Quantum Clackers Picture for a photoexcited one-dimensional Mott Insulator

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Transport properties due to the photoexcited carriers in one-dimensional (1D) Mott insulators are central issues in the interpretations of the pump-probe experiments in molecular solids. Among them, the nature of the Drude components found at the zero frequency [1] is the most critical, because it is deeply related to the relative motion of the carriers, namely the doublons (Ds) and the holons (Hs). In this presentation, we first focus on the Drude weight when the on-site Coulombic repulsion (U) is very large compared with the transfer energy (T). Using the charge model [2, 3] that extracts only the charge degrees of freedom of the 1D Hubbard model and assuming up to two pairs of DH in a ring, it is proved that the Drude weight is completely zero. When we recall that Ds and Hs move in the opposite directions under a uniform electric field and that, when $U >>T$, the carriers never exchange their positions and repel each other, this situation resembles clackers as a toy, where two rigid balls make repeated collisions. In contrast, when U~T, a D and an H can penetrate each other by the tunneling effect, which leads to a finite Drude weight, as shown in Fig. 1. We also demonstrate that the finite frequency part of the Drude peak can be explained from the viewpoint of the relative group velocity. From all these findings, we propose a quantum cracker-toy picture for general situations in a 1D photoexcited Mott insulator.

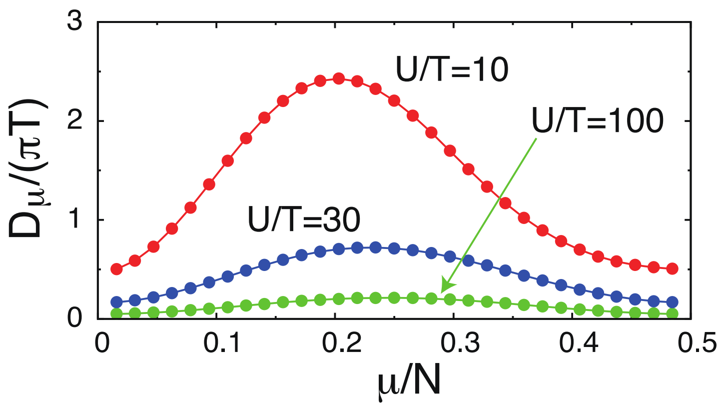

Fig. 1. Drude wight at zero frequency, D_μ, as a function of the mode number μ. Here, μ takes 1~(N/2-1) with N being the system size.

References

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