Interpreting FMR experiments: Tradition vs. Machine Learning

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The phenomenon of ferromagnetic resonance (FMR) is still widely used to determine the spatial distribution of magnetic free energy, and thus to determine the magnetocrystalline anisotropy constants of magnetic materials. There exist at least three methods of analyzing experimental data: fitting them to the Kittel equation [Phys. Rev. 73, 155 (1948)], fitting them to the Smith-Beljers equation [Philips Res. Rep. 10, 113 (1955)], and the latest method - using machine learning techniques [Phys. Rev. **B** 98, 144415 (2018)].
We compare the results of applying these three methods to the analysis of an old FMR experiment carried out for magnetite [Phys. Rev, 78, 449 (1950)] and a newer one for epitaxial layers of magnetic semiconductor (Ga, Mn)As on (113) GaAs [Phys. Rev. **B** 81, 155203 (2010), Phys.Rev. **B** 91, 184403 (2018)].
The results of our analysis show that the use of machine learning has a significant advantage over older methods. This approach allows us to unambiguously determine the spatial distribution of free energy (and thus magnetocrystalline energy).
This applies in particular when the FMR measurements were carried out in different crystallographic planes and the directions crystallographic axes of the sample do not coincide with the directions of the shape anisotropy. Then the use of machine learning techniques is necessary.