Summary: blogspot, Academia

Lorentz perpendicular action experiment

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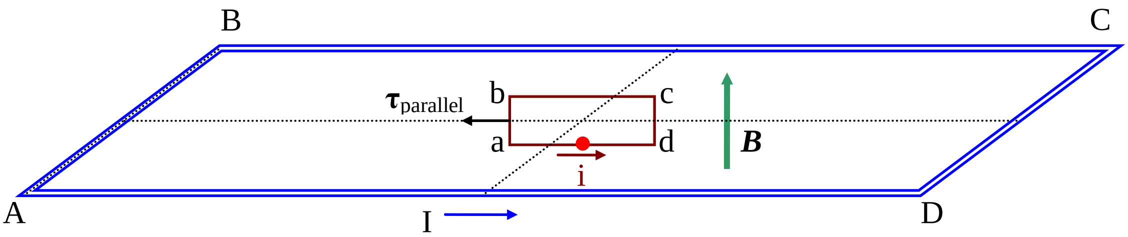
4 December 2012

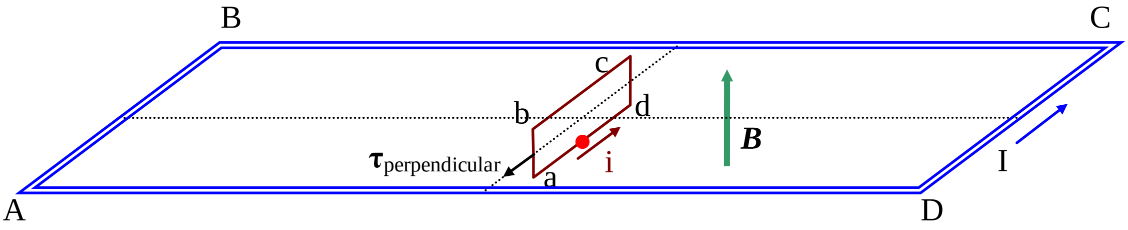
1. Experiment design

I have shown an inconsistency of the Lorentz force law (see **Lorentz force on open circuit,** Links blogspot academia). To remedy this problem, I have proposed a correct law (see **Correct differential magnetic force law,** Links blogspot academia) and an experiment design **Lorentz torque experiment** (Links blogspot academia) to get precise data of magnetic force to compare with predictions by the two laws.

Now, I propose a simpler but more impressive experiment which is a visual demonstration of the inconsistency of the Lorentz force law and whose result can be shown by video. Figure 1 shows the setup. A small rectangular coil *abcd*, called the test coil, is placed at the center of a long rectangular coil *ABCD*, called the inducing coil. The test coil is free to turn about its long axle. The current *I* in *ABCD* induces a magnetic field ***B*** which exerts a Lorentz force on the current *i* of the test coil and makes it tilt.



(a) Parallel position



(b) Perpendicular position

Figure 1

The purpose of this experiment is to show that, when the two coils are perpendicular to each other, the magnetic force on the test coil is much weaker than predicted by the Lorentz force law. In fact, I have demonstrated that the interaction between two perpendicular currents, named "perpendicular action", was zero (see the article **Lorentz force on open circuit**).

In order to make sure that the Lorentz force is strong enough to tilt the test coil, we will adjust the installation so that the test coil tilts when the two coils are parallel (Figure 1 (a)). The installation is adjusted by varying the mass of a ballast (the red dot in Figure 1), which is attached on the test coil. In parallel position (Figure 1 (a)), the ballasted test coil must stay inclined under the Lorentz force.

As the magnetic field **B** is independent of the orientation of the test coil, the Lorentz force should be strong enough to tilt the coil in perpendicular position too (Figure 1 (b)). However, in perpendicular position the torque on the test coil is created by perpendicular action that is zero, the torque is in reality very weak and the test coil should stay vertical pulled by the ballast.

2. Theoretical prediction

I have computed numerically the magnetic force acted on the test coil. The method of computation is explained in **Calculation of the Lorentz' Torque and the Ampere's torque** (Links: blogspot academia). Lorentz force between two coils is expressed as follow, with $\mathbf{dl}_1$ and $\mathbf{dl}_2$ being vector current elements:

$$\mathbf{F} = \frac{\mu_0 I_1 I_2}{4\pi} \int_{C1} \int_{C2} d\mathbf{l}_2 \times \left(d\mathbf{l}_1 \times \frac{\mathbf{e}_r}{r_{12}^{\ 2}} \right) \tag{1}$$

Magnetic force without perpendicular action is expressed as follow, the correct law:

$$\mathbf{F} = -\frac{\mu_0 I_1 I_2}{4\pi} \int_{C1} \int_{C2} (d\mathbf{l}_1 \bullet d\mathbf{l}_2) \frac{\mathbf{e}_r}{r_{12}^{\ 2}} \tag{2}$$

We notice that both forces **F** does not depend on the size of the two coils, as long as the proportion is respected. In effect, if the size of the two coils is multiplied by a factor of α, then r_{12} , $\mathbf{dl}_1$ and $\mathbf{dl}_2$ will be multiplied by the same factor and the force **F** is multiplied by α^2/α^2 . Thus, **F** stays the same. This property implies that, whatever the size of the coils, the force tilting the test coil is the same.

