How the Magnetic Field Works

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The existence of the magnetic field and the force it creates has been known for a long time, but just how this magnetic field works and what creates the forces that magnets exert has remained a complete mystery. This paper attempts to fully explain the origin and the physical mechanics behind the magnetic force as being mediated by an invisible positron/electron dipole sea which can be polarized as a magnetic field and can deflect electrons which are passing through it.

1. What mediates the magnetic field

When we put a nail near a magnet, we say that the nail is attracted to the "magnetic field". But just what is this magnetic field? It seems like the magnet creates a special area around the magnet where it exerts a force on other objects without touching them. What could this magnetic "field" made out of? What is different between a region of space which has a magnetic field and one that doesn't?

If you were a farmer, you might think of a "field" like a field of corn, which is made out of individual stalks and these are what fills the space in the farm. So this is one way to think of a "field" which an area which is filled with identical objects. So, you might also think of a "magnetic" field as being an area that is filled with some kind of object. Suppose we filled a field full of flags instead of corn. If we have the wind blow through the field, all the flags will align in the same direction. So now we have a field which can have the characteristic that it can "point" in a particular direction. So instead of the flags being randomly oriented, we can say there is a "field" where all the flags are pointed in the same direction. This analogy is the key to understanding how the magnetic field works.

I would assert there must absolutely be something physical, made out of real physical particles that act just like the flags in the wind analogy which form a field. When all of these particles "point" in the same direction, this is what we recognize as a "magnetic" field. So we start out with a sea of randomly oriented particles that fills all of space. When those particles are aligned to point in a single direction, that is what I would call a magnetic field.

But what could possibly be this sea of flag-like particles that mediates the magnetic field? Whatever this sea is built out of must be extremely difficult to detect. This field is pervasive and must exist everywhere including the vacuum of space since magnetic fields can pass through a perfect vacuum. No "field" of physical particles has ever been detected in a vacuum. However, one of the most difficult particles to detect are "neutral" particles. These particles are a combination of positive and negative charge and on the whole, they don't have a net charge. These neutral particles interact very little with matter. They don't leave traces in our particle physics experiments because there is nothing to trigger a trace in a cloud chamber or to record the passage of a particle through a detector. These are invisible ghost particles. The most common neutral particle we know of is the neutron, but this decays in about 15 minutes, so we can't make the magnetic sea field out of this unstable particle.

2. The neutral poselectron particle

The simplest neutral particle that we could think of would consist of a single negative charge from an electron and a single positive charge from a proton. But this is known as simple hydrogen. A vacuum is not filled with hydrogen. But there is another hypothetical particle which is would be even simpler than a hydrogen atom. This particle would consist of a 'positron' and an electron. This will be called a 'poselectron' in this paper since it is made out of a positron and an electron. The positron is the anti-matter equivalent of the electron. It is identical to the electron in every way except that it has the opposite positive charge. It should not be confused with the much more complex proton which is nearly 2000 times more massive.

However, since the positron is the anti-matter partner of the electron, when you bring them together, they annihilate themselves and are converted in to gamma rays. Conventional wisdom says that the particles were "converted" into energy and there is nothing left of the "particles". This concept that matter has been converted into energy has been pounded into everyone's brain since birth and the evidence that the energy follows E=mc^2 is used to assert that the mass must have been destroyed. So theoretically, the poselectron cannot exist in the minds of most people.

However, what is the real evidence that it didn't actually produce a neutral poselectron particle? If a neutral particle were to be formed out of a positron and electron, the result would be exceedingly difficult to detect. It would not show up on any of our detectors and would appear as nothing. So the evidence that we don't "see" anything is not particularly good evidence that the positron and electron really disappeared into energy. We would fully expect that if a positron and electron did form a bond instead of being destroyed, that we wouldn't be able to easily detect the resulting particle. This would be especially true if the particle disappeared into a sea of identical particles.

