GRAVITOMAGNETISM AND LIGHT

charge polarization inside electrons &atomic nuclei

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INTRODUCTION

This book is about evidence for charge polarization inside electrons and atomic nuclei. Such polarization can be shown to explain apparent quantum discontinuities and the apparent spacetime distortions of Relativity.

We start with the two most damaging mistakes in the history of physics that led to the unnecessary added premises of Quantum Mechanics and Special and General Relativity.

The first mistake was Roemer’s so called measurement of the speed of light in 1676 and the second was Kaufmann’s 1903 measurement of the apparent increase of the mass of beta electrons as their velocity increased. The experts of the times in these specific sorts of measurements, in each case, were ignored. Preference was given to the opinions of a larger number of scientists whose expertise lay elsewhere

The damage caused by these mistakes continues to undermine our basic understanding of electromagnetic radiation, gravity and the atom. Recent advances in optics and electronics provide the necessary tools to correct these mistakes and put physics back on track.

When we do so, we shall see that gravity is a form of magnetism and that magnetism is a form of electrostatic force involving charge polarization inside electrons and inside atomic nuclei. We shall see also that the delay associated with electromagnetic induction and radiation is due to the reaction time of charge polarization inside electrons and atomic nuclei of the receiver.

Let's summarize briefly the two mistakes. First, Roemer’s measurement of the speed of light required that light be a wave front or a group of moving particles while Bradley’s and Fizeau’s light speed measurements allowed light to be interpreted as the cumulative effect of instantaneous forces at a distance. That is, Roemer's measurement required that reflected Sunlight, reflected from the surfaces of Jupiter's moons, traveled as a wave front or particle for about 40 minutes using Bradley's value (or 55 minutes using Roemer's value) until it reached the Earth. By which time an observer on the Earth would have moved with the Earth a substantial distance, sometimes from under clouds, to a location with an unclouded view of the night sky. That is Roemer's measurement did not require constant exposure to the light source.

However, recent light speed measurements suggest that constant exposure is required and that the cumulative effect interpretation is closer to the facts.

It is necessary to point out here that communications with distant probes, radar reflections off the moons of distant planets, etc., do not confirm Roemer's measurement as they would seem to at first glance.

The radar measurements involve waiting a few seconds or numerous minutes for reflection or echo but the data received must be statistically analysed from noise and is to some extent ‘chosen’ so as to confirm what is otherwise observed or which does not contradict what is otherwise observed. That is many different starting times are assumed when comparing the "received" voltage changes over time with the sent pattern of voltage changes over time until the most "similar" time series is determined.(In the summation or integration of sets of time series, the random noise cancels out and small repeated signals at regular intervals, add. But these finite patterns may having nothing to do with the topography of the radar target).

The location of a distant space craft is determined by several methods and a computer algorithm that in effect throws out any estimate that doesn't agree with the rest, produces an estimate that is used to position the receiving antenna. Hence the speed of light estimate, apparently used, need not be used to track the position of the craft. Preference may be given to estimates from the mass and initial acceleration of
the space craft and the gravitational influences of the sun and nearby planets etc., from astronomical observations from the space craft of its surroundings, from the Doppler shift with respect to the Earth, etc., with previous estimates of positions to estimate subsequent positions according to basic Newtonian mechanics.Of course, the speed of light assumption is also implicit in the Doppler estimate.

That is, the speed of light assumption implicitly involves the assumption that weak and strong sources from the same distance arrive with the same delay. The possibility for a greater delay for the weak source is somehow compensated by weaker delay making influences proportional to the weaker intensity of the source.

As the weak or strong source moves further from the receiver, there is no change in the delay making influences proportional to the intrinsic intensity of the source but there is a change in distance that reduces the strength of the received signal and so the delay in the receiving of the signal. Hence as a spacecraft moves further radially from the Earth, its signal gets weaker and the delay is assumed to increase by $\Delta r/c$.

But suppose that as 'r' increases beyond a certain value, eg 22,500 miles or .12 seconds- where the geostationary satellites are, the delay in the arrival of a signal is slightly but noticeably greater for weaker sources. Suppose also that sources where the delay is .2 seconds or more, due to the intrinsic weakness of the source as well as to the distance from the source, are too faint at the receiver to be distinguished from noise. If the receiver temperature is lowered, it may be possible to receive the signal ie successive modulations of the carrier but with lesser delay. We discuss later in the section on radiation and induction a possible mechanism to explain how signals are stored in the receiver during the delay and so explain the maximal delay possible for a given number of successive modulations.

