

The Moti Lal Rustgi Memorial Lecture

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The Spin on Electronics!

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Today, nearly all microelectronic devices are based on storing or flowing the electron's charge. The electron also possesses a quantum mechanical property termed "spin", that gives rise to magnetism. Electrical current is comprised of "spin-up" and "spin-down" electrons, which behave as largely independent spin currents. The flow of these spin currents can be controlled in thin-film structures composed of atomically thin layers of conducting magnetic materials separated by non-magnetic conducting or insulating layers. The resistance of such devices, so-called spin-valves and magnetic tunnelling junctions, respectively, can be varied by controlling the relative magnetic orientation of the magnetic layers, giving rise to magneto-resistance tailored for different applications. Recent advances in generating, manipulating and detecting spin-polarized electrons and electrical current make possible new classes of spin based sensor, memory and logic devices, generally referred to as the field of *spintronics*. In particular, the spin-valve is a key component of all magnetic hard-disk drives manufactured today and enabled their nearly 1,000-fold increase in capacity over the past seven years¹. The magnetic tunnel junction allows for a novel, high performance random access solid state memory which maintains its memory in the absence of electrical power. The respective strengths of these two major classes of digital data storage devices, namely the very low cost of disk drives and the high performance and reliability of solid state memories, may be combined in the future into a single spintronic memory-storage technology, the magnetic racetrack. We discuss the future of spintronic devices including, for example, the possibility of the life recorder, a device that could record everything you see or hear throughout your lifetime².

1. Stuart Parkin et al., *Magnetically engineered spintronic sensors and memory*. Proc. IEEE **91**, 661-680 (2003).
2. Kevin Maney, "Every move you make could be stored on a PLR", US Today, September 8, 2004.

Information on all of the Rustgi Lectures and on Professor Rustgi and Dr. Parkin can be found at <http://www.physics.buffalo.edu/talks/Rustgi-Lectures.html> .