Is Magnetism Ultimately Electrostatic?

Years of evidence for charge polarization inside electrons and atomic nuclei, from high energy collision data, permit the hypothesis that electrostatic dipoles inside atomic nuclei can account for the magnetism of current carrying wires.

Here is one of many quotes asserting this "Moreover nuclear charge polarization occurs[in protons] during the fission process." 1)Noshad, Houshyar: "Nuclear Charge distribution of fission products originated from fission of nuclei induced by 45-69 MeV protons" Iranian Journal of Physics Research Vol 7, No.4, 2007 available at (http://journals.iut.ac.ir/ijpr/eabsv7n4y2008p47.pdf).

Another example is the detection of a repulsion between a current carrying wire and a charged foil opposite to the statically induced attraction when the current was in a specific direction.

As parallel current carrying wires are drawn further apart, the force between them, whether attraction or repulsion, decreases as the reciprocal of the distance. If we consider parallel infinitesimal segments of wire, and assume the force between them decreases in proportion to the reciprocal of the distance squared , then for wires of various finite lengths, the force between them should be inversely proportional to the distance between them- the observed force. Ampere was the first to demonstrate this.

But you say, the force between electrostatic dipoles decreases as an inverse fourth power of distance, how can this cause an inverse square force for infinitesimal or Angstrom long segments? The answer is that the electrostatic dipoles increase in proportion to the distance between them. That is, attractively oriented collinear electrostatic dipoles transverse to a pair of attractive parallel current carrying segments interfere with each other less as they are drawn further apart. Thus the inverse fourth power electrostatic dipole force reduces to an inverse square force for infinitesimal segments of parallel wires – which, after integration, reduces further to the observed force between parallel current carrying wires, of finite lengths, inversely proportional to the distance between them.

We can represent this mathematically as follows:

$$F = -9(10^9)(rnAev/c)(rnAev^*/c)ds\,ds^*/r^4$$
$$= -10^{-7} ii^* ds\,ds^*/r^2$$

The currents per unit length are, i, and i^* equal to the number of electrons, n, per unit volume, times A the cross section area of the wire, times v or v^*, the drift velocities of the electrons in the wires in the direction of currents. The drift velocity is $v = eEt/m$ along the length of the wire, as E acts for the times between thermal collisions every $t = 2(10^{-14})$ seconds for copper and c is $\sqrt{3}$ times the speed of light, and e and m are the charge and mass of the electron. The collinear electrostatic dipoles per unit length associated with the parallel currents are $(rnAev/c) and (rnAev*/c)$. The negative sign indicates the parallel currents are in the same direction and so, like the collinear dipoles, are attractively oriented.

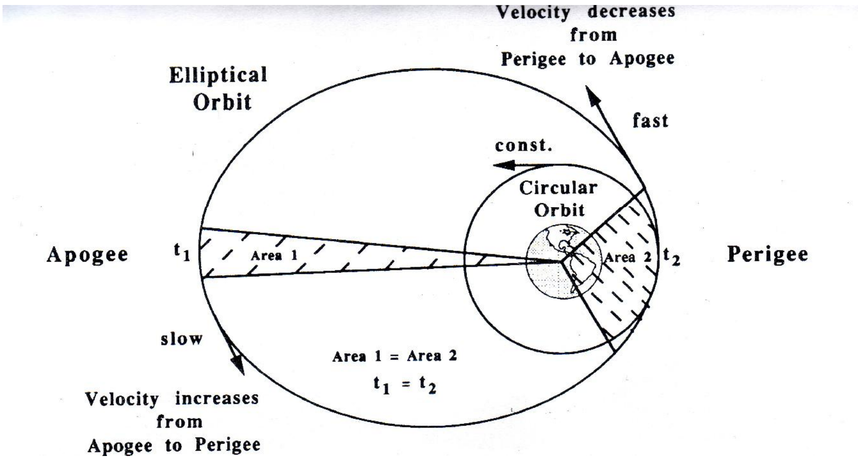
But you say, the electrostatic dipole model of magnetism seems to contradict the evident transparency of metals to magnetic fields though not to electrostatic fields! Not at all! The reason essentially is because the electrostatic dipoles, are very numerous and very small.

