Dicke effect in a double quantum-dot molecule

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Resonant tunneling through two parallel quantum dots has attracted much interest recently. For instance, Holleitner *et al.* [1] studied how the molecular states of semiconductor quantum dots connected in parallel to the leads can be coherently probed and manipulated in transport experiments, while Kubala *et al.*[2] reported a level attraction in an Aharonov-Bohm interferometer with two quantum dots in it arms. Moreover, Kang *et al*. [3] and Boese *et al* [4] studied the double quantum dot molecule in the parallel geometry in the presence of a magnetic flux.

In this we consider electron transport through a parallel quantum-dot molecule embedded in an Aharonov-Bohm interferometer connected asymmetrically to leads. We show that with a period of a quantum of flux (Φ_0=h/e) the magnetic filed allows interchanging the roles of the bonding and antibonding states in the transmission spectrum(See Fig.1). For intermediate values of the flux (namely, semi-integer multiples of a quantum of flux) the parallel molecule behaves as if it were connected in series. We also find that whenever the flux is close to integer multiples of $\Phi_{0,}$ the density of states shows an ultranarrow and a broad peak at the energies of the molecular states, associated to Fano and Breit-Wigner line shapes in the conductance. When the flux has exactly the above values, the conductance experiences the suppression of the Fano line shape, indicating a localization of the corresponding molecular state, similarly to what takes place for the symmetrical case in the absence of magnetic field.[5] We find that these results hold even under a strong left-right asymmetry. This phenomenon resembles the Dicke effect in optics, which takes place in the spontaneous emission of a pair of atoms radiating a photon with a wave length much larger than the separation between them. [6] The luminescence spectrum is characterized by a narrow and a broad peak, associated with long and short-lived states, respectively. The former state, coupled weakly to the electromagnetic field, is called *subradiant*, and the latter, strongly coupled, *superradiant* state.

References:

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Figure 1: Conductance as a function of the Fermi energy for interdot coupling $t_c = \Gamma_0$, (with Γ_0 the level broadening), for Aharonov-Bohm phase (a) $\phi = \pi$ (solid line) and $\phi=0$ (dashed line), and (b) $\phi = 1.9\,\pi$ (solid line) and $\phi = 2\pi$ (dashed line).