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Experimental Determination of the Force in the Magnetic Field of an Air Coil

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Abstract: This experiment measures the force exerted by an air coil on a conductor ring in a uniform magnetic field as a function of the conductor ring current I. A uniform magnetic field is produced in a long, slotted air coil, and the conducting loop is of length s. = 8 cm is inserted into the slot where the force sensor is attached. Only the horizontal part of the conductors generates the force component measured by the force sensor. Thus, the ratio between the force F and the loop current I is used to determine the magnetic flux density B.

Key words: magnetic field, ring, charge, Lorentz force, magnetic flux density, velocity.

The main part: Magnetic flux density, or more simply the magnetic field B, is a vectorial quantity. A force F acts on a charge q passing through a magnetic field B with a velocity v; the size of the force depends on the strength and direction of the magnetic field. We can say

$$F = q\cdot(\vartheta \times \mathrm{B}). \quad (1)$$

The Lorentz force F is also a vectorial quantity, and is perpendicular to the plane defined by ϑ and B.

We can understand the force acting on a current-carrying conductor in a magnetic field as the sum of the individual forces acting on the moving charge carriers which make up the current. The Lorentz force F acts on every single charge carrier q moving with the drift velocity ϑ. For a straight conductor, this gives us the total force

$$F = q\cdot \mathrm{nAs}\cdot(\vartheta \times \mathrm{B}), \quad (2)$$

as the number of charge carriers in the conductor is the product of the density n of the charge carriers, the conductor cross-section A and the length s of the section of the conductor within the magnetic field.

It is common to introduce the vector s, which points along the direction of the conductor segment. Also, the product $qnA\vartheta$ is equivalent to the current I. Thus, the force of a magnetic field on a straight, current-carrying conductor section is defined by

$$F = I\cdot(s \times \mathrm{B}) \quad (3)$$

and the absolute value of the force by

$F = I\cdot s\cdot \mathrm{B}$, when s and B are perpendicular to each other. The force F and the current I are thus proportional to each other, and the proportionality factor is B.

The advantage of the air coil is that the magnetic flux density B within it can be calculated easily and compared with the value arrived at through experiment. For a long air coil, we can say

$$B = \mu_0 \cdot N \cdot I_C / L \quad (4)$$

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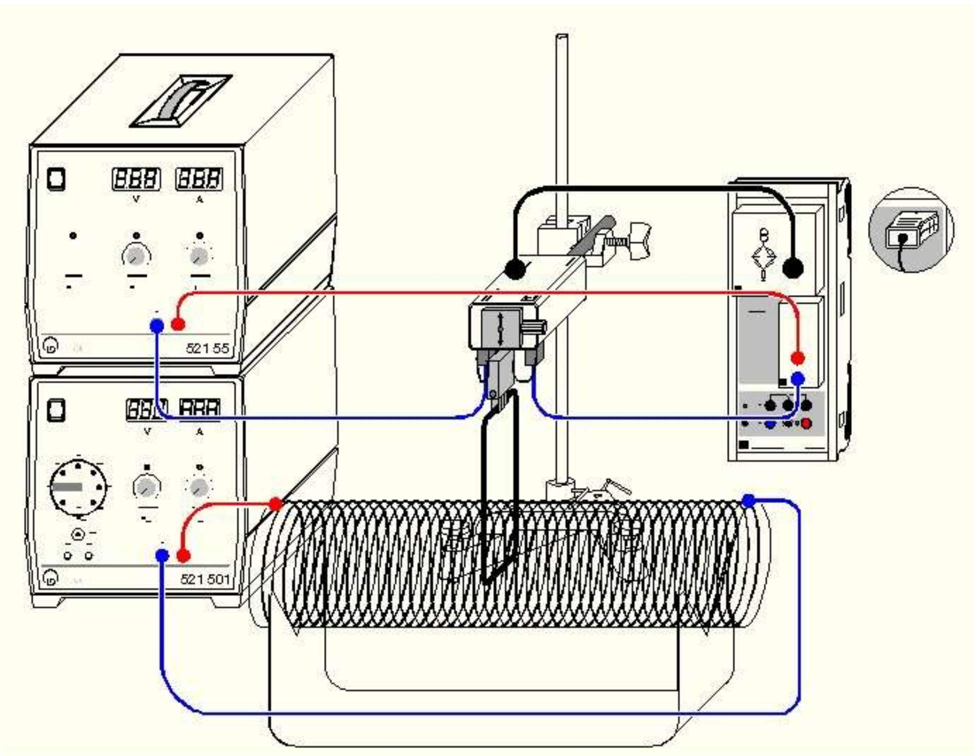
with the magnetic field constant $\mu_0 = 4\pi \cdot 10^{-7}$ Vs/Am, the number of turns N of the coils, the coil current I_C and the length L of the air coil.
The following equipment was used in this experiment: Sensor-CASSY, CASSY Lab 2, Bridge box with Force sensor and Multicore cable, 6-pole, 1.5 m or Force sensor S, ±1 N, 30-A box, Support for conductor loops, Conductor loops for force measurement, Field coil, d = 120 mm, Stand for tubes and coils, High current power supply, AC/DC power supply 0...15 V, Stand base, V-shape, 20 cm, Stand rod, 47 cm, Leybold multiclamp, Connecting leads, 100 cm, red, Connecting leads, 100 cm, blue, PC with Windows XP/Vista/7/8.