Consider a specific example: two parallel current carrying wires, 2.58mm diameter, one on either side of, and, 1 mm of insulation from, an equally long, 2mm thick, 10mm wide metal strip not carrying current. The proposed maximal co-linear electrostatic dipole lengths 'inside' nuclei, are .1 Angstrom and are oriented in the same direction. The dipoles in each wire when the currents are in the same direction, produce a small displacement of charge in the non current carrying strip between the wires that produces a displacement of electrons and positive lattice nuclei in this strip, in effect dipoles oriented in the same way as the dipoles in the wires. (note the dipole to point charge forces producing this displacement varies inversely as the distance cubed, much weaker than the inverse distance force between our dipoles)

Thus the pulling of the wires toward each other, due to the inversely- proportional- to-distance, force, is slightly increased. If the currents in the wires are in opposite directions, they produce nearly equal forces in opposite directions on the metal strip between them. and so little net displacement of charge in the metal strip. The only noticeable force is the inverse distance force between dipoles. Thus there is no electrostatic shielding effect in either case- as we readily observe with magnets placed on opposite sides of a sheet of aluminum etc..

In ferromagnetic materials etc, the magnetic field of electron spin and the magnetic field of an orbiting charge are in combination attributable to an electrostatic dipole inside the electron in two mutually perpendicular directions transverse to, and perpendicular to, its motion. More on ferromagnetism and diamagnetism vis a vis electrostatic dipoles below.

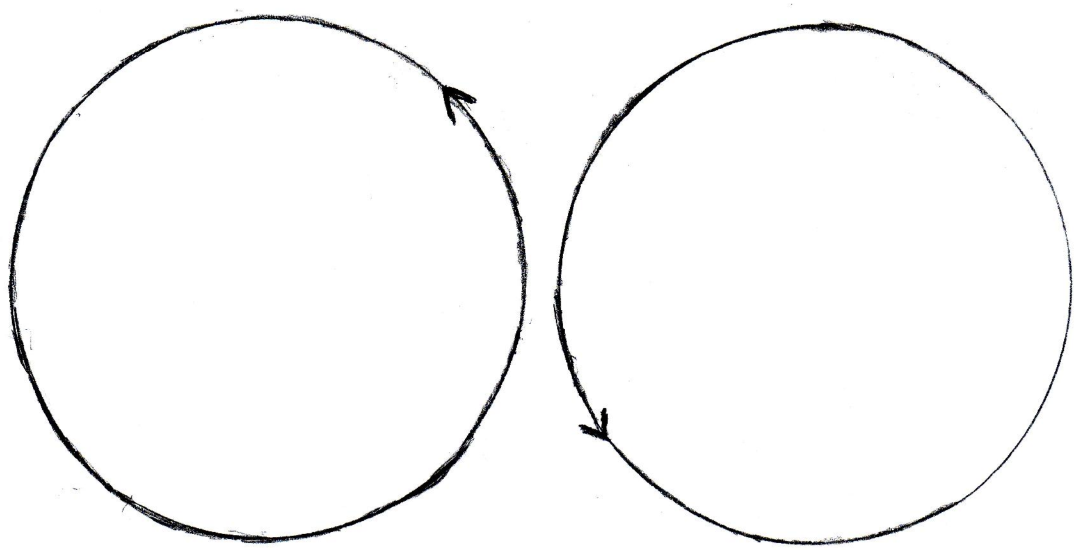
How does the polarization inside atomic nuclei (and inside electrons) come about? We could have an orbiting charged particle within the nuclei and free electrons of radius $R=10^{-15}$ meters approximately, that is, of very small mass, m*, and such that when added to the central mass and charge, the total charge and mass of the electron and of the nucleus are as observed. When the sustained field, E, acts on the free electrons, it also acts on the orbiting charge inside the free electrons and inside the lattice nuclei. The result is an increase in the interior orbital charge velocity analogous to the engine burn of a rocket moved from a circular to an elliptical orbit.



