Structure of Bloch eigenstates on a honeycomb lattice

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The tight-binding model of quantum particles on a honeycomb lattice is investigated in the presence of homogeneous magnetic field. Provided the magnetic flux per unit hexagon is rational of the elementary flux, the one-particle Hamiltonian is expressed in terms of the generators of the quantum group $U_q(sl_2)$. Employing the functional representation of the quantum group $U_q(sl_2)$ the Harper equation is rewritten as a system of two coupled functional equations in the complex plane. For the special values of quasi-momentum the entangled system admits solutions in terms of polynomials. The system is shown to exhibit certain symmetry allowing to resolve the entanglement, and basic single equation determining the eigenvalues and eigenstates (polynomials) is obtained. Equations specifying locations of the roots of polynomials in the complex plane are found. Employing numerical analysis the roots of polynomials corresponding to different eigenstates are solved out and the diagrams exhibiting the ordered structure of one-particle eigenstates are depicted.

References

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