Diamagnetism and Ferromagnetism

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It is helpful first to explain magnetic moments of electrons and atoms in terms of electrostatic dipoles. The tangential componet of the forces producing the velocities of electrons in orbit also produce radial charge polarization inside the electrons; the proximity of the nucleus r meters away, inhibits the magnitude of the dipole in the orbiting electron. This is analagous to the inhibition of transverse dipoles as in the nuclei and free electrons of parallel current carrying wires. That is, there is a transverse force between nucleus and electron that inhibits the tendency of the orbiting negative charge inside the electron to become more elliptical. The dipole length increases as r increases. So the dipole in the orbiting electron of mass, m, in the ground orbit of hydrogen is erv/c where $mvr = \hbar$. This dipole then is equal to the Bohr magneton $\mu_B = e\hbar/2mc$, which is the unit in which the magnetic interaction of atoms with applied magnetic forces is usually expressed.

1. Introduction

An example of the interaction of atoms and an applied magnetic force is the force on a gas of neutral atoms from a heated oven that pass through a magnetic field as in the Stern-Gerlach experiment that showed the quantum effect of a magnetic field. The spectral lines were discrete instead of a continuous band. We will look at their experiment in terms of electrostatic dipoles instead of electron spin. Then we will show how these dipoles in other atoms produce ferro-, para- and dia-magnetism.

2. Ferromagnetism and Diamagnetism

Stern and Gerlach produced a gas, composed of silver atoms, thermodynamically forced from a high temperature region to a lower temperature region, and a small fraction of these through collimating slits and then through a magnetic field. "Thermodynamically forced" means stronger and more frequent pushes from hotter atoms than colder atoms.

The spectra produced by the gas in the field has two distinct lines of light at nearly the same wavelength, while, with the field turned off, there is only one line. These lines correspond to the average frequencies of radiation emitted as an excited electron falls back to the normal orbit (or moves from the normal orbit(s) to the excited orbit) which is really two slightly different "normal" orbits when the magnetic field is applied.

Roughly half of the atoms have one normal orbit and the other half a slightly different normal orbit as described below. When orbital electrons are in a normal state or other metastable state, the effective oscillations of electrons in neighboring atoms are according to the least energy principle, completely out of phase and their radiation cancels. During a transition however, radiation is not cancelled by opposite oscillations of surrounding orbits; and so it is transmitted. Note, the average frequency is not measurably different from the difference frequency as discussed in the next section on Light.

The total magnetic moment of the silver atom is, after the canceling of oppositely oriented dipoles from the other orbiting electrons in the same atom, only the effect of the average electrostatic dipole field of a single unpaired orbital electron in the outermost orbit. This can be visualized as the projection of an electrostatic dipole in an electron at a point of the electron's orbit onto a line from this point to a point on an axial line perpendicular to the electron's orbital plane through the nucleus. The projection from all of these spokes onto the axis gives the total electrostatic dipole field of the atom with one orbiting electron.

The electrostatic dipoles produced by the orbital electron at successive instants of time at different points in the orbit, is, because of the small size of the orbit and the great speed of the electron, equivalent to the simultaneous electrostatic dipoles at points all along a current carrying coil of diameter on the order of centimeters or larger, instead of Angstroms, as shown in the following diagram.

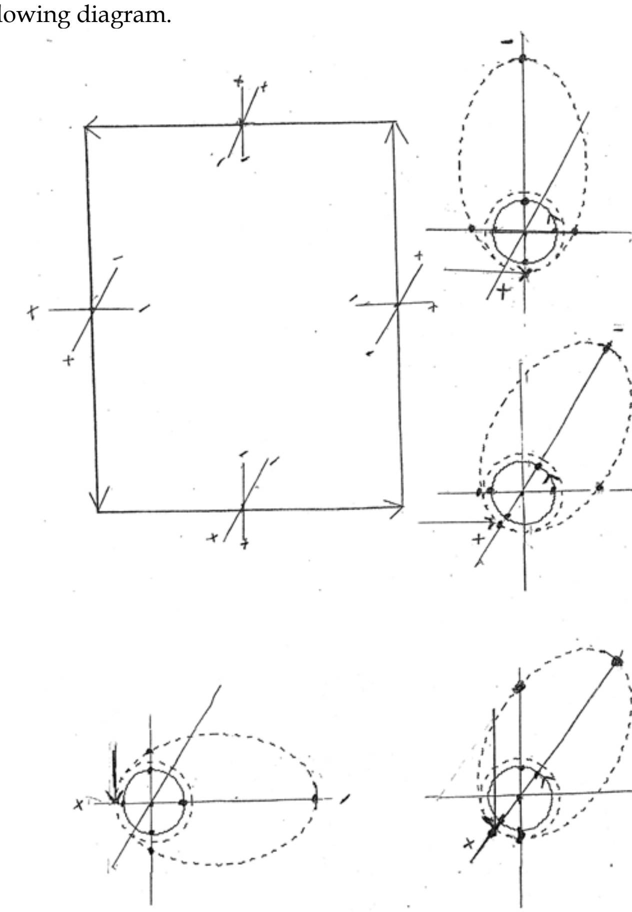

Fig. 1. Dipoles inside a current carrying loop and how the dipoles are produced inside electrons and inside atomic nuclei.

