PHYS 115

Contemporary Physics - Spring '07

Rec. Assignment #1

Drawing magnetic field lines

The Biot-Savart law is for constant current is:

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

In general this is an integral for every point is space around the loop of current. There are however, a few geometrical configurations that permit considerable simplification. In the case of a wire that passes perpendicular to the plane, the lines of constant magnetic field will curl around the wire according to the right hand rule (i.e. they will have no component out of the plane). You will be modeling such a system in this assignment. Please set $\frac{I\mu_0}{4\pi} = 1$ for this problem.

First create a grid of points over the interval (-1,-1) : (1,1), that is create an array of x and y coordinates (call them X,Y). For each point on that grid you will need to calculate the magnetic field. Save its components in the arrays Bx, By. You can plot these vector field lines with:

```
from pylab import *
quiver(X,Y,Bx,By, scale=150)
show()
```

What does $d\mathbf{l}$ look like in the plane? If the wire is coming out of the xy-plane then $d\mathbf{l} =< 0, 0, 1 >$. You do not need to consider the other sections of the wire because they do not contribute to the magnetic field (why?). Plot the magnetic field for the following configurations:

- A single wire coming out of the page at the origin
- Two wires separated by a distance of 1, running in parallel.
- Two wires separated by a distance of 1, running anti-parallel.

You **must** answer this question to get complete credit on the assignment (leave it as a comment in your code). Look at the magnetic field lines, from far away (or equivalently when they become close together). What do they lines look like when they run in parallel? Anti-parallel?