B_field_dipole

April 5, 2018

This notebook computes the vector of the magnetic field at any given point and also shows these vectors for some spherical surface. There is still work to be done on beautifying the visual, and the next step is to combine the codes to show a particle moving in this magnetic field. Again, the pictures don't show up in the pdf for whatever reason, so this notebook is also saved to the github.

```
In [1]: from pylab import *
        import numpy as np
        from math import pi,radians
        from vpython import *

        earth_r = 6.371*10**6 #radius of earth in meters

        B_const=3.12*10**(-5)*(earth_r)**3 #units of T*m^3
        dim = 3

        def dipole(r,angle): #angle is magnetic latitude
            B=np.zeros(dim)
            B[0]=-2*B_const*sin(angle)/(r**3) #r component
            B[1]=-B_const*cos(angle)/(r**3) #theta component
            #no phi component anywhere because there is azimuthal symmetry
            return B
```

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In [5]: dx = 10

        for latitude in arange(-90,90+dx, dx):
            fieldstrength = dipole(earth_r, latitude)
            #print((fieldstrength), 'latitude:', latitude)
            lat_angle = radians(90-latitude)
            print(lat_angle)
            for phi in arange(0, 2*pi+(pi/dx), pi/dx):
                field = vector(fieldstrength[0], fieldstrength[1],0)
                scale = 10*8
                arrow(pos=vector(sin(lat_angle)*cos(phi),sin(lat_angle)*sin(phi),cos(lat_angle
                      axis=field*scale, shaftwidth= .05, color=color.green)
        #for latitude in arange(-90,90+dx, dx):    #These give the option to plot more points
        #    fieldstrength = dipole(1.2*earth_r, latitude)   #It makes the dipole field lines
        #    lat_angle = radians(90-latitude)
        #    for phi in arange(0, 2*pi+(pi/dx), pi/dx):
        #        field = vector(fieldstrength[0], fieldstrength[1],0)
        #        scale = 10*8
        #        arrow(pos=vector(1.2*sin(lat_angle)*cos(phi),1.2*sin(lat_angle)*sin(phi),1.2*
        #              axis=field*scale, shaftwidth= .05, color=color.green)
        #for latitude in arange(-90,90+dx, dx):
        #    fieldstrength = dipole(1.1*earth_r, latitude)
        #    lat_angle = radians(90-latitude)
        #    for phi in arange(0, 2*pi+(pi/dx), pi/dx):
        #        field = vector(fieldstrength[0], fieldstrength[1],0)
        #        scale = 10*8
        #        arrow(pos=vector(1.1*sin(lat_angle)*cos(phi),1.1*sin(lat_angle)*sin(phi),1.1*
        #              axis=field*scale, shaftwidth= .05, color=color.green)

        scene = canvas(title='Dipole B Field')
```

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3.141592653589793
2.9670597283903604
2.792526803190927
2.6179938779914944
2.443460952792061
2.2689280275926285
2.0943951023931953
1.9198621771937625
1.7453292519943295
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1.5707963267948966
1.3962634015954636
1.2217304763960306
1.0471975511965976
0.8726646259971648
0.6981317007977318
0.5235987755982988
0.3490658503988659
0.17453292519943295
0.0
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