

Correction to the Biot–Savart law

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1. Physical significance of the corrected magnetic force law

My parallel and perpendicular actions and macroscopic Aharonov-Bohm effect experiments have shown new type of magnetic force that the Lorentz force law cannot explain. See:

Consequences of macroscopic Aharonov-Bohm effect

<http://pengkuanem.blogspot.com/2013/07/consequences-of-macroscopic-aharonov.html>

Current and parallel action

<http://pengkuanem.blogspot.com/2013/06/current-and-parallel-action.html>

Unknown properties of magnetic force and Lorentz force law

<http://pengkuanem.blogspot.com/2013/04/unknown-properties-of-magnetic-force.html>

The corrected magnetic force law that I propose explains well the new phenomena. This law expresses the magnetic force that 2 current elements dI_1 and dI_2 act on one another (see Figure 1):

$$d^2\mathbf{F} = -\frac{\mu_0}{4\pi} (dI_2 \cdot dI_1) \frac{\mathbf{r}}{r^3} \quad (1)$$

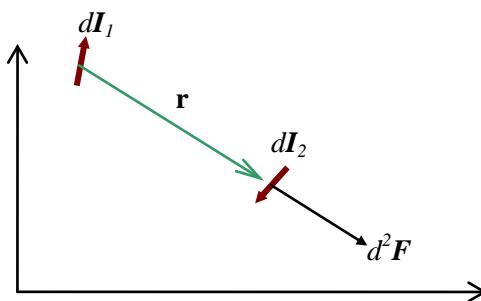


Figure 1

This law states that the magnetic force between 2 current elements lies on the radial vector \mathbf{r} , but not perpendicular to the current. Its intensity is inversely proportional to the square of the distance. So, this law is an inverse square law like Coulomb's law. At the place of charges' product is the scalar product of the 2 current elements. This means that the intensity of the magnetic force varies as the cosine of the angle made by the 2 current elements. When the 2 currents are in the same direction, they attract one another, when they are opposed, they repulse one another, when they are perpendicular to one another, no force arises. For closed loops, this law gives the same values as the Lorentz force law.

2. Correction to the Biot–Savart law

The Lorentz force law expresses Lorentz force as the cross product of a current element and the local magnetic field. The corrected magnetic force law must also be a product of current element and magnetic field. For finding this expression, we develop the 3 vectors of the equation (1):

$$\begin{aligned} dI_1 &= dI_{1,x}\mathbf{e}_x + dI_{1,y}\mathbf{e}_y + dI_{1,z}\mathbf{e}_z \\ dI_2 &= dI_{2,x}\mathbf{e}_x + dI_{2,y}\mathbf{e}_y + dI_{2,z}\mathbf{e}_z \\ \mathbf{r} &= (x_2 - x_1)\mathbf{e}_x + (y_2 - y_1)\mathbf{e}_y + (z_2 - z_1)\mathbf{e}_z \end{aligned} \quad (2)$$

Then, we write the product of the 3 vectors in matrix form:

$$(d\mathbf{I}_2 \cdot d\mathbf{I}_1) \frac{\mathbf{r}}{r^3} = [d\mathbf{I}_2][d\mathbf{I}_1] \begin{bmatrix} \mathbf{r} \\ r^3 \end{bmatrix} = [dI_{2,x} \quad dI_{2,y} \quad dI_{2,z}] \begin{bmatrix} dI_{1,x} \\ dI_{1,y} \\ dI_{1,z} \end{bmatrix} \begin{bmatrix} \frac{x_2 - x_1}{r^3} & \frac{y_2 - y_1}{r^3} & \frac{z_2 - z_1}{r^3} \end{bmatrix} \quad (3)$$

The product of the last 2 matrices is developed into a 3×3 matrix:

$$[d\mathbf{I}_1] \begin{bmatrix} \mathbf{r} \\ r^3 \end{bmatrix} = \begin{bmatrix} dI_{1,x} \frac{x_2 - x_1}{r^3} & dI_{1,x} \frac{y_2 - y_1}{r^3} & dI_{1,x} \frac{z_2 - z_1}{r^3} \\ dI_{1,y} \frac{x_2 - x_1}{r^3} & dI_{1,y} \frac{y_2 - y_1}{r^3} & dI_{1,y} \frac{z_2 - z_1}{r^3} \\ dI_{1,z} \frac{x_2 - x_1}{r^3} & dI_{1,z} \frac{y_2 - y_1}{r^3} & dI_{1,z} \frac{z_2 - z_1}{r^3} \end{bmatrix} \quad (4)$$

Then, the equation (1) is written into matrix form:

$$d^2\mathbf{F} = [dI_{2,x} \quad dI_{2,y} \quad dI_{2,z}] \left\{ -\frac{\mu_0}{4\pi} \begin{bmatrix} dI_{1,x} \frac{x_2 - x_1}{r^3} & dI_{1,x} \frac{y_2 - y_1}{r^3} & dI_{1,x} \frac{z_2 - z_1}{r^3} \\ dI_{1,y} \frac{x_2 - x_1}{r^3} & dI_{1,y} \frac{y_2 - y_1}{r^3} & dI_{1,y} \frac{z_2 - z_1}{r^3} \\ dI_{1,z} \frac{x_2 - x_1}{r^3} & dI_{1,z} \frac{y_2 - y_1}{r^3} & dI_{1,z} \frac{z_2 - z_1}{r^3} \end{bmatrix} \right\} \quad (5)$$

