Consequences of macroscopic Aharonov-Bohm effect

Peng Kuan 彭宽 titang78@gmail.com

4 July 2013

The importance of the Aharonov–Bohm effect is underlined by the qualification "one of the seven wonders of the quantum world" by the New Scientist magazine. Why is this effect so important in physics? Here is an explanation, page "Aharonov–Bohm effect" from Wikipedia:

> http://en.wikipedia.org/wiki/Aharonov%E2%80%93Bohm_effect
> The Aharonov–Bohm effect is important conceptually because it bears on three issues apparent in the recasting of (Maxwell's) classical electromagnetic theory as a gauge theory, which before the advent of quantum mechanics could be argued to be a mathematical reformulation with no physical consequences. The Aharonov–Bohm thought experiments and their experimental realization imply that the issues were not just philosophical.
> The three issues are:
> 1) Whether potentials are "physical" or just a convenient tool for calculating force fields;
> 2) Whether action principles are fundamental;
> 3) The principle of locality.

The magnetic field of a solenoid can be simulated by a bar magnet. I have preformed an experiment showing a bar magnet exerting a force on a current and another showing the attraction force the bar magnet exerts on small iron bit and aluminum scraps. I have also derived a theoretical law for this force using my corrected magnetic force law. See:

Non-Lorentzian Magnetic force and Aharonov-Bohm effect in CRT
http://pengkuanem.blogspot.com/2013/06/non-lorentzian-magnetic-force-and.html
Macroscopic Aharonov–Bohm effect experiment and theory
http://pengkuanem.blogspot.com/2013/06/macroscopic-aharonovbohm-effect.html
Unknown properties of magnetic force and Lorentz force law
http://pengkuanem.blogspot.com/2013/04/unknown-properties-of-magnetic-force.html

These experiments and theory have consequences on the traditional explanation for the Aharonov–Bohm effect. In the following, I will explain the implication of my experiments and theory with respect to the three points above. First point: "Whether potentials are 'physical' or just a convenient tool for calculating force fields". In the page "Aharonov–Bohm effect" of Wikipedia we read:

> http://en.wikipedia.org/wiki/Aharonov%E2%80%93Bohm_effect
> **Potentials vs. fields**
> The Aharonov–Bohm effect illustrates the physicality of electromagnetic potentials, Φ and A. Previously it was possible to argue that only the electromagnetic fields are physical, while the electromagnetic potentials are purely mathematical constructs, that due to gauge freedom aren't even unique for a given electromagnetic field. Electric and magnetic fields and forces are, however, gauge invariant and therefore directly observable, and unlike potentials, appear in the Lorentz force formula.

What does deflect moving electrons in a region where magnetic field is zero? There, the only nonzero physical quantity is magnetic vector potential. So, the Aharonov–Bohm effect is considered as a direct action of the magnetic vector potential on electron. This idea was a major innovation in physics in that potential became materially active just as force.

But my experiments show that the bar magnet exerts a force on the current carrying wire and makes it move, that the bar magnet exerts an attraction force on small piece of iron and aluminum scraps and attach them on its surface. So, a real magnetic force exists in the region near the middle of the bar magnet. This force explains the Aharonov–Bohm effect. In consequence, the magnetic vector potential is not the cause of this effect and "direct action of potential" collapses.

Second point: "Whether action principles are fundamental". In the page "Aharonov–Bohm effect" of Wikipedia we read:

> http://en.wikipedia.org/wiki/Aharonov%E2%80%93Bohm_effect
> **Global action vs. local forces**
> Similarly, the Aharonov–Bohm effect illustrates that the Lagrangian approach to dynamics, based on energies, is not just a computational aid to the Newtonian approach, based on forces. Thus the Aharonov–Bohm effect validates the view that forces are an incomplete way to formulate physics, and potential energies must be used instead.

We do not possess a law for the action of magnetic vector potential. In other words, we do not know how and where it acts on electron. So, this action is thought to be a "global action" over the entire trajectory of a moving electron. The idea of global action is as fundamental as force.

My theory and experiments prove that the Aharonov–Bohm effect is the consequence of a local force with precise law of application. Thus, "global action" collapses.

Third point: "The principle of locality". In the page "Aharonov–Bohm effect" of Wikipedia we read:

> http://en.wikipedia.org/wiki/Aharonov%E2%80%93Bohm_effect
> **Locality of electromagnetic effects**
> The Aharonov–Bohm effect shows that the local E and B fields do not contain full information about the electromagnetic field, and the electromagnetic four-potential, (Φ,A), must be used instead. By Stokes' theorem, the magnitude of the Aharonov–Bohm effect can be calculated using the electromagnetic fields alone, or using the four-potential alone. But when using just the electromagnetic fields, the effect depends on the field values in a region from which the test particle is excluded. In contrast, when using just the electromagnetic four-potential, the effect only depends on the potential in the region where the test particle is allowed. Therefore we can either abandon the principle of locality, which most physicists are reluctant to do, or we are forced to accept that the electromagnetic four-potential offers a more complete description of electromagnetism than the electric and magnetic fields can. In classical electromagnetism the two descriptions were equivalent. With the addition of quantum theory, though, the electromagnetic potentials Φ and A are seen as being more fundamental. Despite this, all observable effects end up being expressible in terms of the electromagnetic fields, E and B. This is interesting because, while you can calculate the electromagnetic field from the four-potential, due to gauge freedom the reverse is not true.

This effect is thought to manifest only on microscopic level where quantum effect predominates. Coincidently, magnetic field is located in a region separated from its action, suggesting the "spooky action at a distance" of quantum entanglement. Thus, this effect is seen as an important experimental proof of quantum action at a distance.

My experiments have shown that this effect is due to a macroscopic force that acts on electrons at their precise location. Thus, the quantum meaning of this effect collapses.

The Aharonov–Bohm effect has played an important role in electromagnetic gauge theory. In the page "Introduction to gauge theory" of Wikipedia, http://en.wikipedia.org/wiki/Introduction_to_gauge_theory
the only physical experiment cited as illustration is the Aharonov–Bohm effect, because it is the only experimental manifestation of direct action of potential. Now, gauge theory has lost its most important experimental proof.

Comment

In summary, physicists have invented direct action of potential, a fundamental global action for explaining the Aharonov–Bohm effect. They have also seen in this effect the salvaging experimental proof of quantum action at a distance similar to entanglement. But the real cause of this effect is a force and all these “fundamental discoveries” become illusion. Because of these grave consequences, the experiments Aharonov–Bohm effect in CRT, macroscopic Aharonov–Bohm effect with current and solenoid and measurement of the magnitude of macroscopic Aharonov–Bohm force are very important. Do not hesitate to perform them.

By the way, for doing the Aharonov–Bohm effect in CRT experiment, it may be more convenient to dispose the solenoids horizontally rather than vertically as I first suggested. This way one can easily change the length of the solenoids and compare the difference of effect.

Before constructing the solenoids, one can test the force on electron beam with a bar magnet. By varying the distance between the bar magnet and the CRT, one will see the light dot on the screen moving. This test can help defining parameters such as length, diameter, number of turns and current for the solenoids and voltage for the CRT.