Designing magnetic meta-materials using finite size effects

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Finite size effects can have profound effects on physical properties of materials. For example, one dimensional confinement strongly alters the ordering temperature of structural and magnetic phase transitions. Confinement in the remaining two dimensions can be used to fabricate meta-materials with e.g. completely unique magnetic and optical properties. For example, one can make arrays of magnetic islands, with well-defined sizes and distances between the islands which can be described as "super-spins". Such "super-spins" have recently been shown to exhibit phase transitions, in which the islands can indeed be viewed and described as gigantic artificial atoms. The criteria for obtaining "super-spin" structures with intrinsic dynamics and ordering will be discussed and exemplified. The results will be used to demonstrate the possibility to design new energy and length-scales in materials. One- and two-dimensional Ising systems will be used to demonstrate the properties of such structures while special emphasis will be devoted to phase transitions and dynamics of artificial spin ices.