INVITED

The Three Spin System

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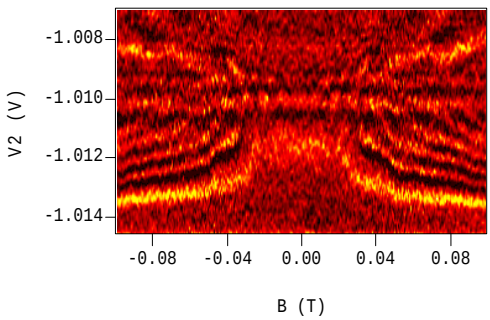
Double quantum dot circuits have been the focus of intense study over the last decade. Recently we have investigated the linear triple quantum dot system [1-4]. A variety of novel physics and applications have already emerged from these investigations. The isolation of the center quantum dot from leads, for example, has led to the discovery of quantum backaction via single phonon interferometery [2] as well as a new charge detection approach which significantly enhances the signal to noise for spin qubit readout [4]. The Pauli blockade double quantum dot rectification effect evolves to a full insulator phenomenon (spinsulator) in a triple quantum dot with a resonant leakage current which involves a non-intuitive spin busing via coherent superpositions of quantum states [3].



Coherent behavior of three spins has also been demonstrated with Landau-Zener-Stückleberg manipulation [1]. In this work we use the triple quantum dot circuit formed in GaAs/AlGaAs heterostructure by lateral gates to study the coherent properties of the three spin system in more detail. The two-spin singlets and triplets of the two spin system are replaced with doublets and quadruplets in the three-spin scenario. Our device enables us to tune the magnitude of the exchange couplings between the three spins and the relative strength of the exchange to the hyperfine interactions. By varying these experimental parameters as well as pulse shapes we are able to study the coherent behavior of pairs of different three-spin states. The figure shows an example of experimental data where disparate coherent oscillations between different pairs of the three-spin states are revealed. We find that such magnetic field plots are able to distinguish and identify different species of coherent oscillations, in particular, the all-exchange oscillations [5] are manifested as horizontal fringes as they are related to a field independent part of the energy spectrum. The all-exchange spin qubit does provide protection against global noise effects such as magnetic field fluctuations but we also find that coherent behavior between other three spin states have different attractive properties such as a reduced sensitivity to local charge noise.

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