Numerical Methods for the Solution of the Quasistatic Darwin Formulation

BSc-thesis, MSc-thesis or project/internship work
Electrical engineering / Computational engineering /
Accelerator physics / Mathematics

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1. Context

For the simulation of electromagnetic fields in many situations, quasistatic approximations to Maxwell's equations are sufficient. The most well-known approximations are magneto-quasistatics (MQS) and electro-quasistatics (EQS). However, there is another formulation due to Darwin [1] which essentially combines MQS and EQS and allows to predict the behavior of problems as shown in Fig. 1. The Darwin formulation is less explored from the view point of computational engineering and thus many questions can be addressed within a thesis project.

2. Task

The Darwin formulation shall be understood from literature, the question of gauging shall be addressed, and existence and uniqueness analyzed. Circuit coupling equations must be derived, and the differential-algebraic index of the system could be determined. Finally, an iterative numerical simulation scheme shall be developed for the efficient time-domain simulation.

3. Prerequisites

Basis knowledge of electromagnetism, finite elements, some experience with programming, interest in numerical analysis.

References

[1] C. G. Darwin, "The dynamical motion of charged particles," Philos. Mag. 39, 537–551, 1920.
[2] I. Cortes Garcia et al. "Systems of Differential Algebraic Equations in Computational Electromagnetics". In: Benchmarks in Differential-Algebraic Equations. Springer, 2018.

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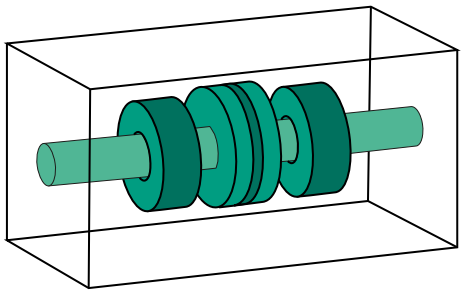

Fig. 1. A Quasistatic problem that cannot be analyzed with standard MQS or EQS formulations [2]