The magnetic field given by Ampere's law is zero but the motor rotates

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Note: The original title is "The magnetic field is zero but the motor works". But I have found that it has led people thinking that I claim that the magnetic field is actually zero. This is not my position. Only Ampere's law gives zero but not the experiment. So, I have changed the title.

1. The motor that puts Ampere's law in trouble

The magnetic field outside an infinite solenoid is zero. This is taught in all text books. Here are 3 links about the magnetic field of a solenoid:
From Wikipedia, Solenoid ; From Hyperphysics: solenoid ; Q&A from Department of Physics University of Illinois at Urbana-Champaign: "Why is the magnetic field around a solenoid zero?"

With good accuracy, the magnetic field in the middle region outside a long bar magnet is zero. So, the Lorentz force must be zero there. But look at the video of my experiment "Macroscopic Aharonov–Bohm effect motor" http://youtu.be/786wRJqhoMY. Does the coil rotate without force?

Let us calculate the magnetic field outside a bar magnet in the mid-plane perpendicular to it. According to Ampere's law, the line integral of the magnetic field on the closed rectangular contour "abcd" (Figure 1) equals the current that crosses the enclosed surface. As no current crosses it, the line integral is zero.

The Figure 2 shows that the field vectors in the mid-plane are perpendicular to it. Thus, the vectors $\mathbf{B}_1$ and $\mathbf{B}_3$ are perpendicular to ab and cd which are infinitely close to the plane. This implies that the line integrals of $\mathbf{B}_1$ on ab and $\mathbf{B}_3$ on cd are zero. If we stretch ab to infinity, the magnetic field $\mathbf{B}_2$ is zero. As the line integral on abcd is zero, the vectors $\mathbf{B}_2$ and $\mathbf{B}_4$ are equal and then, $\mathbf{B}_4$ is zero. So, the magnetic field $\mathbf{B}_4$ is zero in the entire mid-plane outside a bar magnet.

This is a result of Ampere's law. Actually, I have computed the ratio of the magnitude of the magnetic field between the mid-point and the ends for my bar magnet. The value is <5%.

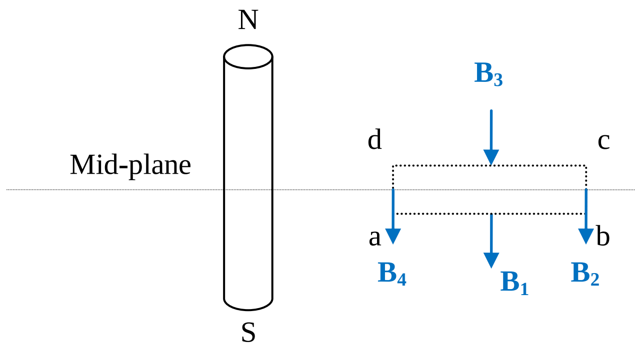

Figure 1

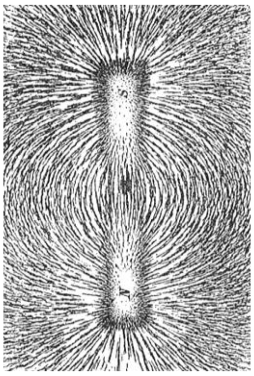

Figure 2

In the beginning of my video, I have tested the magnetic field with an iron bolt. We see that it is attracted by both ends but not by the middle of the magnet. So, the magnetic field is negligible there. The prediction of Ampere's law is corroborated by the bolt.

But the functioning of the motor shows clearly that the magnetic field is strong enough to make the coil rotate rapidly near and away from the bar magnet. The prediction of Ampere's law is contradicted by the motor. So, Ampere's law is incorrect.

2. Lorentz force law in trouble

Usually magnetic force is computed using the Lorentz force law and is called Lorentz force. Because the magnetic field given by Ampere's law is zero, the Lorentz force should be zero too. This is incorrect since the rotation of the coil shows a strong magnetic force.

However, the magnetic force shown by the motor is predicted by my corrected magnetic force law given in Unknown properties of magnetic force and Lorentz force law(word), (pdf). Briefly, magnetic force is a tensor product:

$$d\boldsymbol{F} = [d\boldsymbol{I}_2][\boldsymbol{M}] \tag{1}$$

where $[\boldsymbol{M}]$ is the 3×3 magnetic field tensor and $[d\boldsymbol{I}_2]$ is the line tensor of the current element.

