# PHYS 115

Contemporary Physics - Spring '07

Rec. Assignment #2

## Drawing magnetic field lines part deux

This assignment builds off of the previous one. You still will be using the Biot-Savart law for a constant current:

$$\mathbf{B} = I\frac{\mu_o}{4\pi}\int \frac{d\mathbf{l} \times \hat{\mathbf{r}}}{r^2} \tag{1}$$

This time however, you have to explicitly evaluate the integral. Your 'loop' of current will be a circle centered in the xy-plane at z=0 with a radius of 0.5. As before use $\frac{I\mu_0}{4\pi} = 1$ as we are only interested in the qualitative solution.

There is a conceptual problem to deal with before you begin. The magnetic field **B** now has components in the x,y and z directions. To visualize **B** over a 2D plane, a projection must be done. The simplest projection is to map the 3D vectors onto the 2D plane by ignoring the $\hat{z}$ component of the magnetic field. Thus you will be plotting the $\hat{x}$ and $\hat{y}$ components of the magnetic field and setting the $\hat{z}$ component equal to zero.

Create the same grid of points over the interval (-1,-1) : (1,1) and plot the vector components (x,y) of the magnetic field for the following planes:

- The plane parallel to the loop (z=0)
- The plane parallel and above the loop (z=2)
- The plane perpendicular to the loop (x=0)

It may help to draw pictures of what you intend to plot before you dive in. Remember that you are making a visual model of the magnetic field. If the graph is 'messy' it obscures the intent. With that in mind, you can see that the vectors very close to the wire will have a magnitude far greater than any other. For the sake of clarity, set them equal to zero.

To integrate along the loop, you will need to pull out discrete sections of the circle. You may find the following equations helpful for converting r,$\theta$ components to x,y: $x = r\cos\theta$ and $y = r\sin\theta$ (look up polar coordinates if interested).