Ferromagnetic coupling in GaN doped with Mn

Dariusz Sztenkiel
Institute of Physics, Polish Academy of Sciences, Aleja Lotnikow 32/46, PL-02668, Warszawa, Poland

In the dilute case, for $x \leq 0.01$, the paramagnetic properties of $Ga_{1-x}Mn_xN$ were successfully described using single ion crystal field model (CFM) approach. However, in order to obtain the magnetization $M(T,H)$ of $Ga_{1-x}Mn_xN$ at higher manganese concentration $x>0.02$, we extend the previous single ion CFM, by considering pairs, triplets and quartets of Mn^{3+} ions coupled by a ferromagnetic superexchange interaction $-J\mathbf{S}_1\mathbf{S}_2$ [2]. Our simulations are exploited in explaining experimental magnetic properties of $Ga_{1-x}Mn_xN$ with $x \approx 0.03$, where the presence of small magnetic clusters gains in significance. However, due to the numerical complexity of CFM, the simulations are limited to very small structures. An efficient approach to simulate large systems is to use the classical approximation. Therefore, in the second part of my presentation I will show results of the atomistic spin model simulations obtained within the frame of Landau-Lifshitz-Gilbert approach [3,4].

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[3] Y. K. Edathumkandy and D. Sztenkiel, *Comparative study of magnetic properties of Mn^{3+} magnetic clusters in GaN using classical and quantum simulations* , *arXiv*:2108.01474
[4] D. Sztenkiel, et al., to be published