Computation of the self force of a coil

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The object of this article is to compute the overall Lorentz force a coil exerts on itself. For the coil shown in Figure 1 (1), which is composed by 2 parts, 'a' and 'b' and connected together through 2 condensers, we compute the forces on each part, then sum the 2 forces. Naturally, many physicists suggest to compute the force by integrating the Lorentz force on the wire produced by the magnetic field in the vicinity of the wire, $\vec{B}_1$. In this way, the force on the part 'a' of the coil, $\vec{F}_1$, will be computed as below:

$$\vec{F}_1 = \int_a I d\vec{l} \times \vec{B}_1$$
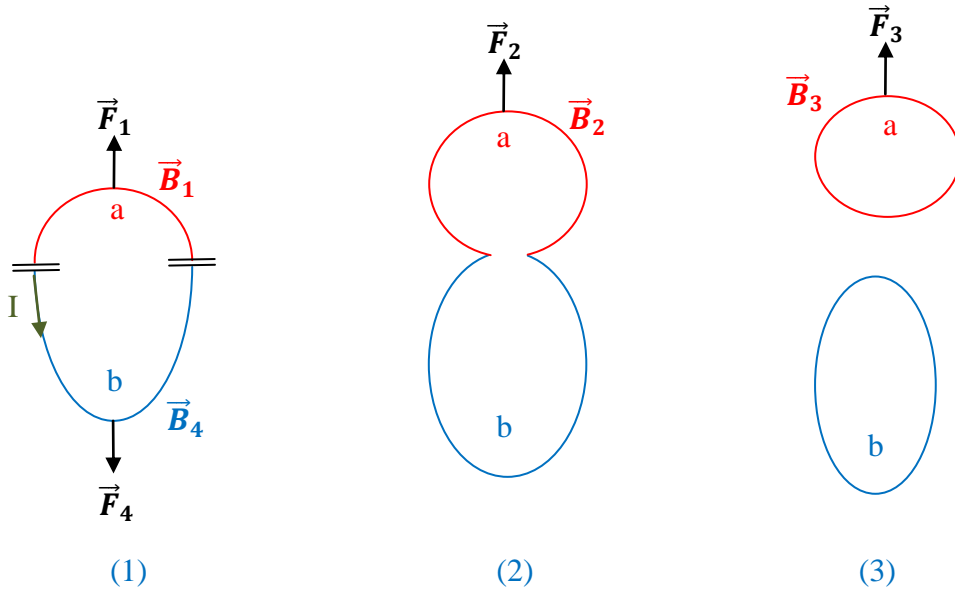

Figure 1

But are we sure what exactly $\vec{B}_1$ is? At a point 's' on the wire, the magnetic field $\vec{B}_1(s)$ is the sum of the magnetic fields from the part 'a', $\vec{B}_{1,a}$, and from the part 'b', $\vec{B}_{1,b}$. By integrating the Biot-Savart law over the part 'a' excepting the point 's' itself and over the part 'b', $\vec{B}_1(s)$ is:

$$\vec{B}_1(s) = \int_{a-s} I d\vec{l}_a \times \vec{r} + \int_b I d\vec{l}_b \times \vec{r}$$
$$\vec{B}_1 = \vec{B}_{1,a} + \vec{B}_{1,b}$$

Then, the Lorentz force on 'a' is the sum of $\vec{F}_{1,a}$ from 'a' and $\vec{F}_{1,b}$ from 'b':

$$\vec{F}_1 = \int_a I d\vec{l} \times (\vec{B}_{1,a} + \vec{B}_{1,b}) = \vec{F}_{1,a} + \vec{F}_{1,b} \tag{1}$$

