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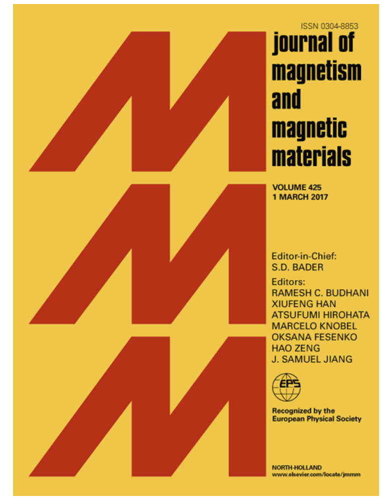

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Highly Parallel Demagnetization Field Calculation Using the Fast Multipole Method on Tetrahedral Meshes with Continuous Sources

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Abstract

The long-range magnetic field is the most time-consuming part in micromagnetic simulations. Computational improvements can relieve problems related to this bottleneck. This work presents an efficient implementation of the Fast Multipole Method [FMM] for the magnetic scalar potential as used in micromagnetics. The novelty lies in extending FMM to linearly magnetized tetrahedral sources making it interesting also for other areas of computational physics. We treat the near field directly and in use (exact) numerical integration on the multipole expansion in the far field. This approach tackles important issues like the vectorial and continuous nature of the magnetic field. By using FMM the calculations scale linearly in time and memory.

Keywords: Micromagnetic, Stray-field, Fast multipole method, High performance computing

1. Introduction

Micromagnetic algorithms are an important tool for the simulation of ferromagnetic materials used in electric motors, storage systems and magnetic sensors. In micromagnetic simulations the demagnetization field is the most time-consuming part. More broadly Poisson's equation has to be solved in many areas of computational physics. Numerous algorithms for solving the problem exist, e.g. [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11]. Direct solutions compute all pair-wise interactions and hence they scale with $\mathcal{O}(N^2)$ operations, where N denotes the number of interaction partners.

Modern Finite Element Method (FEM) implementations[12], [9] have linear scaling for the Poisson equation only for closed boundary conditions when a

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