CROSS-RELAXATION BETWEEN MOLECULAR SPECIES IN METHANE: NMR STUDIES

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Introduction

Methane has a very complex ground state at low temperatures, consisting of a mixture of different molecular species: corresponding to different orientational symmetries. We report NMR studies of the nuclear spin relaxation at low temperatures that is determined by cross-relaxation between these species. The E species have total nuclear spin I=0 and do not participate except with their slow conversion into other species: T (I=1) and A (I=2).

Results and Discussion

Measurements of the NMR relaxation using coherent pulsed NMR techniques show the existence of three different relaxation rates (see Fig. 1). The samples studies were aged at low temperatures for three days and the distinct three stage relaxation of Fig. 1 was most noticeable for the aged samples. The time scale for aging is comparable to that for the conversion of the species to A species. The fast relaxation is attributed to the fluctuation rate τ_R for reorientations of the T species. The value of τ_R estimated from the observed value of T_1/T_2, assuming relaxation is dominated by the motion of the T species, is ~ 8 μsec. This value is consistent with that determined from using the known second moment of methane.

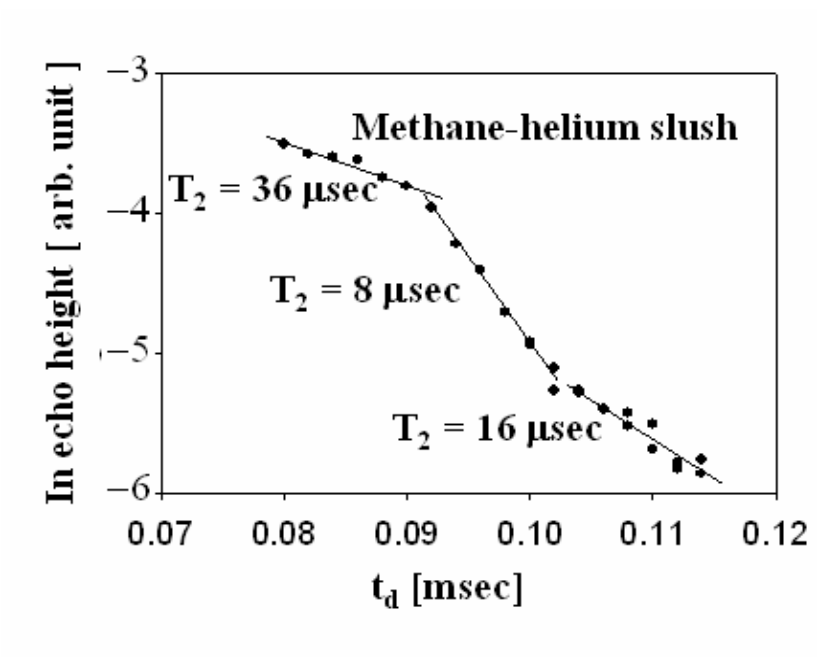

Figure 1. Measurements of the nuclear spin-spin relaxation time, T_2, in small particles of solid methane at 4 K.

Conclusions

NMR studies of the thermal relaxation for finely divided methane particles suspended in liquid helium reveal a three-step relaxation process that depends on the spin-spin interactions of the different molecular species and the age of the sample. It appears that fast reorientational fluctuations of the T species dominate the relaxation process.

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