During the experiment, the device is assembled in the following order.
The force sensor holds the 8 cm long conductor loop via the support and is positioned so that the conductor loop is inserted in the slot of the air coil. The conductor loop must not touch the air coil. The two 4-mm sockets on the bottom of the force sensor are intended for supplying the conductor loop support. They are not connected internally. The force sensor is connected to the bridge box at input A of Sensor-CASSY. The current flows from the 20 A supply unit via the 30 A box on input B of Sensor-CASSY through the conductor loop and back to the power supply. The current of the second 5 A power supply flows through the air coil.



(Pic.1)

In the settings, the force zero point is set with Force FA1 → 0 ← and, if necessary, the alignment LED of the bridge box is turned on with LED on/off.

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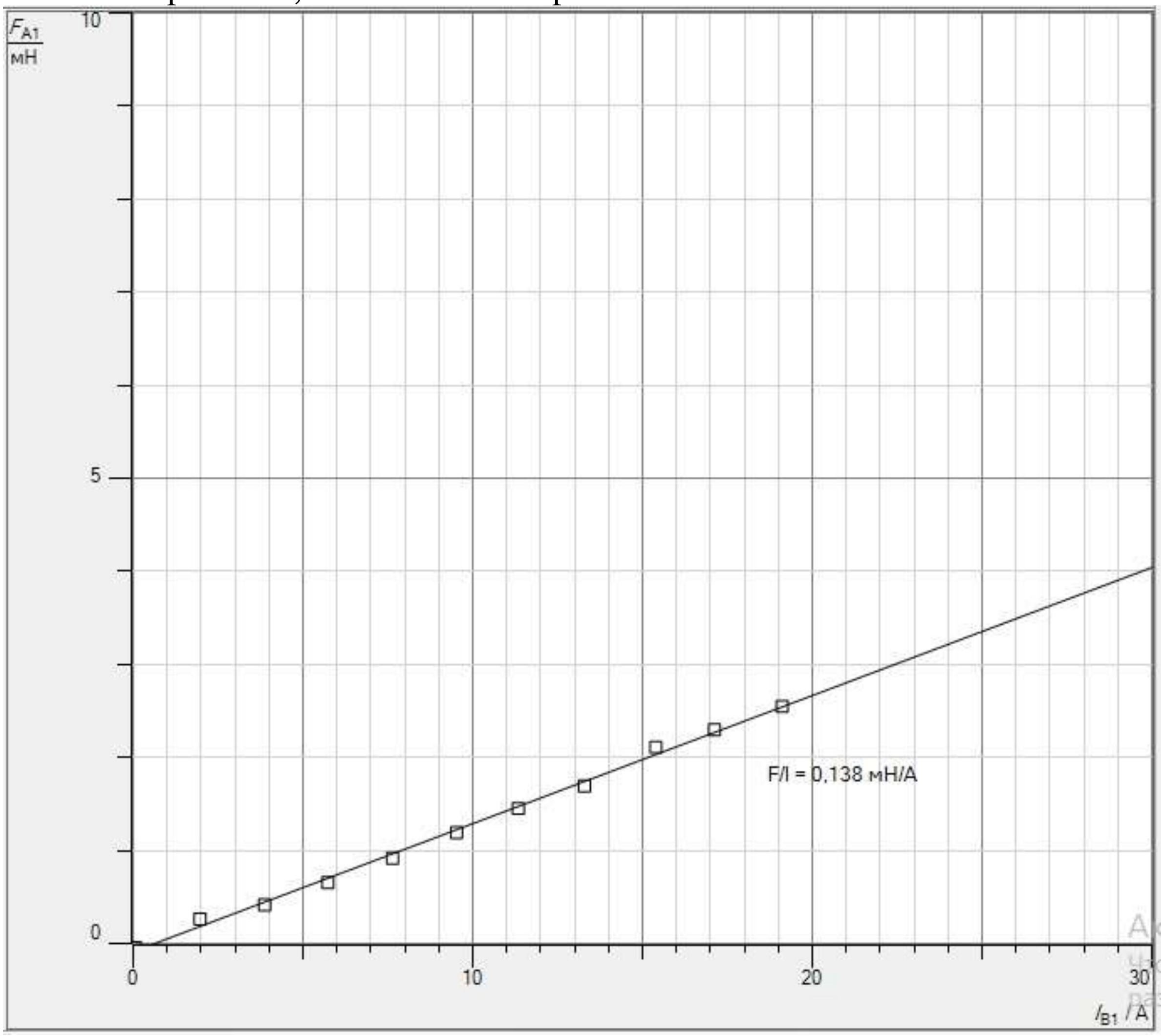
The current zero point can be set with → 0 ← in the IB1 settings.
In the power supply of the air coil, about IC = 5 A is set.
The conductive ring current I is increased from 0-20 A in steps of 2 to 5 A and the measured value is recorded each time. You can remove an invalid dimension from the table by going to Table → Delete last table row.
If only negative forces are measured, the connections on the conductor loop support are reversed.
The experiment must be performed quickly, because the conductor ring and support can only be loaded with 20 A for a short time.
At the end of the experiment, the conductor loop current is set to 0 A.



