Room temperature manipulation of long lifetime spins in metallic-like carbon nanospheres

Full Title

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Abstract

The time-window for processing electron spin information (spintronics) in solid-state quantum electronic devices is determined by the spin-lattice (T_1) and spin-spin (T_2) relaxation times of electrons. Minimising the effects of spin-orbit coupling and the local magnetic contributions of neighbouring atoms on T_1 and T_2 at room temperature remain substantial challenges to practical spintronics. Here, we report a record-high conduction electron T_1=T_2 of 175 ns at 300 K in 37 nm ± 7 nm carbon spheres, which exceeds by far the highest values observed for any conducting solid state material of comparable size. The long T_1=T_2 is due to quantum confinement effects, to the intrinsically weak spin-orbit coupling of carbon, and to the protecting nature of the outer shells of the inner spins from the influences of environmental disturbances. Following the observation of spin polarization by electron spin resonance, we controlled the quantum state of the electron spin by applying short bursts of an oscillating magnetic field and observed coherent oscillations of the spin state. These results demonstrate the feasibility of operating electron spins in conducting carbon nanospheres as quantum bits at room temperature.