$\vec{F}_{1,a}$ is the force the part 'a' exerts on itself. Normally, according to Newton's third law, $\vec{F}_{1,a}$ should be zero and $\vec{F}_1$ should be simply:

$$\vec{F}_1 = \int_a I d\vec{l} \times \vec{B}_{1,b} = \vec{F}_{1,b} \tag{2}$$

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Figure 1 (3) illustrates clearly this. In Figure 1 (3) 'a' and 'b' are two closed coils. The Lorentz force on the coil 'a' is produced by the magnetic field from 'b', $\vec{B}_{3,b}$:

$$\vec{F}_3 = \int_a Id\vec{l} \times \vec{B}_{3,b}$$

In fact, we have implicitly excluded the field from the coil 'a' itself, $\vec{B}_{3,a}$. This is correct because in Figure 1 (3) 'a' is an independent magnetic body and the force a body exerts on itself is 0:

$$\vec{F}_{3,a} = \int_a Id\vec{l} \times \vec{B}_{3,a} = 0$$

It is logical that $\vec{F}_3$ is exerted by the body 'b' only. For the single coil in Figure 1 (1), the parts 'a' and 'b' are also two magnetic bodies. They are not fundamentally different from the 2 coils of Figure 1 (3), as the merge of two distinct coils into one single coil shows (see Figure 1 (2)). We can also see the 2 coils in Figure 1 (3) to be wires of finite length just like the parts 'a' and 'b' in Figure 1 (1).

So, by applying the same logic to Figure 1 (1), we conclude that equation (2) is correct. But why is equation (1) wrong? In fact, because the part 'a' is a semicircle wire, Lorentz force being perpendicular to current, all Lorentz forces on the wire have a positive vertical component and then, the integration of them gives rise to a nonzero self force $\vec{F}_{1,a}$:

$$\vec{F}_{1,a} = \int_a Id\vec{l} \times \vec{B}_{1,a} \neq 0$$

In the same way, there is also a self force on the part 'b', $\vec{F}_{1,b}$. The sum $\vec{F}_{1,a} + \vec{F}_{1,b}$ is the self force on the whole coil. As the Lorentz force that a closed coil exerts on itself is zero, the self force on the whole coil is equal to the inverse of the force the part 'b' exerts on the part 'a', $\vec{F}_1$, plus $\vec{F}_4$, the force the part 'a' exerts on the part 'b'. That is:

$$\vec{F}_{1,a} + \vec{F}_{1,b} = -\left(\vec{F}_1 + \vec{F}_4\right)$$

$\vec{F}_1$ is given by equation (2) , $\vec{F}_4$ is given below:

$$\vec{F}_4 = \int_b Id\vec{l} \times \vec{B}_{4,a}$$

I have computed $\vec{F}_1 + \vec{F}_4$ for a closed coil. Figure 2 shows the computed coil whose part 'a' is a semicircle and the part 'b' is a semi-ellipse. The values of $\vec{F}_1$ and $\vec{F}_4$ as well as $\vec{F}_1 + \vec{F}_4$ are given in Table 1. $\vec{F}_1 + \vec{F}_4$ is drawn against the numbers of segments in Figure 3. We see that $\vec{F}_1 + \vec{F}_4$ reaches a nonzero limit when N is large.

Nonzero self force is unphysical because it would make the coil walk without any external force. As the nonzero self force is correctly computed with the Lorentz force law, it indicates that this law is wrong.
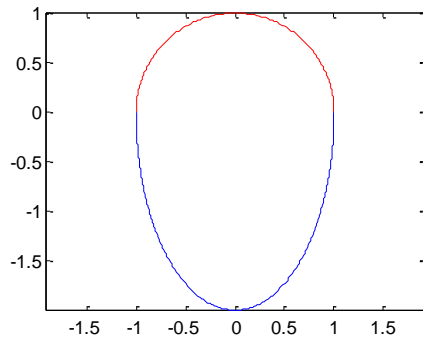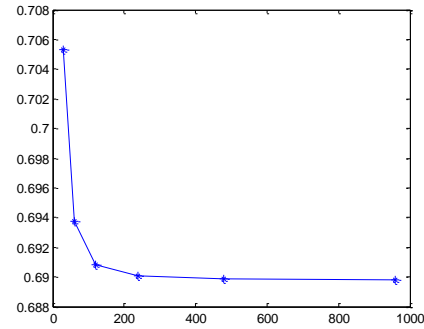
Figure 2

Figure 3

Segments	Force in 10^{-7} Newton		
N	F_1	F_4	$F_1 + F_4$
30	1.6365	-0.9312	0.7053
60	1.6197	-0.9259	0.6937
120	1.6154	-0.9246	0.6908
240	1.6144	-0.9243	0.6901
480	1.6141	-0.9242	0.6899
960	1.6140	-0.9242	0.6898

Table 1

Comment

The Lorentz force on a part of a coil must be computed with the magnetic field of the complementary part of the same coil. This appears to me as the natural choice, but some physicists have argued that the Lorentz force should be computed with the total magnetic field. To answer their argument, I have given the above demonstration.

