Bloch-Landau-Zener oscillations in a quasi-periodic potential

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Bloch oscillations and Landau-Zener tunneling are ubiquitous phenomena which can be observed in the dynamics of quantum particles or wavepackets in periodic potentials under action of a linear force. Such physical setting remains meaningful for aperiodic potentials too, although band-gap structure does not exist anymore. We consider the dynamics of Bose-Einstein condensates in a tilted quasi-periodic optical lattice, with the excited states having energies below the mobility edge, and thus being localized in space. We show that the observed oscillatory behavior is enabled by tunneling between the initial state and a state (or several states) located nearby in the coordinate-energy space. The states involved in such Bloch-Landau-Zener oscillations are determined by a selection rule consisting of the condition of their spatial proximity and a condition of quasi-resonances occurring at avoided crossings of the energy levels. The latter condition is formulated mathematically using the Gershgorin circle theorem. The effect of the inter-atomic interactions on the dynamics is also predicted on the bases of the developed theory.

References

[1] H. C. Prates and V. V. Konotop, Phys. Rev. Res. **6**, L022011 (2024)