Also we require that free electrons have an orbiting charged particle of charge, say $-2e$, and larger mass core of charge, $+e$, and that the lattice nuclei have orbiting charged particles of charge, $-e$ and a larger mass core of $+2e$, inside the atomic nuclei. That is, the field causing an elliptization of the negative orbital charge and so a polarization of negative charge, in a specific direction will produce the same polarization direction inside the nucleus and inside the free electron.

Also an atomic nucleus and an inner orbital electron repel each other if their orbiting negative charges are close enough. Thus the electron orbit in hydrogen cannot become smaller than the half Angstrom ground orbit radius, with the negative orbiting charge around the electron being repelled by the negative orbiting charge around the nucleus.

And so the mystery of why the orbiting electron does not fall into the nucleus is partially explained. The other aspect of the mystery, why the electron velocity does not slow to a stop, as its energy is radiated away, is explained by the dynamic cooperation of adjacent atoms. That is, the timing of adjacent orbital electrons is, half of the time, to oppose their orbital motion and half of the time to reinforce their orbital motion.



The orbital electrons, at the arrow points in the above diagram, are reinforcing their orbital motions but just prior to this they were opposing each other's orbital motions.

Of course such a model assumes particles moving at supposedly impossible speeds inside electrons and inside atomic nuclei. The answer to this is not "Tachyons". Rather it is that the apparent mass increase of Beta electrons to infinity as the speed of light is approached, is due to a decreasing rate of increase of the electrostatic dipoles inside the speeding electrons. In the early 1900s, Kaufmann showed the trajectories of the slightly faster high speed electrons ejected by radium nuclei moved more slowly than expected. The electron trajectories showed a decreasing rate of increase of the response of faster electrons to a magnetic field and to an electrostatic field through which they moved

From (1)the roughly 10^{-15} meter radius,R, of the nucleus and of the electron and (2) The equal sustained fields, E, producing equal currents in parallel wires r meters apart producing dipoles proportional to the distance apart and to the current, $rneAv/c$ -and so to, E:

We can infer the mass, $m^* = 10^{-56}$ kg, of the orbiting charge and the eccentricity, ε, of the orbit needed to produce these dipole lengths, $rv/c = \varepsilon/(1-\varepsilon)$ times 10^{-15} meters where ε <.99999 so rv/c < 10^{-10} meters. The argument is as follows:

The centripetal acceleration of our proposed hypothetical system inside the electron and inside the nucleus is

$m * v_0^2 / R = 9 \times (10^9) \times 2e^2 / R^2$ implies

$v_0 = [9 \times (10^9) \times 2e^2 / Rm*]^{1/2} = [(9) \times (2) \times (2.56)]^{1/2} \times (10^{(9-38+15)/2}) = (6.62) \times (10^{-7}) / m*^{1/2}$

Is there another relation which would help in determining, m*? In the time between collisions, 10^{-14} seconds, the sustained electric field, E, in the wire that produces the drift velocity of the electrons also produces a transverse ellipse of eccentricity, ε, of the orbital charge inside the atomic nuclei and inside the free electrons. The increase in orbital velocity required for an ellipse of eccentricity ε, is

$eEt / m* = v_1 - v_0$

$= (1+\varepsilon)^{1/2} v_0 - v_0 = (1 + \varepsilon/2) v_0 - v_0 = v_0 \varepsilon / 2 = (\varepsilon/2) \times (6.62) \times (10^{-7}) / m*^{1/2}$

This follows from the general equation for an orbiting charged mass around an oppositely charged mass,

$(m\rho^2)(v_0{}^2 / k\rho) = 1 + \varepsilon \cos\alpha$

where $k = 9 \times (10^9) e^2$. and ρ is the distance from a stationary central charged particle to a moving charged mass, m, etc..

And what also follows is that the distance between the center of charge of the small orbiting mass,m*, and the position of the core mass of opposite charge of twice the magnitude can be written in terms of the eccentricity as, $R\varepsilon/(1-\varepsilon)$, where we assume, $R=10^{-15}$ meters.

