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The Spin Torque Lego - from spin torque nano-devices to advanced computing architectures¹

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Spin transfer torque (STT), predicted in 1996 [1], and first observed around 2000, brought spintronic devices to the realm of active elements. A whole class of new devices, based on the combined effects of STT for writing and Giant Magneto-Resistance or Tunnel Magneto-Resistance for reading has emerged. The second generation of MRAMs, based on spin torque writing : the STT-RAM, is under industrial development and should be out on the market in three years. But spin torque devices are not limited to binary memories. We will rapidly present how the spin torque effect also allows to implement non-linear nano-oscillators, spin-wave emitters, controlled stochastic devices and microwave nano-detectors. What is extremely interesting is that all these functionalities can be obtained using the same materials, the exact same stack, simply by changing the device geometry and its bias conditions. So these different devices can be seen as Lego bricks, each brick with its own functionality. During this talk, I will show how spin torque can be engineered to build new bricks, such as the Spintronic Memristor, an artificial magnetic nano-synapse. I will then give hints on how to assemble these bricks in order to build novel types of computing architectures, with a special focus on neuromorphic circuits.

[1] J. C. Slonczewski, J. Magn. Mater. 159, 1 (1996) & L. Berger, Phys. Rev. B 54, 9353 (1996)

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