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David Adler Lectureship Award in the Field of Materials Physics: Racetrack Memory - a high-performance, storage class memory using magnetic domain-walls manipulated by current

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Racetrack Memory is a novel high-performance, non-volatile storage-class memory in which magnetic domains are used to store information in a "magnetic racetrack" [1]. The magnetic racetrack promises a solid state memory with storage capacities and cost rivaling that of magnetic disk drives but with much improved performance and reliability: a "hard disk on a chip". The magnetic racetrack is comprised of a magnetic nanowire in which a series of magnetic domain walls are shifted to and fro along the wire using nanosecond-long pulses of spin polarized current [2]. We have demonstrated the underlying physics that makes Racetrack Memory possible [3,4] and all the basic functions - creation, and manipulation of a train of domain walls and their detection. The physics underlying the current induced dynamics of domain walls will also be discussed. In particular, we show that the domain walls respond as if they have mass, leading to significant inertial driven motion of the domain walls over long times after the current pulses are switched off [3]. We also demonstrate that in perpendicularly magnetized nanowires there are two independent current driving mechanisms: one derived from bulk spin-dependent scattering that drives the domain walls in the direction of electron flow, and a second interfacial mechanism that can drive the domain walls either along or against the electron flow, depending on subtle changes in the nanowire structure. Finally, we demonstrate thermally induced spin currents are large enough that they can be used to manipulate domain walls.

[1] S.S.P. Parkin, US Patent 6,834,005 (2004); S.S.P. Parkin et al., Science 320, 190 (2008); S.S.P. Parkin, Scientific American (June 2009).

[2] M. Hayashi, L. Thomas, R. Moriya, C. Rettner and S.S.P. Parkin, Science 320, 209 (2008).

[3] L. Thomas, R. Moriya, C. Rettner and S.S.P. Parkin, Science 330, 1810 (2010).

[4] X. Jiang et al. Nat. Comm. 1:25 (2010) and Nano Lett. 11, 96 (2011).