Thus we can determine the hypothetical orbiting mass, m*, from the electric field E associated with a specific current carrying wire parallel to another such wire at a specific distance and experiencing an attractive force proportional to the currents,

$$F = -9 \times (10^9) \times (rnAev / c)(rnAev* / c) ds ds* / r^4$$
$$= -10^{-7} ii* ds ds* / r^2$$

For example, suppose our parallel wires are r=2cm apart, of copper with a 2mm diameter carrying a current of one Amp so $A = (3.14) \times (1^2) \times (10^{-3})^2$ and, following the standard free electron model of current,

$1 = nAev = (8.47) \times (3.14) \times (1.6) \times (10^{28-6-19})(v) = 4.255 \times (10^4)(v)$

so $v = (2.35) \times 10^{-5}$ meters per second,

$v = eEt / m = (2) \times (1.6) \times (10^{-19}) \times (E) \times (10^{-14}) / (9) \times (10^{-31})$

if $t = 2 \times (10^{-14})$ seconds, then the resistivity of copper is as observed, $\rho = m_e / ne^2 t$

Thus $E = 9 \times (2.35) \times (10^{-31=5}) / [(3.2) \times (10^{33})] = 6.6 \times (10^{-3}) V / meter$

(If E and so v increases, the time between collisions, t, becomes smaller and E, must increase more to maintain a specific, v, value unless the wire burns or breaks.) The electrostatic dipole moment is

$rv/c = (2.35/\sqrt{3})(10^{-15})meters = R\varepsilon/(1-\varepsilon) = (10^{-15})\varepsilon/(1-\varepsilon)$

implying that ε/(1-ε) ≈ 2.35; so by trial and error .9/.1 = 9 and .8/.2 = 4 and .7/.3 =2.33 so ε = .7 approximately when E=6.6× (10^3) V/meter.(If rv/c is much smaller, for example, 10^{-18} meters then ε/(1-ε) is .001 about so ε= .001/.999 = .001001 . Therefore $eEt/m^{\circ} = (\varepsilon/2)v_0$ is much smaller and so E is about .007 times the previous value of E, namely, 46.2× (10^{-6}) $V/meter$.

Note a larger value of separation, r, would imply a larger dipole for the same, v, and E, due to a lack of interference from the transverse dipole field of the other wire. If the dipole moment (length), rv/c was 10^{-10} meters say, then ε = .99999 with ε/(1-ε) = 10^5 = .99999/.00001

This could also happen with drift velocity, v= 1 meter/sec and r=10^{-2} meters, so rv/c = 10^{-10} meters would mean, $E = 10^2 V/meter$ and the current would be 100 megaAmps and the millimeter radius wire would break. But if the electron were moving in low pressure gas, the density of electrons and current and time between collisions would be less. For example suppose $E = 10^4\ V/meter$ and we have a proton whose initial radius is 10^{-15} but is subject to this field for 10^{-7} seconds before a collision.

Thus the dipole could be fairly large with a small or medium E field and an average drift velocity small enough so as not to break the wire. The value of, ε, might be slightly larger say .999 instead of .7. This suggests a maximum value of E of about $1\,V/meter$ for this velocity, v, in this wire and that our estimate of, m*, based on our example is reasonable although it could be one or two order of magnitudes greater or less.

Since, from above, v_0 =(6.62) × (10^{-7})/$\sqrt{m*}$, we can solve for m*:

