Dynamical control of electronic states in AC-Driven Quantum Dots

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We investigate the dynamics of two interacting electrons moving in a one-dimensional array of quantum dots under the influence of an ac field.

The quantum dot array is modeled as a single-band tight-binding model of Hubbard type and its dynamics is analyzed by means of the Floquet approach which has been shown to be very accurate for describing the dynamics of interacting electrons in single[1] and double quantum dots [2].

Our results show that the system exhibits two distinct regimes of behaviour, depending on the ratio of the strength of the driving field to the inter-electron Coulomb repulsion. When the ac field dominates an effect termed coherent destruction of tunneling occurs at certain frequencies, in which transport along the array is supressed[3].

In the other, weak driving, regime we find the surprising result that the two electrons can bind into a single composite particle- despite the strong Coulomb repulsion between them- which can then be controlled by the ac field in an analogous way [4].

We show how calculation of the Floquet quasienergies of the system explains these results, and how the ac fields can be used to control localization in interacting systems of electrons.

These results hold out the exciting possibility of using AC fields to control the time evolution of entangled states in mesoscopic devices, which has great relevance to the rapidly advancing field of quantum information processing.

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