This would be similar to watching 2 hydrogen atoms and an oxygen atom combine in a sea of water. You would see energy coming from the reaction and then the hydrogen and oxygen atom would apparently disappear because you can't tell the difference between the newly formed water molecule and all the existing water molecules surrounding it. It is completely hidden from view. Remember that this is the same logic used to say that matter was destroyed because we saw the creation of energy. There is no difference in the logic, but we know that the oxygen and hydrogen were not destroyed, so why do we think the positron and electron were destroyed?

How could we determine if the positron and electron still existed? One way would be to break up the positron/electron particle and then we would see a free positron and electron sprout

out of nowhere. This is exactly what happens in "pair-production". We see gamma rays causing positrons and electrons to appear out of nowhere. We also see positrons and electrons sprouting out of empty space in massive quantities in high energy accelerator experiments. These particles are often considered "junk" reactions and are totally ignored, but it is these "junk" reactions that is telling you that space is made out of poselectrons.

What we have now is that the poselectron has found the ultimate hiding place in the universe. Nobody has found the poselectron yet, because everyone thinks it cannot exist. It is the perfect crime – hiding in plain sight in the one place we think it cannot exist. However, we should be able to detect the presence of these particles if we take off our blinders and actually perform experiments to confirm or deny their existence. I am reminded of a quote from Einstein's critics that if you don't believe me, then do the experiments, you will find it to be true.

3. The magnetic field of poselectrons

If we take space as being made out of a sea of poselectrons, the mystery of the magnetic field can be solved. One characteristic of the magnetic field is has a "direction" for the magnetic field lines. This is like the direction that the flags are pointed in a field of flags. The poselectron is a "dipole" particle which means that it has a positive and a negative side. Therefore, it can "point" its positive end towards a particular direction. The poselectron particles would tend to align themselves so that negative/positive charges point at each other. However, it would not be likely that all of the dipoles would be aligned in the same direction. Smaller domains might be aligned, but overall, they would be pointing in random directions. If these domains could be aligned, then this would provide a "direction" or linear polarization for the magnetic field. An alignment of the poselectron sea could represent a "magnetic field". The orientation of the dipoles form a directional vector which shows which way the magnetic field is pointing.

It is also known that magnetic fields form in the presence of electrons in motion. If an electron were to move through the poselectron sea, what would it do to the alignment of the sea? As an electron passes by a dipole pair, the positive ends of the dipoles would tend to be pointed at the electron. As more electrons go in the same direction, it will "comb" the poselectron field to point in the same direction. This is like the wind combing a field of flags to all point in the same direction. This is why moving electric charges are intimately associated with creating a magnetic field. The moving electrons are taking the randomly oriented poselectron dipole sea and re-ordering it to all point in the same direction.

A region of this combed and aligned poselectron sea will influence the surrounding sea and cause it to be aligned as well and the degree of alignment will drop off with distance from the electrons which are causing the alignment. Once the electrons stop combing the field, random thermal energy will return the poselectron sea back to its random orientation. The poselectron sea can therefore provide a medium which can represent a vector direction for the magnetic field. The density or degree of alignment represent a vector magnitude. Therefore, the poselectron sea can represent the two most important aspects of a magnetic field which is a vector direction and magnitude.

4. How electrons deflect through a magnetic field

Now that we have established what a magnetic field consists of, we can explain why electrons are deflected in such a field. If an electron approaches at a 90 degree angle to the magnetic field lines which are aligned dipoles, it will see a negative charge on one side and a positive charge on the other as shown in Fig 1.

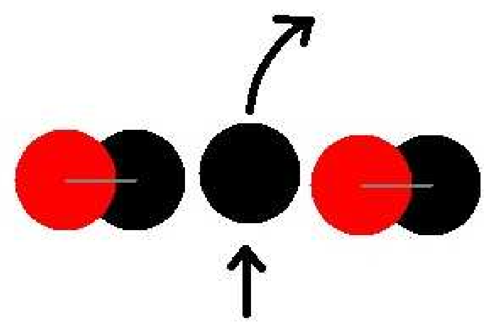


Fig. 1. Electron deflected towards the positive dipole

The electron will be attracted to the positive side and if all of the poselectrons are aligned in a similar manner, the electron will continue to be pulled to the positive side and the amount of force that gets applied will directly depend on the speed of the electron, since it gets a bump of force for every set of dipoles it goes by. The faster it goes, the more bumps it gets. This is why the magnetic force depends on the velocity of the electron. The force exerted on a charge in a magnetic field is expressed by:

