PSY 132 M 4PM

***Charge-to-Mass Ratio of the Electron***

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***Abstract***

Using an electron gun and some Helmholtz coils, we manipulated the path of a beam of electrons in a magnetic field to curve back on itself. Using this, we found the ratio of

e/me.

***Objectives***

The objective of this lab was to use a set of Helmholtz coils and an electron gun to find the ratio of charge to mass of an electron. We also found the graphs for Voltage as it relates to R2 and the electric field as it relates to 1/R.

***Procedure***

To begin, we plugged in the coils. While we were waiting for them to heat up, we measured the distance between the coils and the radius of the coils on the inside and outside.

For the first part we set V=300V. We then varied the current through the coils to strengthen the magnetic field deflecting the beam so that it turned back and hit the measuring stick inside the sphere. We took measurements of the current at each centimeter mark between 11 and 5, then again between 5 and 11. Finally we graphed the electric field against 1/R where R is the radius of the beam’s loop inside the field.

For the next part we set I=1.5A. Instead of varying the current, we changed the voltage of the beam. We changed the beam to the same distances and measured the voltage at each point, then graphed the voltage against R2.

Finally using these two graphs, we found the value of the charge of an electron over the mass of an electron.

***Sample Calculations***

1. e/m based on the slope of B/(1/R):

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2. e/m based on the slope of V/R2:

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***Discussion and Analysis***

Our calculated values for e/m based on our measurements were off by 5 orders of magnitude from one another. Considering that both the charge and mass of an electron are constants, this most likely means there is something grossly wrong with the formulas we used for one of those calculations. Unfortunately we didn’t have time to discover this in class where we could redo the calculations and recheck our measurements, which means we have to accept that one of the values is very, very wrong.

For this lab our goal was to find the ratio of the charge of an electron to the mass of an electron. We did this by finding the deflection of an electron beam in a magnetic field. We measured the deflection against a changing magnetic field and against a higher voltage electron beam, and using the slope of the graphs of those values we found e/m. Ideally, they would have matched each other. Unfortunately, they didn’t. The possibilities for the differences are human error and incorrect equations. Considering the degree of difference in the answers, the possibility that the cause is human error isn’t large enough to consider. The third possibility, fluctuations in the magnetic fields around the area (earth’s, fields caused by current in wires, etc.), would have to be absolutely massive and easily observed in the fluorescing electron beam. Also, we accounted for that by moving the coils and re-measuring in a different orientation.

***Conclusion***

In the end we mostly successfully completed our objective. We learned the relationship between fields and current, and saw what happens when you have a current in an electric field. This is used frequently in mass spectrometers, where the path of the particle depends on its mass (it didn’t in this experiment, because the particles all had a constant mass me).