(The way the dipoles are produced is shown in the accompanying diagrams of orbital charge inside the atomic nuclei and free electrons.)

If the direction of the orbital electron is counter clockwise in say a horizontal plane, and the direction of orbiting charge inside the electron is counter clockwise, the negative pole is always pointing inward. This leads to an average electric dipole projected on a line perpendicular to the orbital plane at the nucleus , with the negative pole pointing upward- if there is a positive charge or pole on or near the axis above the orbital plane. The reverse is true if there is a negative charge or pole on the axis above the orbital plane.

If the electron is moving clockwise and the orbital charge inside the electron is moving counterclockwise, the positive pole is always pointing inward. And a similar effect is obtained. Note that the same effects occur below the orbital plane if there is a positive charge or pole on the axis or near the axis below the orbital plane.

(Note, this force is distinct from the force between two adjacent solenoids. The above diagram of the square coil could also represent one of many current carrying coils connected to form an electromagnet with an air core. The attraction between two such solenoids with currents going in the same direction can be understood in terms of the attraction between similarly oriented dipoles in adjacent segments of the two coils facing each other and the coils behind these. This despite the fact the similarly oriented dipoles on facing sides of two coils are opposite in orientation to those diametrically opposite in each coil.)

The spectra of the silver atoms in the Stern-Gerlach Experiment indicated that half of the outer orbital electron orbits were counter-clockwise with counter-clockwise orbiting charge inside the electron and half were counter clockwise with clockwise orbiting charge inside the electron.

To better see this, consider a circular atomic orbit in the horizontal plane where say two diametrically opposed electrons are moving in a counterclockwise direction as we look down on their orbit as if it were the face of a clock. The implicit tangential force on the right side of the clock that causes the motion of an electron there, say from 3 o'clock to 2 o'clock, also creates an elliptical extension to the left, of the counterclockwise orbiting negative particle inside this electron, creating a negative pole of the dipole inside the electron pointing inward, toward the atomic nucleus.

The electron on the left side moving from 9 o'clock to 8 o'clock apparently produces a dipole with the negative pole pointing away from the nucleus as if the orbiting negative charge inside the electron had been made to move clockwise relative to the orbital electron. Thus the force between the two orbital electrons due to their dipoles is one of attraction. Thus also the net dipole component force pointing upward or downward from these two electrons is zero on a specific dipole of either polarization. From these considerations, atoms, with an even number of electrons, should have no response to an applied magnetic field. Note that the magnetic field is equivalent of an electrostatic dipole. The exceptions are strongly diamagnetic diatomic molecules of Bismuth and Antimony with an odd number of electrons in the outer orbit of the atoms. Apparently the molecular configuration of two atoms is similar to that of a single atom with a pair of electrons in the outer orbit.

But the changing magnetic field of a magnetized ferromagnet as it is brought near diamagnetic material, is to induce movements of electrons in atomic orbits in the diamagnetic material, so that the average electrostatic dipoles produced, are oppositely oriented to, and so repel, the equivalent electrostatic dipole of the ferromagnet. (The mechanism is similar to the momentary, oppositely directed, current induced in a wire when a parallel current carrying wire is brought near it, the so-called 'Lenz effect''. The exact mechanism in terms of electrostatic dipoles inside atomic nuclei and free electrons is described in the next section on light.)

Other atoms where the electrons in the outer orbit are paired and the electrons in the adjacent inner orbit are paired may interpenetrate each other and influence the orientations of the electrostatic dipoles in these electrons.

Iron has two electrons in an outer 4s orbit; that is, the "4" is the value of n and the square of n times the innermost radius orbit gives the radius of the orbit. The "s" indicates that the orbit is circular. The next more inner or 3d orbit has $n^2 = 9$ and "d" indicates that the orbit is the most elliptical orbit of orbits with quantum number, 3. Thus, there is the likelihood that the 6 electrons in the 3d orbit interact with the 2 in the 4s orbit because of greater proximity at times.

One possibility is that the paired electrons in the outermost circular 4s orbit cause one electron of the six in the elliptical 3d orbit to flip over and , the reaction force causes one of the 4s electrons to flip over. Thus the net dipole of each of these and its previously paired dipole will be in the same direction and not zero. That is, the two dipoles are both oriented with the negative pole facing the nuclear core and the projection of these dipoles on lines toward a point on the axis of the orbital plane are both oriented with the negative pole pointing upward. And the projection of these dipoles on the axis is a dipole with the negative pole pointing upward. This net dipole is non zero and twice the magnitude of the net dipole formed by a single orbital electron.

