The Magnetic field of the Electric current and the Magnetic induction

This paper intend to explain the magnetic effect of the steady *electric current, from some new point of view based on the simple observed effects of the accelerating electrons, causing naturally the experienced changes of the electric field potential along the electric wire. The changing acceleration of the electrons explains the created negative electric field of the magnetic induction also.*

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Abstract

Surprisingly nobody found strange that the electrons are not accelerated in a steady electric current, although there is an E electric field along the wire imposed by the U potential difference. The accelerated electrons are creating a charge density distribution and maintaining the potential change along the wire. This charge distribution also creates a radial electrostatic field around the wire decreasing along the wire. The moving external electrons in this electrostatic field are experiencing a changing electrostatic field causing exactly the magnetic effect, repelling when moving against the direction of the current and attracting when moving in the direction of the current. This way the A magnetic potential is based on the real charge distribution of the electrons caused by their acceleration, maintaining the E electric field and the A magnetic potential at the same time.

More importantly the accelerating electrons can explain the magnetic induction also. The changing acceleration of the electrons will create a –E electric field by changing the charge distribution, increasing acceleration lowering the charge density and decreasing acceleration causing an increasing charge density.

The mysterious property of the matter that the electric potential difference is self maintained by the accelerating electrons in the electric current gives a clear explanation to the basic sentence of the relativity that is the velocity of the light is the maximum velocity of the electromagnetic matter. If the charge could move faster than the electromagnetic field than this self maintaining electromagnetic property of the electric current would be failed.

In the atomic scale the Heisenberg uncertainty relation gives the same result, since the moving electron in the atom accelerating in the electric field of the proton, causing a charge distribution on delta x

position difference and with a delta p momentum difference such a way that they product is about the half Planck reduced constant. For the proton this delta x much less in the nucleon, than in the orbit of the electron in the atom, the delta p is much higher because of the greater proton mass.

Simple Experiment

Everybody can repeat my teacher's middle school experiment, placing aluminum folios in form V upside down on the electric wire with static electric current, and seeing them open up measuring the electric potential created by the charge distribution, caused by the acceleration of the electrons. You will see that the folios will draw a parabolic curve, since the way of the accelerated electrons in the wire is proportional with the square of time. This parabolic curve shows the equipotential lines around the wire, where the free external charges are moving, repelled if moving against the direction of the electric current and attracted in the same direction – the magnetic effect of the electric current.

The uniformly accelerated electrons of the steady current

In the steady current $I= dq / dt$, the q electric charge crossing the electric wire at any place in the same time is constant. This does not require that the electrons should move with a constant v velocity and does not exclude the possibility that under the constant electric force created by the $E = - dU / dx$ potential changes the electrons could accelerating.

If the electrons accelerating under the influence of the electric force, then they would arrive to the $x = 1/2a\ t^2$ in the wire. The $dx/dt = at$, means that every second the accelerating q charge will take a linearly growing length of the wire. For simplicity if a=2 then the electrons would found in the wire at x = 1, 4, 9, 16, 25 …, which means that the dx between them should be 3, 5, 7, 9 …, linearly increasing the volume containing the same q electric charge. It means the density of the electric charge decreasing linearly and as the consequence of this the U field is decreasing linearly as expected: $-dU/dx = E = const.$ We can conclude that the electrons are accelerated by the electric U potential, and with this accelerated motion they are maintaining the linear potential decreasing of the U potential along they movement. Important to mention, that the linearly decreasing charge density measured in the referential frame of the moving electrons. Along the wire in its referential frame the charge density lowering parabolic, since the charges takes way proportional with the square of time.

The difference between these two referential frames, namely the referential frame of the wire and the referential frame of the moving electrons gives the relativistic effect. Important to say that the moving electrons presenting the time coordinate, since the electrons are taking linearly increasing way every next time period, and the wire presenting the geometric coordinate. The Lorentz transformations are based on moving light sources of the Michelson - Morley experiment giving a practical method to transform time and geometric coordinates without explaining the source of this mystery. The real mystery is that the accelerating charges are maintaining the accelerating force with their charge distribution locally.

The decreasing U potential is measurable, simply by measuring it at any place along the wire. One of the simple visualizations is the aluminum foils placed on the wire opening differently depending on the local charge density. The static electricity is changing with parabolic potential giving the equipotential line for the external moving electrons in the surrounding of the wire.

The magnetic effect of the decreasing U electric potential

One q electric charge moving parallel along the wire outside of it with velocity v would experience a changing U electric potential along the wire. If it experiencing an emerging potential, it will repel the charge, in case of decreasing U potential it will move closer to the wire. This is exactly the magnetic effect of the electric current.

Magnetic induction

Increasing the electric current I causes increasing magnetic field B by increasing the acceleration of the electrons in the wire, because the number of electric charges is growing with the U electric potential. If the acceleration of electrons is growing, than the charge density dQ/dl will decrease, creating a –E electric field. Since the resistance of the wire is constant, only increasing U electric potential could cause an increasing electric current I=dQ/dt. The electric field is a result of the geometric change of the U potential and the timely change of the A magnetic potential:

$E = - dA/dt - dU/dx$

Necessary to mention that decreasing electric current will decrease the acceleration of the electrons, causing increased charge density and E positive field.

The Lorentz transformation of the Special Relativity

In the frame of the accelerating electrons the charge density lowering linearly because of the linearly growing way they takes every next time period. From the frame of the wire there is a parabolic charge density lowering and this is the source of the relativistic effect.

Heisenberg uncertainty relation

In the atomic scale the Heisenberg uncertainty relation gives the same result, since the moving electron in the atom accelerating in the electric field of the proton, causing a charge distribution on delta x position difference and with a delta p momentum difference such a way that they product is about the half Planck reduced constant. For the proton this delta x much less in the nucleon, than in the orbit of the electron in the atom, the delta p is much higher because of the greater proton mass.

This means that the electron is not a point like particle, but has a real charge distribution.

Conclusions

Needless to say that the accelerating electrons of the steady stationary current are a simple demystification of the magnetic field, by creating a decreasing charge distribution along the wire, maintaining the decreasing U potential and creating the A vector potential experienced by the electrons moving by v velocity relative to the wire. This way it is easier to understand also the time dependent changes of the electric current and the electromagnetic waves as the resulting fields moving by c velocity.

It could be possible something very important law of the nature behind the self maintaining E accelerating force by the accelerated electrons. The accelerated electrons created electromagnetic fields are so natural that they occur as electromagnetic waves traveling with velocity c.