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Entanglement among degrees of freedom of a composite quasiparticle scattering by an impurity on a lattice

Abstract: We study scattering of a composite quasiparticle, which possesses a degree of freedom corresponding to relative separation between two bound particles, by a delta-like impurity potential on a one-dimensional discrete lattice. Different from a composite object in continuum space, for a composite quasiparticle on a discrete lattice, the entanglement between its relative and centre of mass coordinate degrees of freedom arises naturally due to inseparability of the two-particle Hamiltonian. One of the main focuses of our study is to investigate how this inseparability or the entanglement among degrees of freedom of the composite quasiparticle affects the way how it interacts with an external object such as an impurity. We also discuss a change in the entanglement of a composite quasiparticle wave packet during a single impurity scattering and the decoherence effect on the interference pattern created by it. Finally, we propose possible applications of our model to the study of interference phenomena in condensed matter physics such as Anderson localization

Ref: F. Suzuki, M. Litinskaya and W. G. Unruh, Phys. Rev. B. 96, 054307 (2017).