

Lab 6 : Measuring Static Magnetic Fields (I)

All mobile phones now contain a lot of sensors. Among these sensors, one usually finds a 3-axis magnetometer. This contraption is thus able to measure the 3 components B_x , B_y and B_z of the local magnetic field. This first lab is dedicated to the Earth's magnetic field.

1- Setup

We will use an app called PHYPHOX that enables to access and visualise the data collected by the different sensors of your phone. Please download the version of this app corresponding to your OS. Look for the Magnetometer experiment.

2- Checking the Earth's Magnetic Field in your neighbourhood

a) Before you start, check the compass app of your phone to locate the direction of the north.

b) Your mobile phone lets you choose between the magnetic and the geographic north. In the parameters of the compass, find the button that switches from one north to the other. Place your phone horizontally on a sheet of paper and measure the direction of both « north » successively. Do these direction differ? and by how much ?(if you live in the continental US, this angle should not be too large)

$$\Delta\theta = 0^\circ$$

c) We now wish to measure the direction of the magnetic field created by the Earth. Go outside and use the magnetometer function of PHYPHOX. The first tab lets you visualise the components of \vec{B} vs. time. Maintain your phone horizontally and rotate it so as to observe the variations of the components. From what you know on the direction of the Magnetic field, can you identify the directions x , y and z relative to your phone? Draw a sketch of your phone with the 3 axis.



d) Rotate your phone in the horizontal plane so as to cancel the x component of the magnetic field. Measure the components B_y and B_z of the magnetic field (don't forget the units).

$$B_y = -3\mu T$$

$$B_z = -54\mu T$$

Analysis

a) Is the magnetic field horizontal where you live?

No, the magnetic field is not horizontal where I live because the vertical part ($B_z = -54\mu T$) is much stronger than the horizontal part ($B_y = -3\mu T$)

b) If not, can you measure its angle with the horizontal?

The angle with the horizontal is about

$$\theta = \tan^{-1}(54/3) \approx 86^\circ$$

So the field tilts down about 86° from the horizontal.

c) Is the direction of the magnetic field consistent with the direction of the North ? If in doubt, check section 27.1 of the textbook.

Yes, the magnetic field direction is consistent with North.

It points mostly downward and slightly northward, which matches the expected direction of Earth's field in Southern California.