The quantity between the braces is a square matrix named $[d\mathbf{M}]$:

$$[d\mathbf{M}] = -\frac{\mu_0}{4\pi} \begin{bmatrix} dI_{1,x} \frac{x_2 - x_1}{r^3} & dI_{1,x} \frac{y_2 - y_1}{r^3} & dI_{1,x} \frac{z_2 - z_1}{r^3} \\ dI_{1,y} \frac{x_2 - x_1}{r^3} & dI_{1,y} \frac{y_2 - y_1}{r^3} & dI_{1,y} \frac{z_2 - z_1}{r^3} \\ dI_{1,z} \frac{x_2 - x_1}{r^3} & dI_{1,z} \frac{y_2 - y_1}{r^3} & dI_{1,z} \frac{z_2 - z_1}{r^3} \end{bmatrix} \quad (6)$$

Finally, the magnetic force $d^2\mathbf{F}$ is expressed into the product of the line matrix $[d\mathbf{I}_2]$ and the square matrix $[d\mathbf{M}]$:

$$d^2\mathbf{F} = [d\mathbf{I}_2] [d\mathbf{M}] \quad (7)$$

$[d\mathbf{I}_2]$ is the differential current element that feels magnetic force and $[d\mathbf{M}]$ is the local magnetic field, which is now a tensor.

In order to compare with the Lorentz force law, we write the latter in terms of matrix product too:

$$\begin{aligned} d\mathbf{F} &= d\mathbf{I} \times \mathbf{B} \\ &= [dI_x \cdot 0 + dI_y B_z - dI_z B_y \quad -dI_x B_z + dI_y \cdot 0 + dI_z B_x \quad dI_x B_y - dI_y B_x + dI_z \cdot 0] \\ &= [dI_x \quad dI_y \quad dI_z] \begin{bmatrix} 0 & -B_z & B_y \\ B_z & 0 & -B_x \\ -B_y & B_x & 0 \end{bmatrix} \end{aligned} \quad (8)$$

We see that for the Lorentz force law the magnetic field is a tensor with 3 independent components:

$$[\mathbf{M}] = \begin{bmatrix} 0 & -B_z & B_y \\ B_z & 0 & -B_x \\ -B_y & B_x & 0 \end{bmatrix} \quad (9)$$

This is an anti-symmetric tensor whose diagonal elements are zero. This makes Lorentz force not to possess parallel component. The tensor magnetic field $[d\mathbf{M}]$ with 9 degrees of liberty is more general than the vector magnetic field that has only 3. This is why the corrected magnetic force law can

describe complicated phenomena like parallel and perpendicular action and macroscopic Aharonov-Bohm effect while the Lorentz force law cannot.

3. Comment

After having shown experimentally the incorrectness of the Lorentz force law, I unveil here an important part of my magnetic theory: the tensor nature of magnetic field. I have the complete theory that describes complex tensor magnetic field. I used this correct theory to create my experiments and got several evidences of the fail of the Lorentz force law and derived the numerous paradoxes that contradict the classical electromagnetic theory. See my blog <http://pengkuanem.blogspot.fr/>

So, my theory is correct and the Lorentz force law doubtlessly wrong. But why have I the greatest difficulty to make my theory accepted? This is because the classical electromagnetic theory seems flawless. In the past, great breakthroughs in physics were generally made when the old theories have already collapsed, contradicted by new phenomena obtained by accident. The physical community was waiting for new theories.

But with classical electromagnetic theory everyone is happy and no experimental counter-evidence exists. So, it is absolutely necessary to prove experimentally that the classical electromagnetic theory is wrong. This can be done rapidly since the correct theory already exists. I have proposed several experiment designs in my blog. In order to secure the credibility of the experimental evidences, they must be repeated by numerous laboratories. This is why I have been calling for experimenter.

As my experiments have confirmed, real magnetic field is a tensor field. Maxwell's equations use only vector and must be amended. Maxwell has invented a quantity called displacement current in vacuum to keep his equations coherent. Then he used it to derive the wave equation. The tensor nature of magnetic field invalids Maxwell's equations; my paradoxes invalidate displacement current in vacuum. So, electromagnetic wave equation will also be invalidated. See

Displacement magnetism experiment design,

<http://pengkuanem.blogspot.com/2012/07/displacement-magnetism-experiment-design.html>

Energy density of electromagnetic wave

<http://pengkuanem.blogspot.com/2013/01/energy-density-of-electromagnetic-wave.html>

You see, the Maxwell system will fall like a card castle.

We are into a scientific revolution as great as the quantum and relativity ones. Young scientists dream to live in the time of Newton or Einstein. By chance, we are in a such time! How exciting to take part in this revolution by carrying out key experiments and promoting the new theory! By doing so, you will gain the right to say in the future, when they talk about the tensor revolution of electromagnetic theory: "We've done it!"