$$eEt/m* = (\varepsilon/2)\times(6.62)\times(10^{-7})/\sqrt{m*}$$

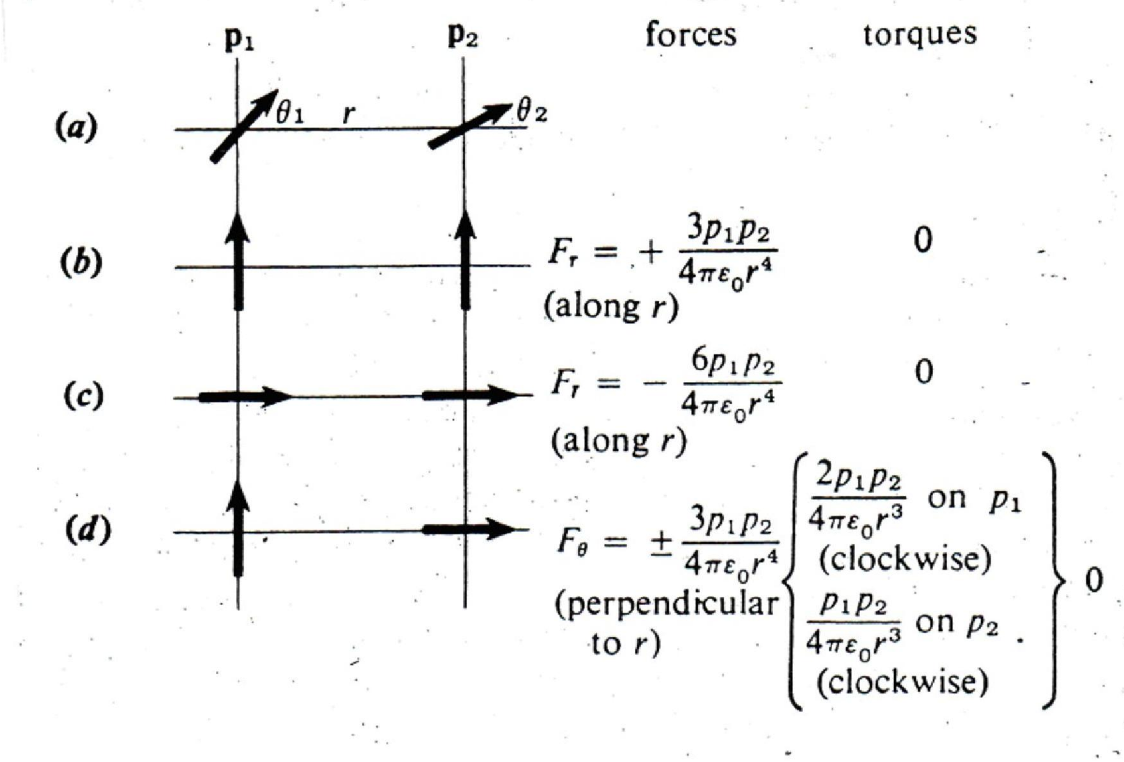
so $eEt = (\varepsilon/2)\times(6.62)\times(10^{-7})\sqrt{m*}$,

so $\sqrt{m*}$ = (1.6) × (6.62) × (2) × $10^{-19-3-14}$/[(.7/2) × (6.62) × 10^{-7}]

= 9.11× (10^{-29}), so m*= 10^{-56} kg approximately. So $v_0 = (6.62)\times(10^{-7})/\sqrt{m*}$ = 10^{21} meters/second, and the frequency, f_0 = $10^{21-(-15)}$ = 10^{36} approximately.

Note that there is a second transverse dipole perpendicular to both the first transverse dipole and to the longitudinal current, but the repulsion between two similarly oriented such dipoles that are parallel to each other, is half as great as the dipole attraction of collinear dipoles and so there is a net attraction. See W.J. Duffin's exceptionally lucid textbook, Electricity and Magnetism, Wiley 1973.

The following diagram from his book shows the forces and torques between dipoles. One must imagine wavy arrows perpendicular to the dipole arrows to be collinear or parallel current carrying wire segments,ds, to see the forces between current carrying segments forming dipoles per unit length: (kr/c) × (nAev) where nAev is the current per unit segment ds:



Since r in such tests is typically a few centimeters and v is typically 10^{-5} to 10^{-3} meters/second, the dipole length, rv/c, is about 10^{-15} to 10^{-13} meters, roughly the diameter of an atomic nucleus to within the 1 to .1 Angstrom diameter of the inner shell of electrons.

But as the distance between parallel wires increases, the transverse dipole forces from each upon the other decrease and so the dipole per unit length, rv/c can increase-at least until other such forces and local forces prevent further expansion of the dipoles beyond about .1 Angstrom. In these cases the dipoles are krv/c where k is less than one.

