PHYS 2020: Homework 9 (due Monday Dec. 7)

Reading: Purcell & Morin, Chapters 6.1–6.6.

Problem 1 (15 points): Consider a setup, known as a **Helmholtz coil**, consisting of two short coils of radius R, each consisting of N loops with current I. The two loops are aligned along the x axis and separated by a distance R, as shown in Fig. 1. What is $\vec{B}$ at a point along the x axis between the coils? You may treat each loop as a single thin circular wire with current NI.

Show that the magnetic field satisfies $\partial\vec{B}/\partial x = 0$ at the point exactly midway between the loops along the x axis. (Actually, one can go further to show that $\partial^2\vec{B}/\partial x^2 = 0$ and $\partial^3\vec{B}/\partial x^3 = 0$ at the midpoint as well. The Helmholtz coil, therefore, is a useful way to make a $\vec{B}$ field that is approximately constant.)

Problem 2 (15 points): Purcell & Morin, 6.43.

Problem 3 (15 points): Purcell & Morin, 6.49.

Problem 4 (15 points): Purcell & Morin, 6.50.

Problem 5 (15 points): Purcell & Morin, 6.61. This setup is known as a **toroid**.

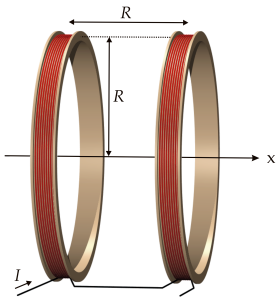

Figure 1: Helmholtz coil.