Magnetic Fields tutorial

Similarities and differences to electric fields

In the previous tutorial on electric fields, we discussed electrical charges which mainly consisted of negatively charged electrons and positive ions, which are atoms that have lost an electron. These charges can be separated as two separate poles of an electric field and contained in metal plates which can be moved about in space relative to each other. The two separate plates produce an electric field between them and this can be represented as lines drawn between the plates with arrows on them showing the direction that a free positive ion would take if it were placed between the plates. The positive ion would be repelled by the positive plate and attracted by the negative plate and would hence flow from the positive to the negative plate (figure 1).

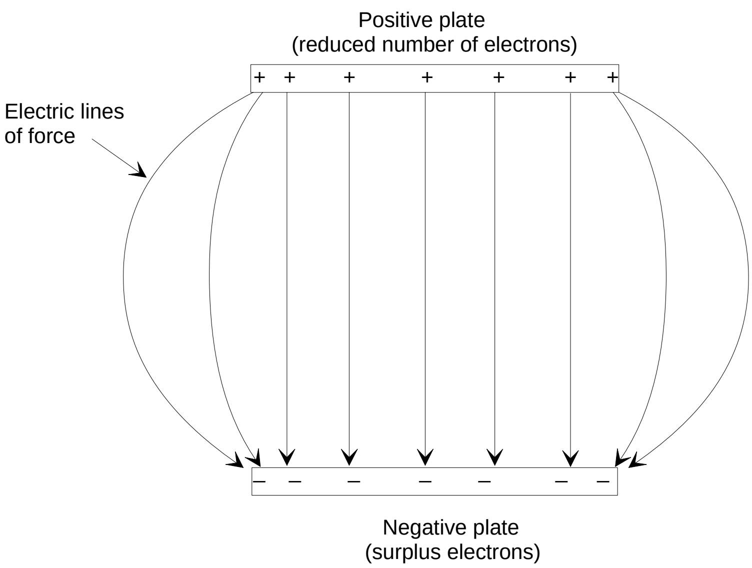

Figure 1 A positive plate and negative plate with an electric field between them

Magnetic fields are produced when electric charges move. In particular, the north and south pole of a magnetic field are produced when electric charges move in circles. You cannot separate the north and south pole of a magnetic field as you can with the positive and negative poles of an electric field. If you were to break a bar magnet in half, each half would still have a north and south pole. Magnetic fields are usually drawn as magnetic lines of force which look similar to the electric lines of force drawn in figure 1. However, the magnetic lines of force do not indicate the path a free positive ion would take, they indicate the direction that a free magnet's north seeking magnetic pole would move along in the absence of any other force on the magnet.

One similarity between electric and magnetic fields is that like poles repel and opposite poles attract each other. Hence the north pole of one magnet is repelled by the north pole of another magnet, but attracted to the south pole of the other magnet.

Static and alternating magnetism

We are all familiar with bar magnets which have a north pole at one end and a south pole at the other. The magnetic lines of force come out of the north end of the magnet and bend back on themselves to flow back into the south end of the magnet. The earth's magnetic field is similar to a bar magnet with the magnetic north pole close to, but not exactly at the geographic north pole (figure 2).

