

Experimental Probing of Exchange Interactions between Localized Spins in a Dilute Magnetic Insulator (Ga,Mn)N

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The sign, magnitude, and range of exchange couplings between pairs of Mn ions is determined by high resolution magnetic measurements on thoroughly characterized $\text{Ga}_{1-x}\text{Mn}_x\text{N}$ and $\text{Ga}_{1-x}\text{Mn}_x\text{N}:\text{Si}$ epilayers with $1\% < x < 3\%$. The findings allow us to verify a series of ab-initio predictions on the possibility of ferromagnetism in dilute magnetic insulators. We demonstrate that the coupling between neighbor Mn ions is ferromagnetic and it changes to antiferromagnetic when the charge state of the Mn ions is reduced from 3+ to 2+. However the coupling is found to be too short-ranged to lead to ferromagnetic ordering above 1.85 K in the studied Mn concentration range up to 3%¹.

¹A. Bonanni, *et al.*, arXiv:1008.2083v1.