$$F = qv \times B$$

Where q is the charge and v is the velocity and B is the magnetic field. This formula says that if the charge is stationary, then no force is exerted by the magnetic field with $v = 0$. The reason for this is if the charge is not moving, then it is not cutting through the dipole layers which is what gives the charge a kick every time it goes past a layer of dipoles. This explains the mystery of why an electron experiences no force in a magnetic field if it is not moving.

5. The magnetic field created by a current carrying wire

Let's consider the case of a single current carrying wire. If you fire an electron perpendicularly towards a current carrying wire, the magnetic force will cause the electron to deflect in the opposite direction as the real physical current flow. If you check the definition of the magnetic field direction and apply the right hand rule and apply it to electrons (be careful the right hand rule normally applies to positive charges and the physical current flow is opposite of what is shown for conventional current).

So why does the wire induce a force on an electron which is in the opposite direction of the electron flow? If we consider figure 1, this is the orientation of the poselectron particles for a current where the electrons are moving to the left. This leaves the positive ends pointing left, which are like flags blown to the left by a wind. We can see in the diagram that an electron approaching perpendicular to this field is deflected towards the right since the electron wants to move towards the positive side of the dipole. Therefore, we can see that the electron will be deflected in the opposite direction as the current which creates the magnetic field. The direction of the force works out to be the same using the conventional right hand rules, but for entirely different reasons.

This behavior of creating an induced electron flow which is in an opposite direction as the electrons which created the original magnetic field is seen in many magnetic phenomenon and is anti-intuitive why it should do that. This is usually stated as a magnetic field inducing a current which opposes the original magnetic field. The reason for this is that the original magnetic field combs the field such that any electrons entering it are deflected in the opposite direction which creates an opposing magnetic force.

6. The magnetic force on an electron running parallel to the current.

We have considered what happens if an electron enters a magnetic field created by a wire in a perpendicular fashion. What happens if it enters the field in a parallel fashion? If the dipole layers are all the same, then we would expect that no force would be experienced by the electron since it would have no incentive to be attracted up or down since the forces are all equal on all sides. However, if an electron is moving parallel to a diverging magnetic field (which means the field is getting weaker as the distance increases from the wire), the electron will actually also be deflected. Almost all magnetic fields are diverging in nature. This is because the magnetic field is being created by a local stream of moving electrons and the field strength drops as you get further away from that local electron stream.

The divergence creates a force because the stronger field will push the electron because the weaker field doesn't have enough strength to keep the electron from going parallel. Fig 2 shows an electron moving in a parallel path to a diverging magnetic field line where the stronger field is shown at the top as a larger red and black dipole. The current carrying wire can be thought to be at the top of this diagram with the electrons moving to the left. Depending on which direction the electron is headed, it is deflected either up or down. For an electron heading right in the opposite direction as the electrons in the wire, the last thing the electron sees as it goes by the dipole is the negatively charged side of the dipole. The electron sees a larger negative charge above it than below, so it is repelled downward by the larger negative charge in this figure and it follows the downward arrow path. If we consider the same electron heading to the left with the current, then the situation is reversed and the last thing the electron sees is the positive ends of the dipole. The electron will be attracted to the strongest positive charge which is at the top and the electron will be deflected upwards in this situation. So in both the parallel and perpendicular direction, an electron will experience a deflecting magnetic force only while it is moving. Once again, if you check this with your conventional definitions of the magnetic field force, you will find that this is the case.

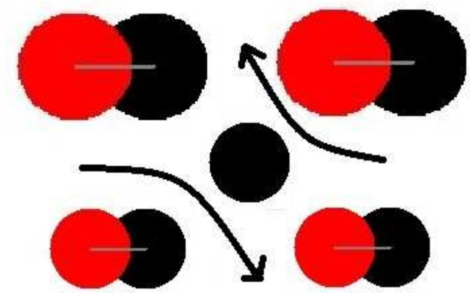


Fig. 2. Electron deflected up or down through diverging magnetic field.

