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Autor: Gelardi, F.M.
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SPIN-SPIN RELAXATION OF E' CENTERS AT LOW TEMPERATURE

F.M.Gelardi, Istituto di Fisica, Via Archirafi 36, I-90123
Palermo, Italy.

Abstract: Relaxation mechanisms in a spin system diluted in glassy silica has been experimentally investigated by spin-echo measurements, at low temperature. The results indicate that the phase coherence loss of the spins is affected by both the instantaneous diffusion (ID) mechanism and the interaction between spins and the tunneling systems (TS) of the glassy matrix.

1. Introduction

In highly inhomogeneous spin systems diluted in glassy matrices, the decay of the two-pulses echo signal is affected by relaxation mechanisms which do not involve only the spins forming the echo. A first one, the ID mechanism, involves resonant and non resonant spins. Owing to ID, the echo decay time τ is related to the pulse area θ by the relation $1/\tau=1/T_2+1/\tau_{id}\sin^2\theta/2$,where τ_{id} is the characteristic time of the ID interactions. A second dephasing mechanism could be , at very low temperatures, the interation between the spin centers and the ensemble of TSs of the glassy matrix. Theoretical models describing this interaction predict a temperature dependence of τ proportional to $T^{-1.3}$.

2. Experimental results

We have carried out our experiments in a spin system of E' centers in glassy silica, in the temperature range 1.7-17 K. In fig.1 are reported experimental values of $1/\tau$ versus $\sin^2\theta/2$ detected at T=4.2 K, togheter with the straight line that best fits the points. The τ dependence points out the effectiveness of ID mechanisms in the echo decay. Moreover, from the fitting parameters we determine their characteristic time, τ_{id}=190±30 μs in the investigated system. In fig.2 the temperature dependence of τ in the range 1.7-17 K is reported. The straight line represents the $T^{-1.3}$ power law, that well fits the experimental points up to T∿4 K. At T≳4 K the experimental points tend to a limit value τ∿30 μs. The experimental results in the temperature range 1.7-4 K are in agreement with the dependence $T^{-1.3}$, experimentally detected in analogous glassy systems by optical echo measurements and, as noted before, expected on the basis of models of the TS-active center interaction in glassy systems. Also the behaviour of τ at T≳4 K can be explained in the frame of these models, by hypothesizing a saturation of the TS-spin interactions, because of the ineffectiveness of the TSs with higher energy gaps in dephasing the spin system.

FIG. 1

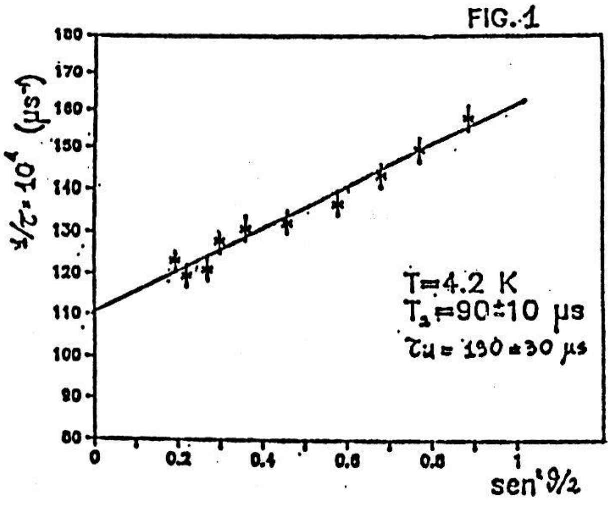

FIG.2