PHYSICS COLLOQUIUM

DR. MARK STILES

NIST, GAITHERSBURG MD

ENERGY-EFFICIENT NEUROMORPHIC COMPUTING WITH MAGNETIC TUNNEL JUNCTIONS

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Human brains can solve many problems with orders of magnitude more energy efficiency than traditional computers. As the importance of such problems, like image, voice, and video recognition increases, so does the drive to develop computers that approach the energy efficiency of the brain. Magnetic devices, especially tunnel junctions, have several properties that make them attractive for such applications. Their conductance depends on the state of the ferromagnets making it easy to read information that is stored in their magnetic state. In addition, the spin current can manipulate the magnetic state. Based on this electrical control of the magnetic state, magnetic tunnel junctions are actively being developed for integration into CMOS integrated circuits to provide non-volatile memory. This development makes it feasible to consider other geometries that have different properties. I describe computing primitives that have been constructed based on the different functionalities of magnetic tunnel junctions. The first group of these uses tunnel junctions in their superparamagnetic state for a population coding scheme or for stochastic computing. The second uses them as non-linear oscillators in the first nanoscale "reservoir" for reservoir computing.

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