7. The magnetic field between parallel wires

Let us consider the magnetic force exerted by two parallel wires which have the current flowing through them The magnetic force causes the two wires to attract if the current if flowing in the same direction and causes a repelling force if the current is flowing in the opposite direction. Why does this happen?

If we consider what is going on in the wire, there are electrons flowing like a wind in the wire. This is causing the poselectrons surrounding the wire to point in the same direction as the current flow like flags in the wind. Between the wires this effect is doubled since there are essentially two wind streams blowing between the wires, this makes the magnetic field stronger between the wires than outside of the two wires.

If you were paying attention to the previous section, you would have learned that when the electrons are moving parallel to the poselectron field, the electron will be deflected towards the region of higher magnetic field (or higher alignment of the poselectron particles).

So as the electrons flow through the wire, they see this stronger magnetic force between the wires and the electrons deflect towards the center. But since the electrons cannot escape the wire, they press upon their container which is the physical wire and causes a force which moves the wire closer to the other wire. So the force we feel on the wire is actually the force of all the electrons trying to move towards the center of the two wires.

You can think of this like we have a box full of electrons, then those electrons decide to go left and hit the left wall. They will drag the entire box to the left and if we try to stop the box from moving left, we will actually feel a pushing force coming from the box. This is the pushing force that we feel when dealing with magnets.

If we then reverse the currents in the wires, then we have winds blowing in opposite directions between the wires and this cancels or reduces the magnetic field between the wires. The electrons now see a higher magnetic field outside of the two wires and they are once again attracted and deflected to the outside of the wires and this causes the electrons to pull the wires apart.

8. How do electromagnets work?

If we take two coils of wire and pass a current through them such that the electrons are flowing in the same direction, we find that these coils attract each other. This is what we feel as the fundamental physical magnetic force. We can feel the force between the two coils with our hands. If we switch the wires around so that the current is flowing in opposite directions, we find they repel each other. Why does this happen? The answer is very simple. If you consider a short segment of a coil, it is basically a straight wire with current running through it. If you just consider two parallel segments from each of the coils, this is just two parallel wires. Then we just apply our knowledge that two parallel wires which have the current moving in the same direction attract. So every segment of the coil attracts the same segment in the other coil and it is easy to see that the coils as a whole will attract each other like two parallel wires attract each other. Another way to see this is that the coil is just two parallel wires that have been twisted into a circle.

9. How do permanent magnets work?

If we understand how an electromagnet works, then how does a permanent magnet work. This doesn't have any coils or electrical source. How can it emit the same force that is created by an electrified coil? To answer this, we have to make some logical speculations. If magnetic fields can be created by a current carrying coil, then there must be something like a current carrying coil within the permanent magnet. But what could that be and how would that work? It has been suggested that the electrons orbiting the atom create this current ring, but experiments have shown that this is not the case and even if it were, there are other atoms which have electrons shells similar to the ferromagnetic elements, but these are not magnetic. Furthermore, our best permanent magnets are made out of rare earth elements like boron and neodymium which are non-magnetic.

I believe that the magnetic properties are determined at a much larger scale than the atoms. The properties must come about at the crystal level. The crystals in a permanent magnet material may have the property that they can form a small superconducting current loop within them. We see these regions as magnetic grains within the material. The ability to form this loop probably strongly depends upon the shape and size of the crystal structure to allow what amounts to a room temperature super conductor. This is why compounds of non-magnetic material can create strongly magnetic materials. It would be a major prediction and confirmation of this theory, if it could be proven that such superconducting loops exist in permanent magnets. If we could understand how these superconducting regions work, we might be able to exploit them to create large room temperate superconducting wires.

