Nanoscale physics

Applying exact energy eigenvalue polynomials and Green's function to the determination of thermodynamic properties of Bloch electrons on 2D anisotropic lattices with magnetic field

Zs. Szakács

Department of Economics and Physics, Technical University of Cluj Napoca, North University Center of Baia Mare, Dr. V. Babes Street, 62/A, Baia Mare, Romania
E-mail: szakacsz@yahoo.com

One considers the model of a tight-binding Bloch electron moving on a 2D square lattice in a constant perpendicular magnetic field with hopping. This model can be applied in the description of the tuning of Wannier-Stark resonances of periodical multilayer structures [1] using magnetic fields. The determination of a suitable generalized energy eigenvalue polynomial [2] is shortly presented. The computation of the diagonal elements for the Green's function mediated over the whole Brillouin zone without the explicit knowledge the eigenvalues or eigenvectors [3] uses these polynomials. The real and imaginary parts of the Green's function are identified with the derivative of the Lyapunov exponent with regard to the energy and with the density of states [4]. Thermodynamic properties of the mentioned electron gas are computed using the Green's function and considering the imaginary part of the result. So magnetic field dependent oscillations of the grandcanonical potential, and properties of entropy, specific heat and energetic level occupancy number can be deduced without the cumbersome use of branched special functions and Heaviside distributions.

1. *Estevez J.O., Arriaga J., Mendez-Blas A., Reyes-Ayona E., Escorcia J., Agarwal V,.* Demonstration of photon Bloch oscillations and Wannier-Stark ladders in dual-periodical multilayer structures based on porous silicon // Nanoscale Research Letters.-2012.**7.**-P. 413
2. *Szakács Zs.*, The generalized eigenvalue polynomial for the anisotropic Harper equation // Romanian Reports in Physics.-2005.-**5.-**P. 35-44.
3. *Zs. Szakacs, D.Todoran, R. Todoran,* The influence of anisotropy on the Green's function of a model crystal // Romanian Reports in Physics.-2013.-**65,** V 4,-P. 1365–1372.
4. *Papp E., Micu C., Szakács Zs.* Revisiting density of state calculations for the Harper equation // International Journal of Modern Physics B.-2002.-**16.-**P. 3481-3489.