Finite size effects in wave packet scattering off a dispersion band gap.

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Abstract:

The wave vector of a wave packet propagating in a periodic medium subject to an external force follows the band dispersion until it reaches the gap. Then it can either reflect and perform Bloch oscillations or make a Zener transition to the neighboring band [1,2]. The reflection and transition amplitudes can be approximated by the Landau-Zener formula, which depends only on the bandgap and the wave vector acceleration, because it is based on the universal quantum normal form of a Hermitian operator in the neighborhood of a conical crossings. While the Landau-Zener formula is exact only in the non-physical limit of infinitely slow forcing and vanishing gap, Colin de Verdiere [3] has shown that for a smooth dispersion the quantum normal form can be constructed to arbitrary order in the gap size.
Using quantum normal theory I will derive the leading finite-speed corrections to the transition amplitudes, showing that they are completely determined by the local behavior of the dispersion, and express them in terms of the curvature of the band dispersion at its extremum. I will use numerical analysis to estimate the domain of applicability of the quantum normal form transformation and the validity of the asymptotic expansion of the transition amplitudes.

References:

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