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Hidden symmetry and spin-splitting effects of electron dispersion in narrow-band semiconductor films. LEONID ISAEV, YONG JOE, ARKADY SATANIN, Department of Physics and Astronomy, Ball State University, Muncie, IN 47306 — It is well known that in the effective mass approximation electron and hole states in bulk lead salt compounds [such as $Pb_{1-x}Sn_x(Se,S)$] can be well described by the two-band model with the Dirac-type effective Hamiltonian. We use this model to investigate the electron spectrum of films with the forbidden band width modulated in (111) (growth) direction. It is found that in a bulk crystal the wave equation for electrons may be reformulated in a supersymmetrical form, which gives a key to understanding the two-fold degeneracy of the spectrum. The film boundaries, in general, destroy the supersymmetry, i.e. size-quantized subbands turn out to be spin-split. However, there exists a class of boundary conditions that do not lift the spin degeneracy. Our central statement is that even when the system does not posses inversion symmetry, which is destroyed by the bulk inhomogeneity, the spin-splitting of the spectrum is a purely surface effect. This is illustrated on an exactly solvable example, when the energy gap varies linearly over the film width. Similar arguments can be applied to more accurate Dimmock's model. Our results then indicate the inconsistency of the widely used boundary conditions when the envelope wavefunction vanishes at the surface of the system and show a new direction to control electron spin states.

Leonid Isaev
Department of Physics and Astronomy
Ball State University, Muncie, IN 47306

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