Chapter 1

Chapter 4 - Problems

1.1 Problems

Problem 1

Assume that the magnetization of magnetite is about 480 mAm^{-1} and using values for other parameters from the text, write a Python program to calculate the following:

a) Self energy (or magnetostatic energy) for a sphere 1, 10 and 100 μm in diameter. [Hint: see Equation 1.1 below for the 'self' energy density. Also, remember the difference between energy and energy density!]

$$\epsilon_{ms} = -\frac{1}{2}\mu_o N_c M^2. \tag{1.1}$$

b) Magnetostatic (shape) anisotropy energy for an ellipsoid whose principal semi-axis is 1 μm and whose major and minor semi-axes are each 0.25 μm. You may use the "nearly spherical" approximation in the text.

c) The critical radius of a sphere at which wall energy equals self energy.

Problem 2

Calculate grain diameter for magnetite spheres with τs of 10^{-1}, 10, 10^2,

10^3, 10^5, 10^9, 10^{15} seconds. Use values for Boltzmann's constant, C (the frequency factor) and $|K_1|$ at room temperature (300K).

Problem 3

Consider a highly elongate rod (needle-shaped grain) of ferromagnetic material.

a) Explain why the demagnetizing factor along the long axis of the rod is about zero and about one half across the axis.

b) For a needle shaped grain of magnetite ($M_s = 4.8 \times 10^5$ Am^{-1}), what external magnetic field is required to magnetize the rod to saturation along the diameter (perpendicular to the long axis)?

c) What is the maximum microscopic coercivity of magnetite (assume an infinitely long grain)?