The transverse dipole field produced by a combination of such dipoles in one wire or a filament in the same wire, makes the transverse elliptical dipoles, formed in a second, parallel wire or filament, revert to a wider circular, less elliptical, smaller dipole, shape, Just as the greater transverse elliptical extension of the transverse dipoles, associated with a greater voltage difference and current, implies an increase of thermal collisions and an increase of thermal resistance, the greater longitudinal as well as elliptical extension implies an even lesser time between electron ion collisions.

The result is a reduced current for the given voltage difference. The ammeter measured “magnetic” transverse electrostatic effect of the current, before an increase in the independently measured ambient magnetic field, is diminished by the smaller transverse electrostatic dipoles as well as the greater thermal resistance effect of a shorter time between electron - ion collisions. Thus the reduction in ammeter measured current when an ambient magnetic field is introduced can be attributed to both of these effects.

The current and electron velocity, v, we measure is the net result of the longitudinal field, E, the electron’s mass, m, and the combined effect of these transverse dipoles and forces in reducing the times between collisions, t, as well as the transverse dipole field that is a measure of the current.

Thus if we consider three parallel current carrying wires, the different dipoles associated with any of the three pairwise interactions are added together by the principle of electrostatic superposition to give three unique dipoles at each of these locations and at any other location a unique force.

Thus we can account for the so called magnetic force between parallel(or otherwise oriented) current carrying wires and the Pinch Effect of streams of electrons in a plasma as the electrostatic force between electrostatic dipoles inside the lattice nuclei of the wires or the electrons in the plasma. At least until rv/c is no larger than the average distance between surrounding particles, eg less than one or one tenth Angstrom inside a wire but larger in a plasma as indicated by the average distance between electrons and ions at atmospheric pressure or lower pressures.

Considering the force which produces elliptization of the orbital charge inside nuclei, assuming the different values of R observed, we find a relation between R and the so called speed of light. We take into account the central force projected on the X axis which acts half of the time in the same direction, half the time in the opposite direction as the exterior force (assumed to be acting along the X axis); thus:

$F = qE \pm [(9) \times (10^9) \times (2q^2)]/R^2$ $F = qE \pm [(9)\times(10^9)\times(2q^2)]/R^2$

$$(F)(x/R) = qE \pm ([(9)\times(2)\times(2.56)]/2.486^3)\times(10^{(9-38+30+15)})x \approx qE \pm c^2 x,$$

$$q \approx (1.6)\times(10^{-19}), R = (2.486)\times 10^{-15}$$

That is, the speed of light squared is the elasticity of charge polarization inside atomic nuclei or inside electrons- if the radius of orbiting charge inside the proton or the electron is exactly R=2.486 femtometers! That is, the speed of light squared is a function of the electron radius and charge and the electrostatic force constant, $(9)\times(10^9)$. Note that the general equation for an elastic system is –kx = mx”(t) which has the general solution:

x=Acos(2πft) where $(2\pi f)^2 = k/m$. Here, m**, is m*** $\approx 10^{-56}$ **kg and** $k=c^2$

So $v_0 = (6.62) \times (10^{-7})/\sqrt{m^*} = 10^{21}$ meters/second, and the frequency, $f_0 = 10^{21-(-15)} = 10^{36}$ approximately. So we see that the speed of light squared is also the product of the mass of the orbital particle inside atomic nuclei and inside electrons times the square of this orbital frequency.

This orbital radius is in the neighborhood of both the electron radius estimated from Xray scattering, 2.8fm, and the radius of the copper nucleus, 4.7fm estimated from nucleus-neutron scattering and the estimation formula , $R = 1.1 \times 10^{-15} \times \sqrt[3]{A}$ where A is the atomic mass number. Some high energy electron electron scattering experiments show Coulomb repulsion at separations of $.2\times (10^{-15})$ meters. If the electron's rest mass, $9.11\times (10^{-30})$kg, is completely convertible into potential energy, $((9) \times (10^9) \times e^2)/R$, then we obtain the classical electron radius,

$$R = ((9)\times(10^9)\times e^2)/mc^2 = (2.824) \times 10^{-15} \text{ meters.}$$

Considering all of these nearly equal possible values for the orbital radius of an actual orbiting mass inside the electron or inside the nucleus of a conductor, we will use, the value, $R=2.48\times (10^{-15})$., that makes the elasticity of the orbit equal to the square root of the ratio of, the electric force between unit charges, to, the magnetic force between unit currents, the so called, speed of light..

