Quantum bit embedding in an ultra-cold Fermi sea

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Single spin impurities embedded in Fermi gases or single atoms or ions combined with Bose-Einstein condensates are examples of a new class of quantum-hybrid systems. They offer the possibility for detailed investigations into the theory of quantum interactions and decoherence and the controlled simulation of different system-environment models synonymous with condensed matter physics and non-equilibrium statistical physics.

Here I will present a realistic and exactly solvable model for a single quantum bit which is coupled to a low-dimensional, ultra-cold Fermi gas. I will show that any initial coherence in the qubit is quickly lost, which is related to the presence of Anderson's orthogonality catastrophe, and which has effects on the entropy of the system and the Loschmidt echo. The latter is closely related to the retarded Green's function, from which the spectral function of the gas can be calculated, so that the results can be compared to classic solid state experiments. I will show that the expected broadening in the orthogonality regime can be observed using Ramsey spectroscopy on the qubit.