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PDE DESCRIPTION OF ELECTRON TRANSPORT IN A SUPERLATTICE UNDER AN EXTERNAL MAGNETIC FIELD

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A superlattice (SL) is a layered material formed by repeated periods of two different semiconductors. The resulting quasi-one-dimensional (1D) crystal has a periodic energy dispersion relation. The electron distribution function in the SL solves a Boltzmann transport equation coupled with a Poisson equation for the self-consistent electric potential and appropriate boundary conditions [1]. Under an external magnetic field **B**, electron transport becomes effectively two-dimensional (2D) except when **B** is perpendicular to the SL growth direction (1D case). The Boltzmann-Poisson system of equations is costly to solve numerically but there is a simpler coarse-grained description when collision and field terms dominate. A singular perturbation procedure allows deriving partial differential equations (PDEs) for the electric potential and the electron density [1, 2]. These PDEs have been solved by finite difference methods similar to those used for the 1D case in [2]. We find that the electron dynamics is strongly dependent on the tilting angle between the magnetic field and the SL growth direction. At a straight angle (1D case), the current through the SL may exhibit stable time-periodic oscillations depending on the voltage between the SL ends. More complex oscillations involving 2D spatio-temporal patterns are found at other tilting angles (2D case).

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