The variation in the experimental values is evidence for an orbital system electron and nucleus in preference to a billiard ball or infinitesimal point charge electron etc.. It is also evidence of a relation between oscillating charge inside the nucleus and the so called speed of light.

We consider later in discussing radio transmission, the interaction between a pair of parallel oscillating current carrying wires where the current in one wire is much weaker; e.g., milliamps to picoamps and the values of, r, may be meters to kilometers to hundreds of kilometers and more. Thus the transverse dipole expansion in the weaker current wire is inhibited initially by the transverse dipole field from the other wire and the effect of the surrounding orbital electrons in the weaker current wire is effective in reducing the dipole expansion from what it would be otherwise, in the receiver wire.

The average or root mean square oscillating dipoles inside atomic nuclei in these parallel oscillating currents could be rv/c per unit length but due to the local effects of the surrounding orbital electrons for large values of v, and r, rv/c may be larger than .1 Angstrom and not permitted. We may have krv/c = .1 Angstrom where $k \le 1$ For example, $r = 10^{18}$ meters and $v=10^{-6}$ meters/second, when the oscillation becomes detectable in the receiver, makes krv/c about k times 10^{18-6-8} , so k must be 10^{-15} or less so that $krv/c = 10^{-11}$. That is, the radiation is received, not after $r/c = 10^{10}$ seconds but after $kr/c = 10^{-15+18-8}$ or 10^{-5} seconds. This received radiation consists of oscillations of rms amplitude, krv/c, equal to about .1 Angstrom, the upper limit. If the distance from the source, r, is increased, then, krv/c will become .1 Angstrom sooner and detectable sooner than kr/c = 10^{-5} seconds.

Consider a much closer and much weaker radiation source, r= 10^1 that produces a detectable oscillation in the receiver of root mean squared velocity, v meters/second, such that rv/c is at most .1 Angstrom. That is, v, can be as large as 10^{-4} meters per second after 10^{1-8} or 10^{-7} seconds.

Thus, the increasing amplitude of oscillating dipoles, $A(t)\cos 2\pi ft,\ A(t) =$ QD(t) inside the lattice nuclei of receiving antenna wires and of molecules of semiconductors and of cells of the eye precede the detectable oscillation of free electrons in the receiving antenna or the excitation of bound electrons from molecules of the eye or of a photodiode or CCD array of pixels or other photoemissive surface.

The delay before radiation is detectable at a distance r, from the source for large enough r- when the intensity at the receiver is sufficiently weak-after r/c seconds- can be kr/c seconds, where k is smaller than 1. Below we show that the supposed evidence for light speed of 186,283 miles per second at distances beyond 200 miles is not as unambiguous as commonly believed.

For example radar reflections from the moon and planets from a continually sending and receiving transceiver could be radar returns from emissions just before reception having been emitted much later than the supposed emissions. The GPS satellites at distances of 12000 miles produce weak signals at the receivers. The strength of the signals can be calibrated to produce delays calculated from the known distances of satellites from fixed GPS receivers and the assumed speed of light. Then the matching of repeated millisecond long codes with a replica code in the receiver so that differences in distance of up to only 180 miles can be detected, can be used to determine the delay to the remote satellites.

Why does such charge polarization with its magnetic effects not occur in dielectric strips subject to an electric field? Because the loosely bound electrons around atomic nuclei in these dielectrics, redistribute themselves, to cancel the effects of the outside electric field on the central nuclei. The dielectric as a whole becomes polarized opposite to the applied field.

But if the applied field is constantly changing, then the nuclei of dielectrics have a chance to respond to the applied field before the surrounding electrons can completely cancel the changing applied field. The result of each change in force will be a small amount of charge polarization transverse to the force or force change.