The presence of billions of these tiny superconducting loops would explain how a permanent magnet can exhibit the same properties as a current carrying wire loop. Initially, there is no current flowing through these pathways or the current loops are randomly oriented. But when exposed to a strong magnetic field, the electrons start to flow and find a path through the crystal so it forms a current loop. Once this current loop starts, it keeps going. Then each of the individual current loops re-enforce each other until they form a field which looks something like the coil of wire, although there are still some significant differences. Each tiny current loop can be thought of as interacting with another tiny current loop and together, they work in concert to create an overall attraction or repelling force.

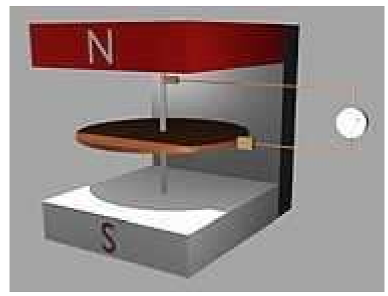
10. Solving Faraday's Paradox

An area that cannot be easily explained by mainstream electromagnetic theory is unipolar induction. The problem seems to be best stated by this wiki page of the Faraday Paradox:

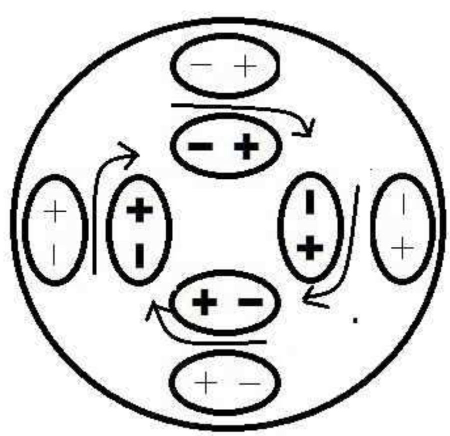
http://en.wikipedia.org/wiki/Faraday_paradox

Here we have a rotating disk in a magnetic field and the disk generates a current from the axis to the outer edge of the disk. This all works perfectly fine with the Lorentz Force Law as you can see the electrons driven to the outer edge. This is mentioned as case 1. What's weird is that if you hold the disk and spin the magnets around, it generates no current. It would seem that the moving magnetic field is still cutting through the disk, so why isn't a current generated? Even weirder than that, if you spin both the disk and the magnets together so that there is no relative motion between them, this generates a current. How can it do this if there is no relative movement?

For case 1, the easiest way to view the homopolar generator is as a spinning disk between the poles of a magnet as is shown below. The disk is directly and completely centered between the poles of a magnet.:



According to my magnetic model, the field between the poles is circular and matches up in the direction and plane of the circular disk. This is very different from the conventional view that the magnetic field lines run between the N and S poles in a straight line. The key is that the magnetic field strength is strongest towards the center of the poles. When you spin the disk, the charges in the disk experience and uneven force as they pass by the line of weaker versus stronger dipoles in the center. I have shown this in the diagram below as bold plus and minus signs showing stronger field strength. They deflect into the direction of the strongest field strength which causes the electrons to migrate towards the center as the disk is spun clockwise and this is what actually generates the current between the rim and the axis as the mobile charges in the disk are attracted to the stronger field strength. If the disk were spun counter clockwise, the electrons would migrate outwards towards the rim and would cause a reverse current.



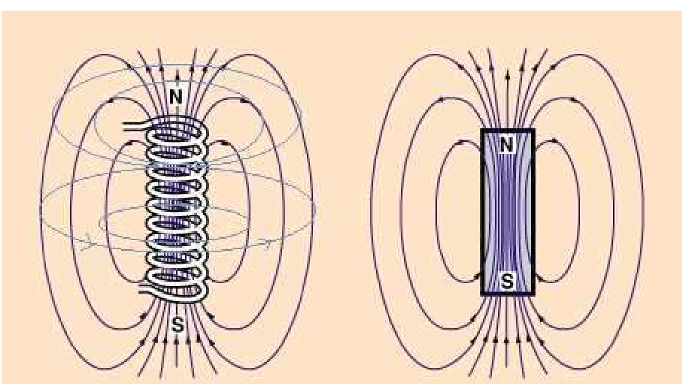
For case 2 the disk remains stationary, so the charges are not moving in any sense. What we do have is the magnet moving around the disk, but the magnetic field is only a stationary alignment of the dipoles. The alignment doesn't change because the true field lines are also circular. So rotating about the axis doesn't change anything. The dipoles themselves don't move with the rotating magnet. They are kept in their same relative positions as if the magnet were not moving. The charges in the disk aren't moving and neither are the dipoles, so we would expect no current to be generated in this situation.

