Current Balance

Ruijia Wang 1003803164
Sifan Shao 1003326625

Purpose

This experiment is to show that two parallel currents attract each other if the currents are in the same direction, and repel each other if the currents are in opposite directions.
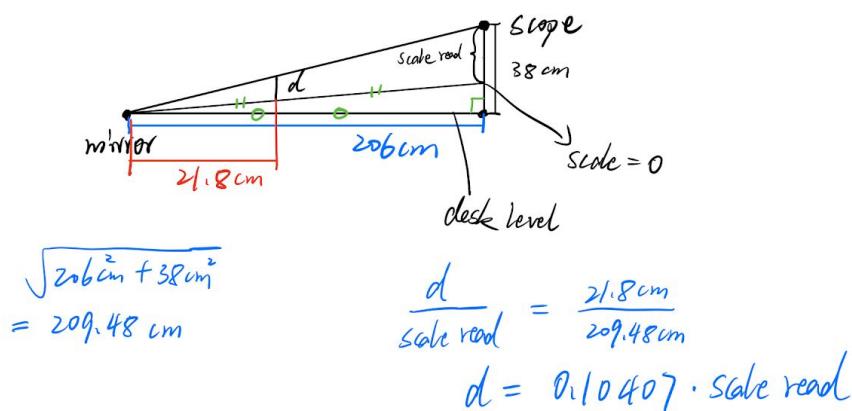
We are going to determine μ_0 in the equation: $\frac{F}{l} = \frac{\mu_0 I^2}{2\pi d}$, where I is current, d is the distance between 2 wires, l is the length of the wires, F is the force loaded on the wire.

Procedures

1. Adjust the scope to find the mirror on the wire, and find the ruler reflected by the mirror. Once this step is done, make sure not to move the set up.
2. Adjust the weight on the opposite side of two wires, make sure two wires are barely touched each other.
3. Turn on the power supply and antimeter, start taking data for unloaded frame. We took a reading every 0.5A, start with 0, until the current reach almost 10A (we did not let the current be 10A for safety). The current and reading on the ruler were recorded when the wire is stabilized.
4. Adjust the power to 0, add 200mg weight onto the pan, and measure again. However, the wire did not move from 0A to 9A.
5. We changed the weight to 20mg and 30mg each and measured again, the wire moved after a few amps of current were added.

Data & Plot
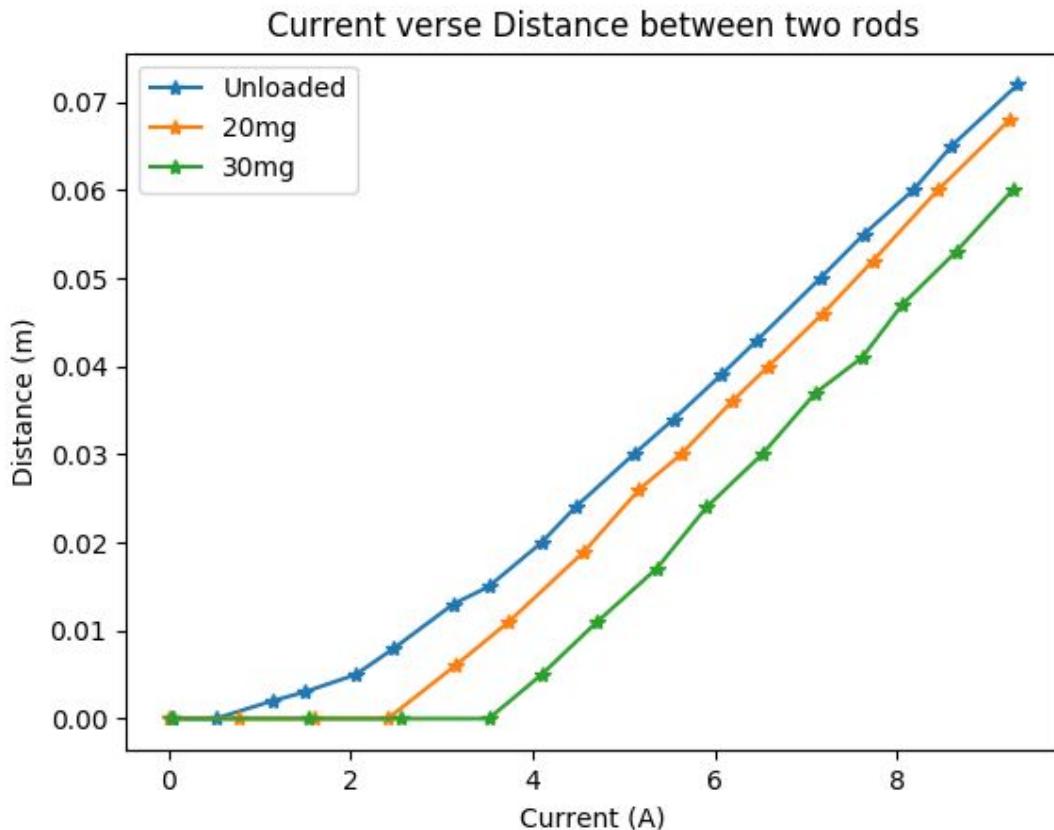
In order to get d, the distance between two conductors, we drew a graph of similar triangles.

the horizontal and vertical distance between mirror and scope are 206cm and 38cm, by pythagorean theory, we get the distance between mirror and ruler. We also measured the direct distance from mirror to the wire. The scale reading depends on what we measured, which is the displacement of ruler scale reflected by the mirror. In the similar triangle, d/scale read = 21.8cm/209.48cm.

For $Fx_1 = mgx_2$, so

$$F_1 = \frac{mgx_2}{x_1} = \frac{m * 0.0098N/g * 21.8cm}{21.44cm} = 0.0001993N \text{ and } F_2 = 0.0002989N$$

Final Output

The estimation of miu when the weight is 20 mg is 4.042896410761123e-06 . The uncertainty is 6.849041968477361e-15

The estimation of miu when the weight is 20 mg is 4.906336097665739e-06 . The uncertainty is 2.470111275113556e-14

Discussion

We can see that our estimation is 4 and 5 times larger than the expected value. Here are the errors and uncertainties that we think may affect this experiment.

1. There is a horizontal distance between the scope and the ruler, which makes a small angle when we measure the reflection in the mirror. This may affect the calculation of similar triangle.

2. The deflection and the image reflected by the mirror on the ruler is very small, but the smallest scale we can read on the ruler is millimeter, so the reading might be not accurate enough. Especially when the current input is low and we are getting only 0 readings.

3. When we measure the distance between mirror and scope, the ruler is not long enough so we measured separately and added them together. This might cause a big error when we calculate the ratio of similar triangles.

4. The distance between two rods is not large enough since we cannot increase the current input to exceed 10A. And on the handout it mentions that the equation only works on large gap (l >> d).

Conclusion

Overall the design of this experiment is a very interesting idea since usually the force between two current is too weak to be shown but in fact we did observe a great change on the deflection when we increases the power input.