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Enhancement of AMR in Permalloy Point Contacts due to Quantum Interference.

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We measure the low-temperature resistance of mechanically-stable permalloy break junctions as a function of contact size and the magnetic field angle in applied fields large enough to saturate the magnetization. We show that the size of the anisotropic magnetoresistance (AMR) signal at low temperature can increase dramatically as the contact cross section is narrowed to the nanometer-scale regime. For metallic devices with R larger than ~ 1 kΩ we observe AMR effects larger than in bulk devices, with an angular variation that can deviate from the sinusoidal bulk dependence, and which are associated with fluctuations in dV/dI of similar magnitude as a function of V. Even more strikingly, we find that point contacts which are completely broken, so as to enter the tunneling regime, also exhibit a tunneling anisotropic magnetoresistance effect (TAMR) as large as 25% when the magnetic-moment directions in the two contacts are rotated together while remaining parallel. We propose that these large AMR and TAMR effects are the result of mesoscopic quantum interference which depends on the orientation of the magnetization, leading to fluctuations of conductance and the spin-dependent local density of states. These fluctuations should affect a broad variety of nanoscale devices that contain magnetic components, producing strong perturbations in measurements of low-temperature spin-dependent transport. This work was done in collaboration with F. Kuemmeth and D. C. Ralph.