Consider CCD images and time exposures on film where visible light frequencies become more visible over time. In these cases the delay is attributable to physical chemical processes of adding successive amplitudes of the received radiation which must be above noise in each case. The effect of adding the light in each pixel over successive instants of time is to make sharper contrasts in any given image.

Thus a space craft's signal as it moves away from the Earth beyond such a distance and supposedly many minutes or hours away from the earth may, as it decreases in strength, increases in delay from .12 seconds to .12000000000001 seconds over the time period of a 1MHz carrier oscillation, ie, 1 microsecond. And then if it doubles in speed, the decrease in strength over the same time duration would be greater etc.

The idea here is that the delay of the signal cannot be greater than a second or so and that differences in delay from small changes of distance at these great distances would be negligible. Therefore the observed frequency shifts cannot be due to the Doppler effect per se. The frequency shift that occurs and is measured can be attributed to the speed of the craft and not to an increase or decrease in the delay of a wave front or stream of photons in traversing the length of a wave period of the original frequency. The exact mechanism is described in the radiation and inductance section. The shift calculated using this mechanism is the same
as the shift calculated using the Doppler assumption

Someone with a GPS device, complained to me recently that signals received from several satellites at slightly different times by his GPS device which could then compute his position, was a conclusive argument against the cumulative effect interpretation of the delay in the speed of light.

I could only reply that in these cases the time differences were of the order of milli to nanoseconds; that during such small intervals of time the cumulative effect and the moving wave/particle interpretation of light give the same results.

He offered no counterargument but he would not be persuaded.

The cumulative effect interpretation makes Einstein's valiant effort to save Maxwell's theory from the Michelson Morely experiment, with dilations and contractions of space-time, unnecessary. In fact if we view light as the cumulative effect of instantaneous forces at a distance Maxwell's premise of an invisible massless field conveying electric and magnetic influences from a source to a receiver is also rendered unnecessary.

The problems of the photon theory, of the wave photon duality or of the probabilistic photon are similarly avoided. The probabilistic photon theory begs the question of what actually happens in the process of emission and reception of a photon. Also and perhaps more importantly, the photon theory does not explain how a photon can move like a particle and yet not have the other characteristics essential to the definition of a particle, like its mass.

One might object that a cumulative instantaneous force theory does not explain how forces can occur between objects which are not touching. The answer to this is that sure, human beings must touch things to mo ve them. But the primitive human experience includes magnetic and electrostatic attractions and repulsions between things which are not touching.

Consider the force between charged particles such as leaves of tin foil on a simple electroscope. The leaves are fastened together at the top by, say, an aluminum paper clip. The aluminum clip and the top part of the leaves are charged. The bottom parts of the leaves are free to move apart and they do because similarly charged particles repel each other. The formula for this repulsion is an inverse square force similar in form to Newton's gravitational force and in the fact that it can act in a vacuum. It is not necessary here to postulate a propagating field or the movement of photons.

In fact if we were to postulate the existence of undefined entities unnecessarily we would stand in violation of the scientific method specifically of Occam's principle of parsimony.

Hence the cumulative effect interpretation of light would, having fewer assumed entities, be preferable to the present theory of light if we could show Roemer's so called measurement to be attributable to other causes. We will discuss these causes in the section on light speed measurements.

The second major mistake in the history of physics has to do with the apparent increase of mass of beta electrons as they approached the speed of light. Beta electrons (electrons emitted by nuclei of radioactive atoms) of various speeds near the speed of light were observed. Their increasing responsiveness to a magnetic field as their velocity increased was seen, unexpectedly, to slack off when the velocity increased beyond a specific amount. The rate of increase of the response, as the velocity increased, unexpectedly decreased. Instead of being attributed to changes in some previously unobserved quality of magnetic responsiveness, these changes were attributed to increasing inertia or mass. The force producing the velocity somehow after some threshold point produced an increase in mass also.

Kaufmann, the one person who had most familiarity with this sort of experiment objected that the data seemed to require different values for the inertial mass in different directions. But his objections were ignored in favor of the simpler explanation offered by Special Relativity whose success in explaining the Michelson Morely experiment was in its favor.

We will discuss Kaufmann's reasons later and show that a better explanation is that there is a change in magnetic responsiveness as the speed of a charged particle increases to the speed of light. The explanation is better because it requires fewer assumptions and is consistent with new discoveries in nuclear physics.

