Electronic mechanism of conductance and spin-transfer torque in magnetic tunneling junctions

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The reading of stored information by means of magnetic tunneling junctions (MTJs) having composition FeCoB/MgO/FeCoB lies at the cutting edge of commercial magnetic storage technology. Also, both reading and writing with such junctions dominate advanced laboratory exploration of magnetic random access memory. I will show how a coherent theory explains the results of experimental measurements of magnetoresistance and current-driven spin transfer torque.

The torque measurements, performed by an IBM/Cornell collaboration, use the method of spin-transfer-excited ferromagnetic resonance. It measures well spin-transfer torque versus angle without requiring large-amplitude excitation of the free magnet. My theory mutually relating the torque to magnetoresistance requires little mathematics and no computation. It expresses both differential conductance and differential in-plane torque together in terms of one set of 4 voltage-dependent parameters which embrace both elastic and inelastic tunneling terms. It explains quantitatively why the anti-parallel differential conductance G_{ap} increases strongly with voltage V, while the corresponding torque effect is constant, for $|V|<400$ mV. A qualitative argument explains how inelastic tunneling due to Coulomb correlations may explain this voltage-dependence of G_{ap}.

9.7 cm

13.4 cm

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