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Helical modes and Majorana fermions in carbon nanotubes JELENA KLINOVAJA, MANUEL SCHMIDT, BERND BRAUNECKER, DANIEL LOSS, Department of Physics, University of Basel — We derive an effective low-energy theory for metallic (armchair and nonarmchair) single-wall nanotubes in the presence of an electric field perpendicular to the nanotube axis, and in the presence of magnetic fields, taking into account spin-orbit interactions and screening effects on the basis of a microscopic tight-binding model [1,2]. The interplay between electric field and spin-orbit interaction allows us to tune armchair nanotubes into a helical conductor in both Dirac valleys. Metallic nonarmchair nanotubes are gapped by the surface curvature, yet helical conduction modes can be restored in one of the valleys by a magnetic field along the nanotube axis. If in proximity with a superconductor, helical modes give rise to Majorana bound states. Furthermore, we discuss electric dipole spin resonance in carbon nanotubes, and find that the Rabi frequency shows a pronounced dependence on the momentum along the nanotube.

[1] J. Klinovaja, M. Schmidt, B. Braunecker, and D. Loss, Phys. Rev. Lett. 106, 156809 (2011).
[2] J. Klinovaja, M. Schmidt, B. Braunecker, and D. Loss, Phys. Rev. B 84, 085452 (2011).

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