Effect of thermodynamic fluctuations of magnetization on the bound magnetic polaron state in ferromagnetic semiconductors

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We extend the theory of the bound magnetic polaron (BMP) in diluted paramagnetic semiconductors to the situation with a ferromagnetic phase transition. This is achieved by including also the classical Gaussian fluctuations of magnetization coming from the quartic (non-Gaussian) term in the effective Ginzburg-Landau Hamiltonian for the spins. Within this approach, we find a ferromagnetically ordered state within the BMP in the temperature range well above the Curie temperature for the host magnetic semiconductor. Numerical results are compared directly with the recently available experimental data for the ferromagnetic semiconductor GdN. The agreement is excellent given the simplicity of our model and is due to the circumstance that the polaron size ($a_B \simeq 1.4$ nm) encompasses a relatively large but finite number ($N \approx 400$) of quasiclassical spins $S = 7/2$ coming from Gd^{3+} ions. The presence of BMP washes out the nation of critical temperature and thus makes the incorporation of classical Gaussian fluctuations sufficient to describes realistically the situation.