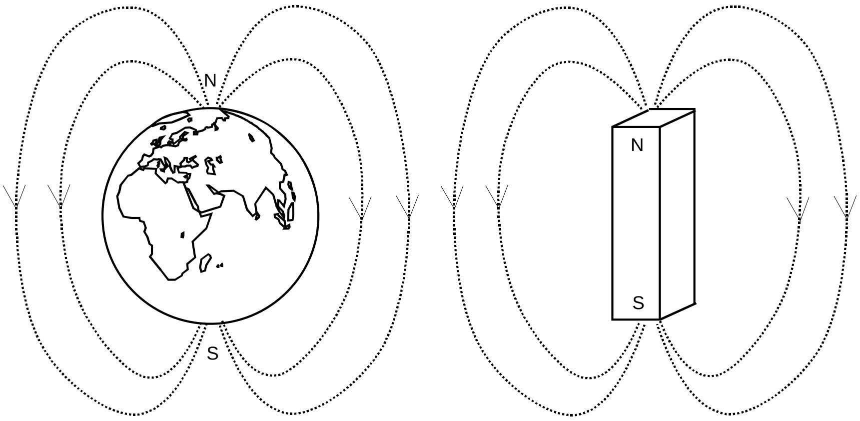

Figure 2 The earth's magnetic field and it's similarity to a bar magnet

This type of magnetic field is known as a static magnetic field because the strength and location of the poles do not change for long periods of time. There are however other types of field which do have constantly changing strength and polarity. For example, the transformers in many electrical items run from a 240 volt 50 Hz mains supply and the direction of the electric current changes 100 times per second in the transformer. This gives rise to a changing magnetic field which reverses direction 100 times per second and constantly changes in strength. Other magnetic fields change polarity at higher frequencies than 100 Hz. For example, the scan field in a TV produces 625 lines in 1/25th of a second, hence the magnetic field which produces the lines changes at 25 x 625 = 15,625 times per second.

<u>How are magnetic fields produced?</u>

Magnetic fields are produced whenever positive or negatively charged particles move. When the particles are stationary, there is no magnetic field associated with them. A simple electromagnet consists of a coil of wire with a dc current flowing through it. The dc current consists of a flow of electrons. When the current flows there will be a north pole at one end and a south pole at the other end of the coil, but when the current stops flowing, the magnetic field also stops. Note how the electrons are forced to go around in circles because of the shape of the coil (figure 3).

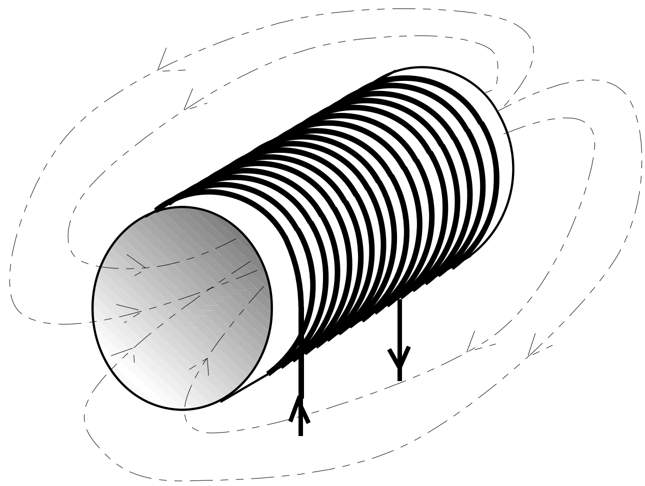

Figure 3 Magnetic field produced by a cylindrical electromagnet

Atomic properties of magnets

Almost all material consists of atoms. Some materials have atomic properties which make them special when it comes to magnetism. In particular, iron, cobalt and nickel are what we call ferromagnetic materials. Many materials have properties which turn each atom into a tiny magnet, but the materials don't act like magnets because the atomic orientation is random and so all of the random magnetic fields from the billions of atoms cancel each other out. However, the atoms of ferromagnetic materials are capable of lining up in the presence of an external magnetic field so that the surrounding electrons of the atoms all spin in the same direction. The circular motion of the electrons around the nucleus of the atoms is similar to the circular motion of the current in the electromagnet described earlier. This makes all of the magnetic properties of the atoms act in unison and hence the material behaves like a magnet. In the case of iron, when the external magnetic field is removed the atoms go back to their random orientation and hence the iron loses its magnetic field, but other materials such as certain alloys of iron retain their magnetism after the external field is removed. These materials are used to make the common magnets that we are used to in our everyday lives.