The parameters for the numerical computation are (only the proportion of size is given):

Inducing coil:	height AB=1	length AD=5	Current I_1=100 A
Test coil:	height ab=0.2	length ad=0.80	Current I_2=1 A

The torque is integrated first:

$$\tau = \int_{C1} \int_{C2} OM \times dF \tag{3}$$

Then the force tilting the test coil is computed as the tangential force F_t that is applied at the point b in Figure 2. The length of lever is half the height of the test coil: $r = \frac{ab}{2}$

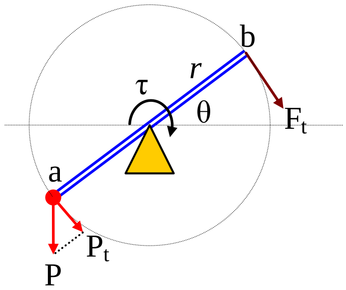


Figure 2

F_t is the quotient of the torque τ and the length of lever r:

$$F_t = \frac{\tau}{r} \tag{4}$$

The numerical values of F_t are given in Table 1 and are in 10^{-5} N.

The weight force of the ballast is P. Its tangential component is P_t and is applied at the point a in Figure 2. P_t depends on the angle of inclination of the test coil θ:

$$P_t = P\cos\theta \tag{5}$$

The force F_t is very weak; so, we use a piece of paper as ballast. The density of ordinary paper is 80 g/M^2. The weight force of one centimeter square of paper is: $7.848\ 10^{-5}$ N

In Figure 3 and Figure 4 the forces F_t and P_t are drawn against the angle of inclination θ. The curves of F_t according to the Lorentz force law are red, that according to the correct law are green and that of P_t are blue. The intersections of the red and green curves with the blue ones indicate that at these angles, the magnetic force is equal to the ballast's force: $P_t = F_t$
And the test coil will stay in equilibrium there.

We see from Figure 3 and Figure 4 that in parallel position, the angle of equilibrium is 30° for both the Lorentz force law and the correct law. But in perpendicular position, the equilibrium angle is 90° for the correct law and 20° for the Lorentz force law.

My prediction for the experiment is that when the 2 coils are parallel to each other, the test coil will stay inclined at 30° with respect to the horizontal plan. As the test coil is turning to perpendicular position, it will rise progressively and become vertical, contradicting the Lorentz force law that predicts an inclination of 20° with respect to the horizontal plan.

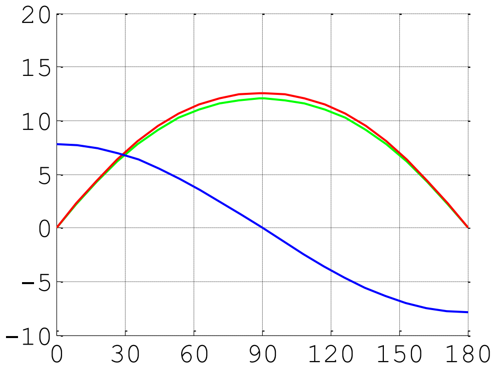


Figure 3 Parallel position

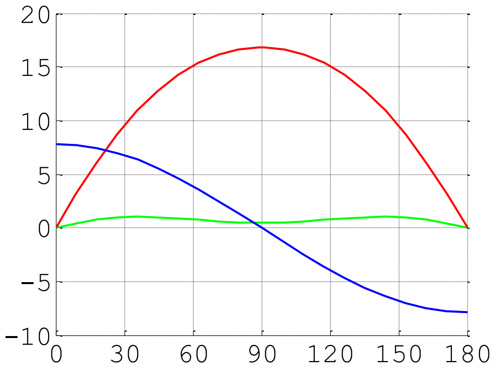


Figure 4 Perpendicular position

3. Comment

For this experiment, one needs:
One rectangular coil of 10×50 cm, 100 turns
One rectangular coil of 2×8 cm, 1 turn
A battery that can deliver 1 ampere of current
One piece of paper of 1×1 cm
One support that lets the test coil to turn freely about its long axle

This experiment is simple and affordable to everyone, although its result is well clear-cut. This is such a good experiment that I wanted to do it by myself and to show the video on the internet. But because of my health problem, I'm not able to carry it out. So, I publish the design and launch a contest for this experiment on the internet.

The object of this contest is to carry out this experiment and to show the video on Youtube. The winner will be the first person who uploads a video of a valid experiment. Please show parameters such as dimension, current and environment. In order to eliminate any possibility of trickery, please show as much details as possible. Tag you video with “Lorentz perpendicular action experiment” to facilitate the search in Youtube.

The prize for the winner is the fame of the first person to experimentally prove that the Lorentz force law is wrong in certain circumstance. This experiment will be so fantastic that the winner’s name will surely be known all over the world.

	Parallel position		Perpendicular position	
Angle °	The correct law	Lorentz force law	The correct law	Lorentz force law
0	0	0	0	0
8.9	2.1861	2.2657	0.4386	3.1102
17.8	4.2674	4.4247	0.7862	6.0393
26.7	6.1562	6.3873	0.9913	8.6571
35.6	7.7933	8.0928	1.0524	10.9002
44.5	9.1505	9.5110	1.0022	12.7561
53.4	10.2253	10.6382	0.8859	14.2386
62.3	11.0320	11.4874	0.7468	15.3697
71.2	11.5923	12.0792	0.6202	16.1707
80.1	11.9273	12.4341	0.5314	16.6579
89.0	12.0523	12.5666	0.4956	16.8414
91.0	12.0523	12.5666	0.4956	16.8414
99.9	11.9273	12.4341	0.5314	16.6579
108.8	11.5923	12.0792	0.6202	16.1707
117.7	11.0320	11.4874	0.7468	15.3697
126.6	10.2253	10.6382	0.8859	14.2386
135.5	9.1505	9.5110	1.0022	12.7561
144.4	7.7933	8.0928	1.0524	10.9002
153.3	6.1562	6.3873	0.9913	8.6571
162.2	4.2674	4.4247	0.7862	6.0393
171.1	2.1861	2.2657	0.4386	3.1102
180.0	0	0	0	0

Table 1 F_t*10^5