This in fact happens all the time as the Earth spins. As the Earth spins on its axis (.465m./s. and orbits the Sun, (29.9m./s.) at a distance on the order of 10^{11} meters and with the Sun orbits the Galactic center 10^{20} meters away at (220m./s.) etc, the motion of the Earth's atoms implies constantly changing forces.

These mechanical forces were initially ultimately electrical on the Earth's major dielectric atoms, eg, silica, and oxygen, and so produced a small amount of charge polarization in these atomic nuclei each time the tangential velocity changes direction. (That mechanical,contact forces are ultimately electrical, is seen from the example of two colliding billiard balls and the electrical nature of the constituent atoms.)

As the Earth turns, the centripetal force due to the initially created radial collinear dipoles that attract each other is at any point , perpendicular to a tangent line which itself is at a slight angle to a subsequent tangent line and thus has a non zero component projection on this subsequent tangent line. And this tangential dipole force produces radial oriented dipoles along a subsequent radial line from the Earth's center to this subsequent tangent line. And in this way the radial and longitudinal dipoles are sustained.

Another possible mechanism to account for the radially and longitudinally oriented dipoles: The initial force that caused the rotation and after, sustained by inertia, was tangential along a west to east line of latitude and thus perpendicular to a radial line to the Earth's center and to a north south or longitudinal line. The radial and longitudinal dipoles initially produced, cause collinear attraction along radial and longitudinal lines etc and in combination, produce forces on protons initially without dipoles, that causes dipoles transverse to the radial dipoles and transverse to the longitudinal dipoles. That is new radial, longitudinal and latitudinal or tangential dipoles are continually produced.

Thus it is possible that an uncancelled electric field, E_{rot}, exists inside the average dielectric atom of average duration, τ, and due to this time limitation and not just to surrounding electrical forces, produces an elliptical extension of orbital charge inside the protons of eccentricity, ε. The increase in orbital velocity from $v_0 = [(9\times(10^9)\times 2e^2)/Rm^*]^{1/2} = 10^{21}$ is $eE_{rot}\tau/m^* = eE_{rot}\tau/10^{-56} = (\varepsilon/2)v_0$. and the dipole produced is, $R\varepsilon/(1-\varepsilon)$ where $\varepsilon = 2v_0 E_{rot}\tau/m^*$ where $v_0 = [(9\times(10^9)\times 2e^2)/Rm^*]^{1/2}$
and m*=10^{-56}.

For example, if the produced dipole length is s=10^{-18}, then $R\varepsilon/(1-\varepsilon) = 10^{-18}$,

so with. $R = 10^{-15}, \varepsilon \approx 10^{-3}$. is the eccentricity.

The electrical force and duration, $eE_{rot}\tau$, producing dipoles is proportional to the force or torque that produced the spin angular momentum of the Earth:
$eE_{rot} = KM_E v_{rot}^2/r_E$ where $M_E = [5.98\times(10^{24}]$ and $v_{rot}^2/r_E = [465]^2/[(6.37)\times(10^6)]$. So $E_{rot}\tau = 2.03\times(10^4)$K volts/meter times τ. The duration may be inversely proportional to the 24 hour period as a measure of how rapidly the tangent lines change direction.

The net result is the existence of co-linear similarly and so attractively oriented electrostatic dipoles along the Earth's radii and along lines of longitude with parallel longitudinal dipoles repelling.

Thus a magnetized steel compass needle is pulled downward and made to line up with lines of longitude. The Earth's magnetic field and that of other planets is thus accounted for. The Earth's magnetic field is just the Earth's Gravitational field measured by magnetic measuring instruments. The slight difference in the pattern of relative strengths of Gravitational and Magnetic fields over the Earth's surface may be attributable to the susceptibility of such instruments to the unequal distribution of iron, cobalt and nickel beneath the Earth's surface and their net direction of magnetization at specific locations (The molten iron core is too hot to produce the constant magnetic fields of magnetized solid iron. But the iron nuclei here have net electric dipoles, just like the other elements, in directions transverse to the spin of the Earth on its axis and to the orbital motion of the Earth around the sun and with the sun around the galactic center).