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Magnetic field asymmetry and high temperature magnetoresistance in single-walled carbon nanotubes

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The length scales and scattering processes in the one-dimensional electron system in single-walled carbon nanotubes remain only partially understood. Measuring the magnetoresistance, in both linear and nonlinear response, is a way to investigate these processes. In disordered nanotubes with ballistic paths much shorter than the length, we observe magnetoresistance in the metallic regime which at low temperatures resembles the universal fluctuations and weak localization seen in higher dimensional metals. A parabolic magnetoresistance persists at room temperature, indicating a significant role for phase coherence and/or interactions at high temperatures. While the linear resistance of a two-terminal sample must be an even function of magnetic field B by Onsager's principle, the nonlinear resistance need not be. Importantly, the B-asymmetric nonlinear terms can in principle be used to infer the strength of electron-electron interactions in the sample [1]. We have therefore also measured in detail the lowest order B-asymmetric current contributions, with a focus on the B-linear term. This has apparently not been done before in any system. Consistent with general theory, at high temperatures the term is small and has a constant sign independent of Fermi energy. At low temperatures it grows and develops mesoscopic fluctuations. Although these result imply that interactions are involved in the transport, calculations specific to nanotubes are needed in order to extract interaction parameters. This work was done by the authors of Ref [2]. *References:* [1] E.L. Ivchenko and B. Spivak, Phys. Rev. B 66, 155404 (2002); [2] Jiang Wei, Michael Shimogawa, Zenghui Wang, Iuliana Radu, Robert Dormaier, and David H. Cobden, Phys. Rev. Lett. (Dec. 2005) (cond-mat/0506275).