Coherent dynamics of electrons in ac driven quantum dot arrays

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A powerful method of manipulating the coherent dynamics of quantum particles is to control the phase of their tunneling. We will show how such phases can be produced in two distinct and complementary ways. We have considered the dynamics of two interacting electrons hopping on a quasi one-dimensional lattice with a non-trivial topology, threaded by a uniform magnetic flux, and study the effect of adding a time-periodic ac electric field. We will show that the dynamical phases produced by the driving field can combine with the familiar Aharonov-Bohm phases arising from the magnetic flux to give precise control over the dynamics and localization of the particles, even in the presence of strong particle interactions [1].

Recent electron spin resonance experiments measure coherent spin rotations of one single electron, a fundamental ingredient for quantum operations. We will show how it is possible to manipulate electron charge and spin dynamics in double and triple quantum dots by means of ac magnetic fields. We demonstrate that by tuning the ac magnetic fields parameters, i.e., the field intensity, frequency and the phase difference between the fields within each dot, coherent destruction of tunneling (and thus charge localization) can be achieved. We show that in contrast with ac electric fields, ac magnetic fields are also able to induce spin locking, i.e., to freeze the electronic spin, at certain field parameters [2]. Spin Blockade has been measured in transport experiments through double and triple quantum dots. We will discuss the effect of ac magnetic fields on Spin Blockade and we will show that it can not only be removed by external ac magnetic fields, but also it can be induced at certain parameters of the field [3].

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