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Absence of Dipole Glass Transition for Randomly Dilute Classical Ising Dipoles

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University of California, Irvine — Randomly dilute dipoles with long range dipolar interactions appear in a variety of solid insulating materials. Based on theoretical studies of spin glasses with long range interactions, one would expect such dilute dipolar systems to undergo a spin glass-like transition as the temperature decreases. However, there has been no experimental evidence for such a transition in very dilute systems. One example where such a transition has not been definitively observed is two level systems that dominate the physics of glasses at low temperatures. Another is LiHo_2Y_{1-x}F_4 with \( x = 4.5\% \). We have investigated the absence of a phase transition in dilute dipolar glasses. Using Wang-Landau Monte Carlo simulations, we show that at low concentrations \( x \), dipoles randomly placed on a cubic lattice with dipolar interactions do not undergo a phase transition as the temperature decreases. We define a characteristic “glass” temperature \( T_g \) as the temperature where the distribution \( P(q, T) \) is flattest. \( q \) is the overlap order parameter. We find that in the thermodynamic limit \( T_g \) goes to zero as \( 1/\sqrt{N} \) where \( N \) is the number of dipoles. The entropy per particle at low temperatures is larger for lower concentrations (\( x = 4.5\% \)) than for higher concentrations (\( x = 20\% \)).

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