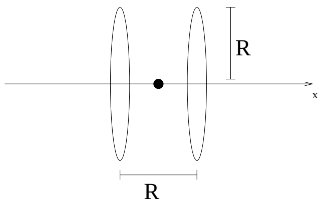
Physics 3345 | **Professor Scalise**
Fall 2000 | **Assignment #2**

Due: Monday 11 September 2000

1. Look up (or better yet, **derive**) the magnetic field along the symmetry axis of a circular current loop in the $y - z$ plane of radius R carrying current I.

2. Plot this field vs. x in the interesting region.

3. Now consider a pair of so-called "Helmholtz coils". These consist of two identical circular current loops with the same symmetry axis, separated by a distance equal to their radius, each carrying current in the same sense (both clockwise for example so the magnetic field at the center is non-zero). We use these coils in the undergraduate laboratory to measure the magnetic field of the Earth.



   Place one coil at $x = +R/2$ and the other at $x = -R/2$. Plot the resulting magnetic field vs. x in the interesting region. You should notice a definite flatness of the field near the origin. The flatness in x is what makes the coils so useful – the magnetic field near the center of the pair is almost constant. The Helmholtz arrangement is obviously much more stable than a single coil (see your first plot).

4. Compute the first two non-zero terms in the Taylor expansion of the single coil magnetic field near the origin.

5. Compute the first two non-zero terms in the Taylor expansion of the Helmholtz magnetic field near the origin. If you see a factor of $\sqrt{125}$ popping out of thin air, you have done this correctly.

6. Comment on the two Taylor expansions. Do you see why the Helmholtz geometry is chosen so carefully (what would happen if the coils were not separated by R)?