This makes iron in a vapor state, 4 times more paramagnetic than silver. That is more responsive momentarily to the same applied magnetic field. But in a solid state, something else happens. These similarly oriented paramagnetic atoms coalesce to form a domain with similarly oriented dipoles. And when a strong external magnetic field is applied to this solid, these domains will be lined up with their magnetic moments parallel to this field. That is, the net electrostatic dipole of the ferromagnetic solid will line up with the net electrostatic dipole of the applied field.

This explanation of ferromagnetism is clearer than the standard wave mechanics explanation. [1] The potential energy of the 4s electron due to the nucleus and other electrons and that of a 3d electron which are sometimes at equal distances from the nucleus are sometimes equal. Note the average energy of each electron can be approximated from spectral data making certain simplifying perturbation assumptions and it is equivalent to the average energy calculated for a specific orbit making similar simplifying assumptions. But the actual cause of magnetism can be explained more clearly in classical terms. The electrons in the same or overlapping orbits repel each other less if the electrostatic dipoles in the electrons are oriented so as to attract each other even if this means a slight decrease in the attraction of the electron to the nucleus or nuclear core. The least energy principle applied to the atomic systems apparently requires this dynamic adjustment in the electron orbits in iron.

The magnetic dipoles of protons and other nuclei and the magnetic dipole of the applied constant magnetic field are net electrostatic dipoles. The orientation of the electrostatic dipoles in the protons of water for example, are, according to the standard theory, randomly oriented but we have shown [2] that there is a residual amount (10^{-18} e) of charge polarization determined by, and lining up with, the longitudinal and tranverse dipoles of all atomic nuclei in the spinning of the Earth etc.. The effect of the applied magnetic (net electrostatic dipole) field is to produce a small re-orientation of these nuclear dipoles to line up somewhat with the strong applied field. This nuclear effect plus the atomic and molecular diamagnetic effects and paramagnetic effects add up to an observed diamagnetic effect in the case of water in a non uniform field, e.g. in the levitation of frogs etc.

But the variation of the nuclear dipoles in Hydrogen atoms in water and other atoms, first aligned with those of a strong uniform magnetic field, and then subject to a changing electric and magnetic field at right angles to the uniform field at microwave frequencies is used in Nuclear Magnetic Resonance (NMR) to identify the atoms. That is, the aligned dipoles are easier to rotate at some frequencies more than others depending on the field strength and the specific nucleus.

3. Conclusion

The relation between ferromagnetism, diamagnetism and gravity is as follows: That Gravity is ultimately magmetic and so electrostatic is related to the views proposed by V.A. Bailey and also those of Thornhill and Scott. [3] Bailey claimed that the Sun had a large net electric charge at the same time that authorities at Harvard vehemently denied it. The net charge was finally measured by NASA space probes as Bailey had contended. Thornhill and Scott claim that the power of the Sun and stars are provided wholly or in part by plasma currents or the solar wind comprised of positive Helium and Hydrogen ions moving away from the Sun and a smaller number of electrons moving toward the Sun but a net flow of positive charge toward the edge of the solar system implying for unexplained reasons a more negative potential in this region.

Other explanations of the solar wind are that electrons and positive ions are present in equal numbers and are pushed out of the Sun by heat and pressure factors at up to 450km/second but are not close enough to recombine. And that they continue by inertia past the Earth unless captured by oppositely charged particles or are deflected by other sources of magnetic and electric fields such as the spinning orbiting Earth etc, to the edge of the solar system etc.. It is helpful to consider the magnetic fields of the plasma streams as due to charge polarization inside the ions and electrons transverse to the direction of the streams. It is also helpful to recognize the electrical interaction between electrically neutral spinning orbital bodies in terms of electrical dipoles and plasmas.

The magnetic field of moving charges in the Sun is added to the magnetic field associated with the 24.7 day rotation of the Sun. The magnetic field due to electrostatic dipoles associated with the Sun's rotation and with the moving charges of plasma streams influence radiation emitted by Sunspots on the Sun's photosphere. Specifically the line of an observed frequency is split into many closely spaced lines showing that the field there is thousands of times stronger than that of the Earth. Also that the first spot in the direction of the Sun's spinning has the opposite polarity of that in a nearby spot that comes next into view. That is, the excitation from one orbit to another of the electrons emitting light is inhibited or stimulated by the surrounding magnetic field, so called, depending on its orientation.

From the mass and number of atoms or ions in the Sun, we can estimate the Gravitational field of the Sun and so the equivalent magnetic or electrostatic dipole field of the Sun not due to the magnetic (gravitational) effect of solar currents. That is the electrostatic dipole field of the Sun is the Gravitational field of the Sun and the magnetic field of the Sun independent of the magnetic or electrostatic dipole field associated with the plasma stream of positive ions and electrons of the solar wind.

References

[1] http://en.wikipedia.org/wiki/Exchange_interaction.

[2] http://mysite.verizon.net/r9ns/book03.3.

[3] W. Thornhill and D. Talbot, **The Electric Universe** (Kronia, 2005). http://www.holoscience.com.

[4] D. Scott,