

# Fractional equation for the anomalous magnetic diffusion in ferromagnetic (Q2-05)

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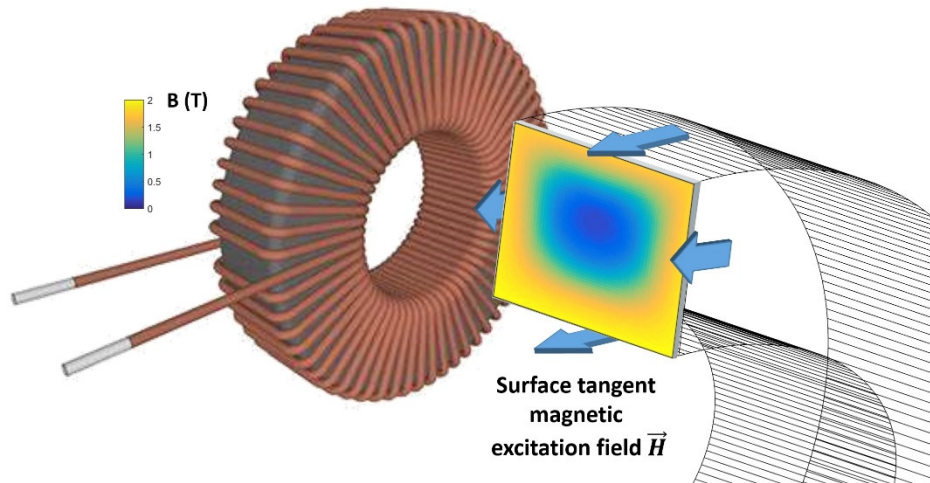
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Ferromagnetic materials are used in a wide range of electromagnetic applications (energy converters, sensors, inductances ...). In this domain, we observe a growing interest in the development of simulation tools reducing the experimental campaigns and improving the knowledge and the performances. Accurate simulation results can only be obtained by coupling precise electromagnetic equations to the exact material laws (hysteresis, saturation, frequency dependence)<sup>1-3</sup>. Under the influence of an external magnetic excitation, the local magnetic state through the ferromagnetic specimen is ruled by the combination of both the magnetic domain kinetics and the external magnetic field diffusion. The usual methods for the simulation of the magnetic behavior are all based on the separation of the magnetic contributions, where the microscopic Eddy currents due to the domain wall motions and the macroscopic ones due to the external magnetic field variations are considered separately<sup>4</sup>. This separation remains artificial, since practically both losses mechanisms occurs simultaneously and interact on each other<sup>5</sup>. In this study, an alternative solution is proposed through the resolution of an anomalous fractional magnetic field diffusion (1, 2 or 3D depending on the experimental situation). The fractional order constitutes an additional degree of freedom in the simulation scheme<sup>6-9</sup>. It is identified through comparisons to experimental results. By adjusting precisely this order, very accurate local and global simulation results can be obtained on a very broad frequency bandwidth. It allows to predict precisely the dynamic magnetic behavior of classic ferromagnetic components.



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