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Phase Diagram of the Disordered RKKY Model in Dilute Magnetic Semiconductors

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We consider ferromagnetism in spatially randomly located magnetic moments, as in a diluted magnetic semiconductor, coupled via the carrier-mediated indirect exchange RKKY interaction. We obtain, via Monte Carlo calculations, the magnetic phase diagram as a function of the impurity moment density n_i and the relative carrier concentration n_c/n_i. As evidenced by the diverging ferromagnetic correlation length and magnetic susceptibility, the boundary between ferromagnetic and non-ferromagnetic phases constitutes a line of zero temperature critical points which can be viewed as a magnetic percolation transition. In the dilute limit, we find that bulk ferromagnetism vanishes for $n_c/n_i > 0.1$. We also incorporate the local antiferromagnetic direct superexchange interaction between nearest neighbor impurities and examine the impact of a damping factor in the RKKY range function. This work has been done in collaboration with Sankar Das Sarma at the University of Maryland and supported by the US-ONR and NSF.

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