Ferromagnetic Monolayers: A fresh Look at Fundamentals

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9.7 cm

Ultrathin ferromagnetic films of Fe, Co, Ni, etc. allow manipulations of the magnetism which are hardly accessible in the bulk : (i) Due to special growth mechanisms crystallographic structures can be prepared which are impossible in bulk magnetism, e.g. tetragonal Ni single crystals. (ii) As a consequence of the finite size effect one can shift the phase transition temperature T_{C} to almost any value between zero and the bulk Curie-temperature. (i) Changes of the c/a-ratio by a few percent or ≈ 0.05 Å of the nearest neighbor distance will change the magnetic anisotropy energy by $10^2 - 10^3$! This dramatic change is caused by the reactivation of orbital magnetism, being not anymore quenched like in bulk cubic ferromagnets. Experimental examples will be given which agree perfectly with ab-initio theory if the input parameter for ab-initio calculations are the real structures and not idealized fcc-, bcc-lattices. (ii) The thickness dependence of T_{C} is used to study the magnetic phase transition and the interlayer exchange coupling in a trilayer of Co/Cu/Ni. Separate $T_{\mathrm{C}}^{\mathrm{Ni}}$ and $T_{\mathrm{C}}^{\mathrm{Co}}$ for a coupled trilayer are observed and the effect of enhanced spin fluctuations in two dimensions will be discussed. For such an exchange-coupled trilayer we find a very strong temperature dependence of $J_{\mathrm{inter}}(T)$. Finally, we will discuss the Curie-Weiss-law for thin Fe films and its critical exponent γ.
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