Conventional electromagnetic theory which defines the magnetic field lines as running through the disk would indicate that these fields lines which are at 90 degree angles to the disk must be cutting through the disk and must therefore be generating a force on the electrons through the Lorenz force. This is where the paradox comes in because the direction and shape of the magnetic field has been defined incorrectly.

For case 3 both the magnet and disk are spinning together. As I mentioned in case 2, the magnetic field doesn't change at all whether the magnet is moving or not. It is simply stronger in the center and weaker going out. However, in this case, the charges in the disk really are moving and they are cutting past the dipoles in the same was as in case 1, so in this case, we would also expect that a current will be generated.

Conventional theory would indicate that if the magnet and disk are moving together, then the field lines would remain stationary relative to the disk and so no current should be generated. Conventional theory cannot explain this and therefore it appears as a paradox.

However, this paradox can be solved. Once we understand the true nature and shape of the magnetic field , it becomes fairly obvious what is going on. Conventional theory has gotten the direction of the magnetic field lines completely wrong.



The diagram shows conventional field lines on the right. These define lines which point downward from the poles and form uniform vertical magnetic field lines between the N and S poles. This is wrong. The correct way to view the magnetic field line is that these field lines run in the same direction as the current that creates it which is shown on the left as light blue lines circling around the coil. This actually makes more sense that the field lines run in parallel to the current, not at a 90 degree angle to it.

To solve the paradox, one must recognize that the magnetic field doesn't change when you rotate the magnet around the axis since the real field lines are circular around the axis. So spinning about the axis makes no difference. Keeping the magnet stationary doesn't make any difference. The only thing that makes a difference is if the mobile charges in the disk are spinning and those are the cases where a current is generated.

The paradox only arises if you think of the field lines as arrows connecting between the N and S poles of a magnet. Then you will have a big conceptual problem because spinning will definitely lead to magnetic field lines cutting through the disk which should generate a current, but they do not.

In most cases, it doesn't matter that the magnetic field lines have been defined incorrectly. However, in the case of unipolar induction, it makes a great deal of difference. Redefining the magnetic field lines in this manner does not lead to a simple formula like the Lorenz force law, however, common electromagnetic interactions such as how 2 current carrying wires attract and repel and how unipolar induction really works can be more easily explained. Therefore one needs to consider whether the field line direction and shape has been defined incorrectly.

11. Conclusions

Initially, the magnetic force appears to a very mysterious phenomenon which almost no one is willing to explain. However, it is possible to explain how this force works if we give it a physical medium which is composed of positron/electron dipoles (poselectrons). An alignment or polarization of this sea of poselectrons is caused by a nearby flow of electrons that act as a kind of a wind that blows through the poselectron sea to align it. Once this poselectron sea is aligned, it can preferentially deflect electrons that are trying to pass through it. It is this deflection of the electrons that we 'feel' as a force when magnets interact with each other. Ultimately, the magnetic force is just a special case of the electrostatic force. So this is the unification of the magnetic force with the electrostatic force.

12. Additional references

For additional information on how the magnetic field works, I would refer you to my short 5 minute video which can be found on the web site:

http://www.howdomagnetsattract.com

I also have two web papers on the magnetic force:

How the magnetic field works:
http://franklinhu.com/howmagfield.html

Did science get the direction of the magnetic field wrong?
http://franklinhu.com/magfield.html

This work on the magnetic field is part of my Theory of Everything which links virtually all the forces as being electrostatic and mediated by the poselectron sea.

http://franklinhu.com/theory.html

I welcome your comments. Please send them to franklinhu@yahoo.com