperature, low-field, rapidly made (i.e. sputtering) that commercial use demands. Hail to them all for their critical roles in helping to creating today's digital wonderland!

Posted by: **Michael Ross** | 09 Oct, 2007