Tight-Binding Model on a Honeycomb Lattice and the Corresponding Single-Particle Spectrum

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This work investigates the electronic properties of crystal structures with a honeycomb geometry. The primary theoretical framework employed is the tight-binding approximation. The relevance of the topic is linked to the significant interest in two-dimensional materials within condensed matter physics and materials science.

In the course of the research, an effective Hamiltonian corresponding to the honeycomb lattice is constructed. The model takes into account the hopping amplitudes between neighboring atoms. By solving the resulting matrix equations, the energy eigenvalues are determined and the analytical dispersion relation of electrons is derived for the first Brillouin zone. The paper focuses on the unique electronic phenomena characteristic of the honeycomb lattice, specifically the band-touching points where charge carriers behave like massless particles.