See **Why magnetic field must be a tensor? (pdf, word)** for more detail. In **Macroscopic Aharonov–Bohm effect experiment and theory (word), (PDF)** , I have given the expression for the forces that drive the motor, the vectors $\mathbf{F}_1$ and $\mathbf{F}_2$ in the Figure 4.

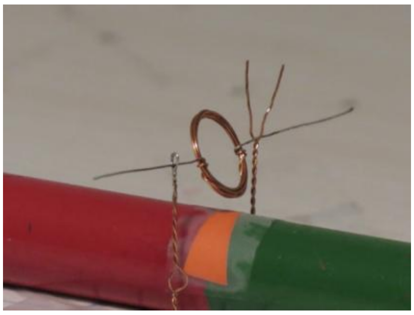

Figure 3

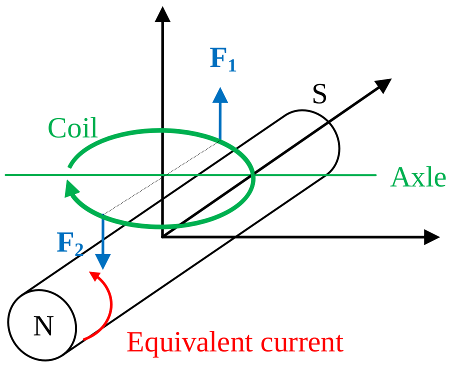

Figure 4

3. Faraday's law in trouble

The energy conservation law is the absolute law that all things respect. This motor is no exception. So, the mechanical power P_{mech} lost by the coil plus the thermal power lost by the resistance P_{therm} equals the electric power provided by the battery P_{elect}, that is:

$$P_{mech} + P_{therm} = P_{elect} \tag{2}$$

The voltage for the mechanical power is computed from the electric power minus the thermal power:

$$U_{mech} = \frac{P_{elect} - P_{therm}}{I} \tag{3}$$

where I is the current intensity.

The voltage induced by the movement of the coil in the magnetic field is given by Faraday’s law and must be equal to the voltage for the mechanical power:

$$U_{Faraday} = -\frac{\partial \Phi}{\partial t} = U_{mech} \tag{4}$$

However, the magnetic field vector given by Ampere’s law is zero. Thus, Faraday’s law gives zero:

$$\Phi = 0 \Rightarrow \frac{\partial \Phi}{\partial t} = 0 \Rightarrow U_{Faraday} = 0 \tag{5}$$

As the equation (3) is exact, the result from Faraday’s law is false. So, Faraday’s law is incorrect.

I wanted to do an experiment to show the fail of Faraday’s law by measuring the voltage. It seems that this motor has done the job.

4. Comments

Classic electromagnetism is a self-consistent intricate theory with all its laws linked together. This is its strength but also its weakness. Once the Ampere’s law is proven wrong, the Lorentz force law and Faraday’s law fall like dominos. As no law can be individually rescued, the entire theory should be overhauled.

Someone has argued that, since the coil rotates, the magnetic field is not zero and, the Lorentz force law still holds. But the reasoning does not go this way. The point here is: Ampere’s law is refuted by experiment and the law is proven wrong.

If you measure the actual magnetic field, you will get confusing result, the kind like the contradicting magnetic field found by the iron bolt and the coil. During the rotation of the coil, the bolt shows still no field around the coil. This is because the real magnetic field is a non-zero tensor which is incompatible with the Lorentz force law and Faraday’s law. Thus, they fail.

Can we find practical use for this motor? Probably not. But this motor is itself a useful tool. If you are a physics student, you can make one and challenge your professor with. Bring it to your classroom and ask your professor:

You: “Professor, around the middle of a long bar magnet, is the magnetic field zero?”
Professor: “Have you learned your lesson? Simply use Ampere’s law with a rectangular path and Blah, Blah, Blah …”
You: “Ah, this is why the iron bolt is not attracted here.”
You show the suspended iron bolt near the middle.
Professor: “You see. The field is zero.”
You: “But, why does this coil rotates here, Professor?”
And you show the motor.
Professor: “💣✂👓★🔔☆☠!”

You win because he cannot explain the contradicting effects with his wrong theory.

There is another thing that we can do with this motor: Construct it as a science toy kit and sell it to physical schools and students. This motor is a perfect tool to show the fail of classic theory. What about selling in the world *1* million units at $10 each? Is any company interested?