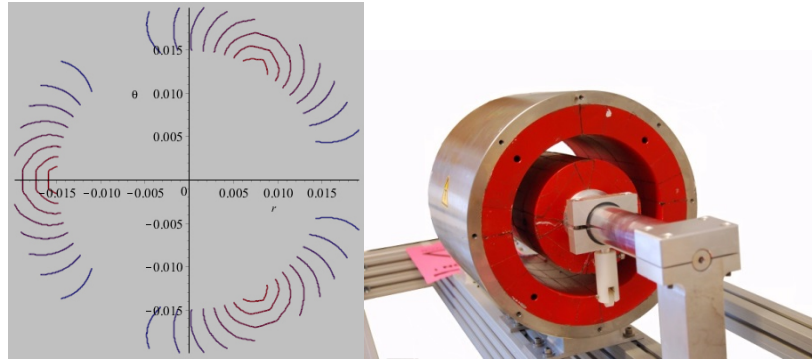


Permanent Halbach Magnet

Project Assignment Description,

01006 Advanced Engineering Mathematics 1 - Spring 2022



Contours of the magnetic field strength between two concentric Halbach magnets together with a permanent magnet based on two concentric Halbachs for research purposes.

Halbach magnets constitute a particular configuration of permanent magnets that can create a homogeneous and relatively large magnetic field. A Halbach is a cylinder of magnetic material, that can be described fairly easily mathematically. One can deduce a general expression for the magnetic field as a function of cylindrical coordinates around the magnet. From this you can compute e.g. magnetic forces and you can combine two concentric Halbach magnets. This is of huge relevance in modern electric motors, NMR scanners and in cases where you need very precise magnetic fields that are limited to specific fields. Moreover, you can use two Halbachs - where one rotates - to turn a magnetic field on and off.

The contents of the project assignment include, but is not limited to the following parts of the curriculum:

- Solutions of systems of linear equations
- Taylor polynomials
- Vector fields
- Space, surface and curve integrals
- Stokes' and Gauss' theorems.

The assignment is more concretely about:

- Finding the analytic solution to the magnetic field around a single Halbach cylinder in 2 dimensions (i.e. it is infinitely long) using Maple
- Combining the solution for one Halbach to two concentric Halbachs that unitedly creates a magnetic field (or annihilates one)
- Using this solution for the investigation of the magnetic field, magnetic forces and the magnetic torque between the two magnets. Here there are open possibilities for different configurations. How large a field can you obtain between two Halbachs given a constant volume of magnetic material and a minimal requirement to the gap between the two magnets?