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The Aharonov-Bohm Interference and Beating in Single-Walled Carbon Nanotube Interferometers JIEN CAO, Stanford University, QIAN WANG, Stanford University, HONGJIE DAI — A hallmark of the Aharonov-Bohm (AB) effect is conductance oscillations of metallic rings or cylinders as a function of enclosed magnetic flux with a period on the order of the flux quantum $\Phi_0 = h/e$ due to quantum interference. Carbon nanotubes are chemically derived cylinders with atomically well-defined structures. Multi-walled nanotubes (MWNT) have radius $r \sim 10$ nm and in magnetic fields parallel to the tube axis, conductance modulations with a period of $B_0 = \Phi_0 / \pi r^2 \sim 10$T in magnetic field have been seen. Single-walled nanotubes (SWNT) are ultra-small with $r \sim 1$ nm and the magnetic field needed to approach $1\Phi_0$ flux through the nanotube cross section is $B_0 \sim 1000$T, far beyond reach by experiments. We show here that in the Fabry-Perot interference regime, beating in the AB-interference between two modes of spiraling electrons with non-degenerate wave-vectors causes conductance modulations under fields much smaller than that needed to reach $1\Phi_{0.}$ Single-walled nanotubes hence represent the smallest cylinders exhibiting the AB effect with rich interference and beating phenomena arising from well-defined molecular orbitals reflective of the nanotube chirality. The observation of quantum beats for the AB effect is to our knowledge unprecedented in mesoscopic systems and is a result of well-defined molecular orbitals of nanotubes in magnetic fields.

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