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Superlattice Phenomena in Nanohelices CHARLES DOWNING, MATTHEW ROBINSON, MIKHAIL PORTNOI, University of Exeter, UNIVERSITY OF EXETER TEAM — Recently artificially-created nanohelices have been demonstrated in various semiconductor systems. We argue that subjecting a nanohelix to an electric field normal to its axis turns it into a superlattice with easily-tunable electronic properties. We investigate such a system, also subjected to a longitudinal electric field along the nanotube axis, and find Bloch oscillations and negative differential conductivity. Taking into account Zener tunneling across the band gap, we find the characteristic N-type dependence of electron drift velocity on the longitudinal field which is commonly used in high-frequency electronics. The merits of using a nanohelix for novel tunable device applications are assessed. We also study dipole transitions across the energy gap, which can be tuned to the THz range by experimentally attainable external fields. There is a drastic change in selection rules for a helix in a transverse field compared to the case of purely chiral structures. For the excitation propagating along the nanohelix axis our results are somewhat similar to those found for a quantum ring pierced by a magnetic flux, with the momentum of a quasiparticle in a helix playing the same role as a flux through a ring. We also discuss possible devices which could utilize these phenomena.

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