ILLINOIS INSTITUTE OF TECHNOLOGY - PHYS 221 L03

Lab Report - Lab 09: Biot-Savart Law with Helmholtz Coil

November 5, 2020

Daniel Ayabe

Daniel Ayabe
Phys 221-L03
Lab 09
TA: Alex Brueske

<div align="center">**Lab 05: Biot-Savart Law with Helmholtz Coil**</div>
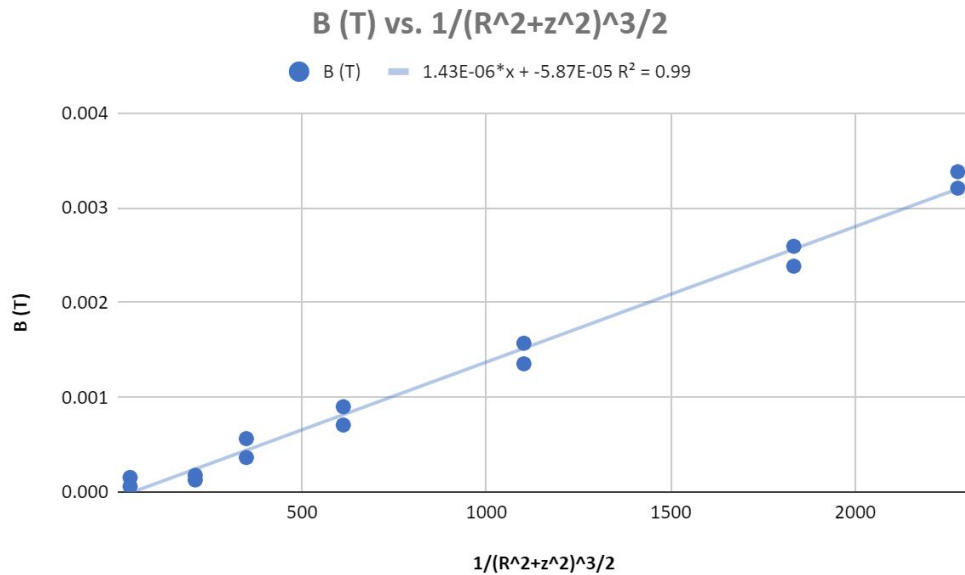
Questions
1. Answer the following questions using the data you acquired from Part 1 of this lab:
    a. Add to your data table(s) a column consisting the value of $1/(R^2 + z^2)^{3/2}$.
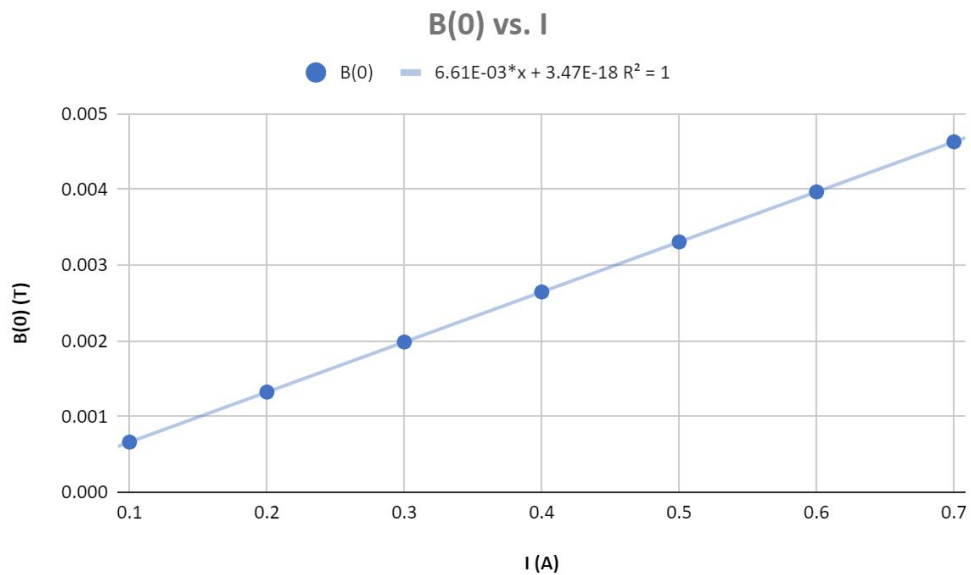   Because we had data for a negative magnetic field as well as positive, I took the absolute values of the negative values and graphed them along with the positive values to gain better data onto one graph.

z (m)	B (T)	$1/(R^2+z^2)^{3/2}$
0	0.00338	2278.028867
0.03	0.002593333333	1833.266101
0.06	0.00157	1101.472356
0.09	0.0009	611.7916754
0.12	0.0005633333333	348.9372999
0.15	0.0001266666667	210.3163522
0.3	0.0001533333333	33.73766
0	0.003206666667	2278.028867
0.03	0.002383333333	1833.266101
0.06	0.001353333333	1101.472356
0.09	0.0007066666667	611.7916754
0.12	0.0003633333333	348.9372999
0.15	0.0001766666667	210.3163522
0.3	0.00006	33.73766

    b. Plot a graph of B(z) versus $1/(R^2 + z^2)^{3/2}$.

B (T) vs. 1/(R^2+z^2)^3/2

● B (T) ▬ 1.43E-06*x + -5.87E-05 R^2 = 0.99

x-axis: 1/(R^2+z^2)^3/2

y-axis: B (T)

c. What is the field value at the center of the loop? Compare this value with Equation 3.

  i. The measured magnetic field at the center of the loop z = 0 was 0.00338 T. Using equation 3 on the lab manual and using the given current value of 1.0A, we get a value of 8.2673×10^{-6} T. These values are very inaccurate from each other, leading me to believe that the equipment for measuring the magnetic field was faulty or not working properly.

d. Find the slope of the best-fit line from your graph. From Equation 2, this slope should correspond theoretically to $\mu_0 I R^2 N/2$ (try proving this). Compare the two values.

  i. The slope of the best-fit line from the above graph was 1.43×10^{-6}. Using the equation given in 1d, the value is calculated to be 1.4517×10^{-6}, which contains a 1.4926% error, which shows that the calculated value is accurate.

2. Answer the following questions using the data you acquired from Part 2 of this lab:

  a. Plot of a graph of B(0) versus I.

B(0) vs. I

B(0)   —— 6.61E-03*x + 3.47E-18 R² = 1

(Graph: y-axis labeled B(0) (T) ranging 0.000 to 0.005; x-axis labeled I (A) ranging 0.1 to 0.7)

b. Find the slope of the best-fit line.

    i.   As seen in the graph above, the slope of the best-fit line is 6.61 x 10^{-3}, or 0.00661.

c. From Equation 2, the slope of this line should correspond to the value of $(8/5\sqrt{5})$ $(\mu_0 N/R)$ (5) Show how to derive equation 5. Compare the slope of your graph with the value obtained from this expression.

    i.   Using equation 5, the slope comes out to be 0.0047. The percent error between this value and the value of the graph is 40.638%.

    ii.