Units of magnetic field strength

The common units used for measuring magnetic field are the Gauss and the Tesla, (10,000 Gauss = 1 Tesla). There are two different units because of the wide variation in strength of magnetic field. The earth's magnetic field is around 0.6 Gauss which is equivalent to 0.00006 Tesla. We generally describe the earth's field in Gauss to get rid of all of the zeros that would be needed if we used Tesla. However some of the strongest magnets used in industry and medicine can be as high as 10 Tesla or 100,000 Gauss and for the same reason we describe the strength of these magnets in Tesla.

Instrumentation for measuring magnetic field

Static magnetic fields as weak as that of the earth are measured using a device known as a magnetometer, but this is an expensive instrument and MARA do not have access to one. However a magnetic compass will at least indicate the orientation of any magnetic field Changing or alternating magnetic fields which are relatively strong can be measured with cheaper instrumentation such as the 2G EMF meter and the Trifield meter. The Trifield meter will detect changing magnetic fields whenever the mode is set to magnetic or sum. In the sum mode, it will detect the sum of the magnetic and electric field so if you only want to measure magnetic field with the Trifield meter, make sure the mode switch is set to the magnetic position. If a bar magnet is slowly brought towards the 2G EMF or Trifield meter, it will not be registered by the meters because they are not capable of measuring static fields, but if the magnet is waved rapidly in front of the meters, they will detect that because the field the meters see is changing. One limitation of both of these meters is that their frequency response is very non-linear. In other words, a 100 Gauss field at 50 Hz will give a very different reading to a 100 Gauss field at 1000 Hz. The vast majority of alternating magnetic fields found in buildings do not change frequency and so the meters can usually be relied upon to indicate where a field is strongest, but you should still be aware of the non-linear response in case you come across an unusual situation during a paranormal investigation.

Output sockets on the 2G EMF and Trifield meters

The Trifield meter has an analogue output socket on the side which mimics the reading of the needle on the meter. This socket can be connected to a chart recorder to give a permanent record of any fluctuations. MARA possess a chart recorder for this purpose. The 2G EMF meter also has a socket on the side but this is designed for headphones and gives the real-time alternating signal detected by the meter instead of the meter needle movement. One advantage of this is that the output can be connected to a computer with spectrum analyser software to indicate the frequency of any detected field. This could narrow your search down to looking for a mains source if the frequency indicated is 50 or 100 Hz. However the relative strength of different frequencies indicated by the spectrum analyser cannot be relied upon because of the non-linear response of the meter.

Magnetic fields in buildings

The majority of paranormal investigations will be done in buildings so here are a few examples of where you might expect to find an alternating magnetic field which can be picked up by the 2 meters that MARA possess.

1) Near a TV which is switched on. The meters will pick up the scan field from the horizontal beam deflectors in the TV

2) Near any mains transformer. This might be inside a piece of electrical equipment or be the power source of something such as a laptop PC or battery charger. The field will only be generated when the device is switched on.

3) Near mains wiring. You will only detect the magnetic field from mains wiring if current is flowing through it and the strength of magnetic field will be directly proportional to the amount of current or power being drawn. You may be able to isolate the source of the magnetic field by turning on/off electrical items in the building.

4) Anything which contains a running electric motor. The larger the motor, the larger the field will be. In particular, elevator motors are amongst the largest you are likely to come across and are also likely to switch on and off without your knowledge if the building is not completely controlled by you during a vigil.

Final word on magnetic fields

There is no evidence at present that spirits or anything paranormal are capable of generating a magnetic field whether it is static or alternating, so you should concentrate on looking for mundane explanations for any fields you detect while keeping an open mind in your investigation.

These notes are meant to accompany a tutorial given at a MARA meeting by Bill Bimson in August 2004. They are not meant as a full explanation of magnetic fields and their application to the paranormal on their own.

Any questions relating to this document or suggestions for improvement may be addressed to Bill Bimson billbimson1@yahoo.co.uk
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