Demagnetizing tensors in curvilinear membranes

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Abstract

Manipulating 2D magnetic structures into 3D geometries leads to a very promising unexplored physics, especially for modern microscale electronics. It has been observed that the shape anisotropy that may arise with these curved geometries can have an impact on some features of the devices such as their flexibility and stretchability that can be particularly interesting to explore for its applications such as flexible circuit boards, solar cells and impedance-based field sensors [1,2]. With this project we aim to extend the study of demagnetizing tensors for a series of self-assembly rolling thin-film micro-scale structures with different dimensions and curvature degrees. We start by analyzing the case of a planar membrane-like geometry, considering a magnetized rectangular ferromagnetic prism varying its dimensions and making its width negligible so there are only 2 dimensions to focus on and see how the anisotropy is affected by changing the geometry. It was possible to find its demagnetizing factor [3] and tensor in order to obtain the magnetostatic self-energy so it could be rewritten in terms of the shape anisotropy which resulted in having two different constants. The same analysis is wanted to be reproduced following the same analytical procedure for a curved membrane with a tubular shape and for a self-enrolled shape, being the latter a new case of study. For these last geometries some new effects need to be considered such as dipolar contributions possibility and the now present volumetric charge density plus surface charge density of the potential leading to a different expression for the magnetostatic self-energy. The objective is to analytically describe these new anisotropy constants and their implication in the stability behavior of the system.

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References

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