Dynamic Entanglement of Interacting Tunneling Systems

Peter Nalbach
Dept. of Physics, Stanford University
Stanford, CA 94305

The low temperature properties of glasses are governed by tunneling systems and their behaviour is well described by the phenomenological Tunneling Model (TM) down to temperatures of about 100 mK[1]. Below that temperatures the tunneling model fails in various aspects which is commonly attributed to small interactions between the tunneling systems. Although the assumption that with decreasing temperature the importance of interactions increases seems natural, the theoretical understanding of the influence of interactions between tunneling systems to their dynamics is still unsatisfactory.

We investigate the phase coherence time of tunneling systems which are weakly interacting with each other. Thereby we show that depending on the ratio $\nu = J/\gamma_t$ of coupling J versus linewidth γ_t of the excitation the dynamics of two tunneling systems are independent from each other for $\nu < 1$ but it is *not* independent for $\nu > 1$ leading to an enhanced phase decoherence.

Within two-pulse echo experiments the phase coherence time can directly be measured. In the case $\nu < 1$ the tunneling systems are independent but still the interaction results in phase decoherence due to spectral diffusion [2, 3]. In the opposite case the dyanmics are entangled which leads to an additional exponentiell decay. In experiments one would expect both cases due to the broad distribution of couplings. But since the exponentiell decay due to the entanglement is faster than spectral diffusion, only the first one should be observed. This may solve the problem of recent echo experiments where the exponential decay was found to be faster than expected from spectral diffusion[4].

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