(Pic.2)

Summary. Power increased linearly with current. The proportionality factor F/I = B·s was derived from the slope of the straight line. This, in turn, made it possible to determine the magnetic field strength B. In this example, with F/I = 0.138 mN/A and s = 0.08 m, B = 1.725 mT.

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Using $B = m_0 \cdot N \cdot IC / L$, values of $m_0 = 1.257$ mVs/Am, N = 120, IC = 4.75 A, and L = 0.41 m give us a calculated value of B = 1.75 mT. Both results were in good agreement within the limits of measurement accuracy.

References

1. Mamadjanov, A. I., and M. N. Izzatullayeva. "MEASUREMENT OF THE MAGNETOSTRICTIVE EFFECT ON FERROMAGNETS USING A MICHELSON INTERFEROMETER." Web of Scientist: International Scientific Research Journal 3.1 (2022): 11-16.
2. Boydedayev, S. R., M. M. Umaraliyev, and A. R. Turgunov. "APPLICATION OF THE VENN DIAGRAM METHOD IN THE LABORATORY LESSON" DETERMINATION OF YOUNG'S MODULUS OF DIFFERENT METALS BY BENDING METHOD"." *Web of Scientist: International Scientific Research Journal* 3.9 (2022): 377-381.
3. Rahimjonovich, Boydedayev Sobirjon, Umaraliyev Maksud Mahmudovich, and Turgunov Adham Rakhmatillayevich. "TO THE MAGNETO-OPTICAL ANISOTROPY OF THE Mg CRYSTAL THE EFFECT OF CHANGING THE MAGNETIC STRUCTURE OF FeBO3." *Web of Scientist: International Scientific Research Journal* 3.9 (2022): 175-180.
4. Rahimjonovich, Boydedayev Sobirjon, Umaraliyev Maksud Mahmudovich, and Turgunov Adham Rakhmatillayevich. "TO STUDY THE DEPENDENCE OF THE INTENSITY OF" ABSOLUTE BLACK MATTER" RADIATION ON TEMPERATURE AND DISTANCE." *Galaxy International Interdisciplinary Research Journal* 9.12 (2021): 671-675.
5. Rahimjonovich, Boydedayev Sobirjon, and Umaraliyev Maksud Mahmudovich. "STUDY OF FERROMAGNETIC HYSTERIZES CURVES IN CASSY LAB." *Web of Scientist: International Scientific Research Journal* 3.9 (2022): 520-525.
6. Mamadjanov, Akhror Ibragimovich, and Adhamjon Raxmatillayevich Turg'unov. "Measurement of Small Deformations with a Mach-Zehnder Interferometer." 2632-9417.
7. Mamadjanov, Ahrorjon Ibragimovich, and Adhamjon Rakhmatillaevich Turgunov. "LIFE TIME KERR-NUT BLACK HOLE." *Scientific Bulletin of Namangan State University* 1.8 (2019): 39-44.
8. Mamadjanov A. I., Soliyev A. Z., Hfsfnov X. B. "DETERMINATION THE RATIO OF HEAT CAPACITY AT CONSTANT PRESSURE WITH CONSTANT HEAT CAPACITY VIA THE VELOCITY OF SOUND WAVES IN GASES"
9. Web of Scientist: International Scientific Research Journal 2 (12), 54-61
10. Gulyamov, G., Dadamirzaev, M. G., Kosimova, M., & Uktamova, M. (2020). THERMOPHOTOEMF OF HOT CHARGE CARRIERS AT pn-JUNCTIONS UNDER EXPOSURE TO A MICROWAVE FIELD AND LIGHT. *Scientific-technical journal*, *3*(5), 66-70.
11. Косимова, М. О., & ўғли Сайфиддинов, О. О. (2022, May). СРАВНЕНИЕ ДИФФУЗИОННЫХ ЕМКОСТЕЙ ТРЕХМЕРНЫХ 3D И ДВУМЕРНЫХ 2D pn— ПЕРЕХОДОВ. In *INTERNATIONAL CONFERENCES ON LEARNING AND TEACHING* (Vol. 1, No. 8, pp. 90-94)