Numerical and Analytical Investigation of the Fermi Surfaces for the Periodic Schrödinger Equation with a Magnetic Field

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The shape of the Fermi surface determines the kinetic and equilibrium properties of the electron gas in the crystal matter as well as the dynamics of a single electron in the crystal. However, a uniform magnetic field changes drastically the translation properties of an electron in the crystal lattice: the appearance of a new length scale (the magnetic length) leads to the famous phenomena related to the *commensurability-incommensurability* transitions. In particular, a fractal structure arises in the spectral diagrams describing the dependence of the two-dimensional electron spectrum on the magnetic flux (Azbel'–Hofstadter butterfly [1]). The translation symmetry of the Bloch electron in a uniform magnetic field is determined by the magnetic translation group [2], which has more complicated structure in comparison with the translation group without the field. Therefore, a modification of the definition of the Fermi surface at high magnetic fields is required [3]. In the present work, we propose a method of building and investigation of the Fermi surfaces in the magnetic Brillouin zone for the three-dimensional Landau operator perturbed by a periodic point potential [4]. Using our previous results concerning the spectrum of this operator [5], we investigate the Fermi surfaces for various types of crystalline lattices and study the dependence of the surface shape on orientation and strength of the magnetic field. Note that the case of simple-cubic lattice was considered earlier in [6].

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