This is the 48th article I published by myself to show the inconsistency of the Lorentz force law. Many of my articles are written to answer an argument. I begun by providing theoretical proofs about the inconsistency with triangle and polygons in **Analyze of the Lorentz forces internal to an equilateral triangle coil** blogspot and **Lorentz forces internal to a polygon coil, analyze and computation,** blogspot. To answer other objections, I have written many articles, for example **Unhappiness of Newton with Lorentz and triangular coil experiment** blogspot academia. The more I write, the better I understand this law and the physicists' way of thinking about the law and the more various proofs I provide. With the number of proofs increasing, the Lorentz force law looks more and more impossible to be correct.

If you have understood and agree with one of my proofs, you are an elite physicist of 21st century, because you search for truth by yourself against the atmosphere of blind belief in established theory. Like heliocentrism that was combated fiercely by believers of geocentrism, the new theory of magnetic force will surely win at last. However, truth does not win simply because it is true, but because believers of old ideas change their mind before irrefutable experimental proofs.

In science, only one contradiction is sufficient to topple a law, but you need much more than a correct proof to convince scientists, since each one has his own way of understanding the law. It is very difficult to make them changing their belief in the law. Even after Galileo had

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shown the phases of Venus and the four satellites of Jupiter, heliocentrism was still refuted during a long period.

I have shown 2 experiments indicating the way of success for the new law, but they are too crude to be publishable (see **Unknown properties of magnetic force and Lorentz force law** blogspot academia). The Galileo of 21st century will be the one who will show convincing experimental proofs disproving the Lorentz force law and validating the corrected magnetic force law.

Program of computation

Executable in Matlab.

```
ax=2;nt=80;
th=(-1:2/(nt*ax):1)*pi/2;
tc=(-1:2/nt:1)*pi/2;
tc=tc+pi;
xh=[ax*cos(th);sin(th)];
xc=[cos(tc);sin(tc)];

a=1;
na=2;xdisp=zeros(na,7);
for ia=1:na
 if ia==1
s2=xh;s1=xc;
 else
s1=xh;s2=xc;
 end
lc=s1;m=length(lc)-1;
x1=(lc(:,2:m+1)+lc(:,1:m))/2;dI1=lc(:,2:m+1)-lc(:,1:m);%
lc=s2;n=length(lc)-1;
x2=(lc(:,2:n+1)+lc(:,1:n))/2;dI2=lc(:,2:n+1)-lc(:,1:n);%

ddfamp=zeros(2,m,n);ddffic=ddfamp;
dfamp=zeros(2,n);dffic=dfamp;dcplamp=dfamp;dcplfic=dfamp;
%Differential force
for j=1:n
for i=1:m
   r12=x2(:,j)-x1(:,i);vr=r12/norm(r12)^3; %radius coefficient
   ddfamp(:,i,j)=-dot(dI2(:,j),dI1(:,i))*vr; %diff force ampere
   ddffic(:,i,j)=dot(dI2(:,j),vr)*dI1(:,i); %diff force fictive
end
end
% First integral
for j=1:n
trp=ddfamp(:,:,j);dfamp(:,j)=sum(trp,2);
trp=ddffic(:,:,j);dffic(:,j)=sum(trp,2);
end
```

```
% Second integral
trp=dfamp;famp=sum(trp,2)*a; %force ampere
trp=dffic;ffic=sum(trp,2)*a; %force fictive
florentz=famp+ffic; %force  lorentz
xdisp(ia,1:5)=[m+n,florentz(1),famp(1),florentz(2),famp(2)];
end
plot(s2(2,:),-s2(1,:),'r-',s1(2,:),-s1(1,:),'b-');axis equal;
xstay=[xstay;[m+n,-xdisp(1,2),-xdisp(2,2),-xdisp(1,2)-xdisp(2,2)]]
return
```