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Tubular structures of magnetic particles: platform for curvilinear nanomagnetism

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We review tubes [1,2] consisting of magnetic dipolar particles as a model for magnetic nanostructures and show, in particular, how to obtain anti-ferromagnetic states. The tubular assemblies of magnetic particles can be realized with different thickness, length, and lattice structures. The universality of dipolar interaction concerning the length scale allows the realization of these systems both at the macro scale as dipolar rotors and mesoscale using magnetic microspheres. Our system consists of tubes created by the assembly of dipolar spheres. The cylindrical topology results in the breakup of degeneracy observed in planar square and triangular packings. As far as the ground state is concerned, the tubes switch from circular to axial magnetization with increasing tube length. All magnetostatic properties found in magnetic nanotubes, in which the dipolar interaction is comparable to or dominant over the exchange interaction, are reproduced by the dipolar tubes including an intermediary helically magnetized state. Besides, we discuss the antiferromagnetic phase resulting from the square arrangement of the dipolar spheres and its interesting vortex state [2]. The proposed system should enable research of tubular magnetic nano-devices at scales that are more accessible for observation simultaneously avoiding material imperfections, existing in solid-state counterparts.

References

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