Persistent currents in single and multiwall carbon nanotubes

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Persistent currents driven by the static magnetic field parallel to the nanotube axis are investigated. In singlewall nanotube due to the hexagonal symmetry of graphene the Fermi surface reduces to a set of points. However the electron or hole doping shifts the Fermi surface upwards or downwards and, as a result, the shape of the Fermi surface changes. We show that this shift influences strongly the persistent currents and discuss the possible currents for zigzag as well as for armchair nanotubes. In multiwall nanotubes the currents are a superposision of currents from different shells having in general different chiralities. In many configurations the currents are small and/or add destructively, resulting in a small net current. Nevertheless it is possible to find such configurations that persistent currents are both large and add coherently so the resulting current is strongly enhanced. We perform some model calculations showing that the multiwall nanotubes with different optimal configurations can exhibit the partial flux expulsion or a small spontaneous flux at Kelvin temperatures. It seems that these properties of carbon nanotubes may have promissing applications in nanoelectronics, e.g. in magnetic sensors and logical circuits and memory storage devices.

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