Doublon relaxation in the Bose-Hubbard model

The decay of a high-energy double occupancy state, doublon, in a narrow-band lattice requires the creation of a coherent many-particle excitation. This leads to an exponentially long relaxation time of such a state. We show that, if the average occupation number is sufficiently small, the corresponding exponent may be evaluated exactly. To this end we develop the quasiclassical approach to calculation of the high order tree-level decay amplitudes. Our approach allows one to calculate the generating function of all n-particle tree-level threshold amplitudes. Such a generating function is shown to obey a classical equation of motion for the coupled doublon and particle fields. This equation admits an analytic solution, which yields an exact expression for the tree-level amplitudes. The similar approach was developed in high-energy physics for calculation of the threshold amplitudes for $1 \to n$ and $2 \to n$ deep inelastic scattering processes.

Reference: A. L. Chudnovskiy, D. M. Gangardt, and A. Kamenev, Phys. Rev. Lett. 108, 085302 (2012)