The increasing number of premises and circumlocutions in modern physics are due to the mistaken interpretations of Roemer's and of Kaufmann's measurements. When Faraday and Maxwell first imagined invisible lines of force, wheels and ball bearings to help them understand electromagnetic induction and radiation as implied by Roemer's experiment, it was not inconceivable that such things existed. But even during Maxwell's lifetime improbable implications of such entities became difficult to ignore. For example the invisible and perhaps vacuous field medium carrying light would have to have the rigidity of iron.

Despite such problems with field theories, the apparent lack of any alternative to explain the phenomena of radiation, e.g. Roemer's measurement, has led to even more extravagant claims for fields.

Physicists like Witten at Harvard, for example believe that latent energy and mass may exist in a complete vacuum, in massless space; that the existence of fields implies such a possiblity. Witten calls these things, these vacuous latent mass-energy things, strings. They are somewhat similar to Wheeler's quantum foam. And other physicists like Kip Thorne at Stanford extending the ideas of John Wheeler, believe there are wormholes in space-time, since space-time near a large dense star could be severely bent out of shape; also perhaps, that these wormholes may lead to otherwise invisible universes. The mathematical complexity of the justification for these speculations confounds journalists who anyway have to be more concerned with catchy phrases and startling images than with scientific clarity.

But one doesn't have to follow a lengthy mathematical argument to see the probable fallacy in such speculations. Regarding latent energy and mass in vacuous space. Our only experience of latent energy and mass is in the presence of other mass and not far from such masses, in empty space. For example, radioactive nuclei produce charged particles of lesser mass that move at high velocities. These particles are visible as they move through cloud chambers and cause condensation around them in their successive positions in the moist vapor of the cloud chamber. But sometimes, uncharged particles may be ejected and soon break up into charged particles that seem to appear out of nowhere. But such things are not observed to occur in vacuous space far from the mass of an excited atomic nucleus.

Hence it is improbable that latent energy and mass can exist in a vacuum. Regarding wormholes, black holes, and other implications of the General Relativity premise that mass distorts space-time and the premise that the density of imploding mass can increase beyond specific limits.

The situation is analogous to a rubber band stretched to the limit. One cannot apply indefinitely a linear formula to describe the amount of stretching produced by a given force on a rubber band. At some point the band loses its elasticity and the relation between force and stretch loses its linearity. And at some point the band breaks but the formula keeps grinding out numbers. The linear formula alone is not enough to tell when the band breaks. When extrapolations claim the existence of stranger and stranger phenomena, it is time, isn't it, to question the validity of the extrapolation and the applicability of one' s basic assumptions and theory.

Necessary information is lacking in black hole and wormhole speculations based on the predictions of equations that are observed to be valid for some values of the independent variables. Will these same formula work for unobserved values of the independent variables? Probably not, especially if the predictions are counter to our previous experience of similar things and events.

Let us look more closely, also, at the assumptions required for black holes and wormholes. Regarding General Relativity: the effect of the Sun's mass in delaying slightly the time, when the eye recognizes light from a distant star, can be attributed to the effect of the Sun's mass on the eye or other receiver of the radiation; that is, we do not have to assume that space time is bent by large masses as assumed by General Relativity. Similarly the precession of the perihelion of the planets may be attributed to a torque interaction between the planets and the Sun as dipoles; we do not have to assume that space-time is bent. By dipoles here I mean electrostatic dipoles and the evidence of such dipoles will be shown in a later section dealing with gravity.

Regarding how much a star can collapse given the forces of repulsion between atomic nuclei and parts of atomic nuclei, the evidence of neutron stars with densities 10^{14} times that of water or of the Sun may point to even greater densities and black holes and singularities. But as we have said, when limits are approached and extrapolations are made of things happening that are unlike anything we observe, it is time to reassess the boundaries of the theory that leads to such extrapolations.

The reassessment involves observing evidence for charged particles inside electrons and atomic nuclei orbiting at supraluminal speeds and what that implies, particularly with regard to accepted hypotheses regarding 1)Ampere's theory of magnetism, 2) the wave,photon and probabilistic photon theories of electromagnetic radiation, 3)the quantum theory of atomic energy levels and of magnetic phenomena, 4)exchange forces and the quark theory of Gell Mann, 5) Einstein's special theory of relativity and mass energy transformations 6) Newton's theory of gravity and Einstein's general relativity theory.

No one after reading the evidence and the arguments in this book can avoid the conclusion that all the forces of nature including gravity, magnetism and the weak and strong nuclear forces are derived from a single force, the electrostatic force.

I MAGNETISM and ELECTRODYNAMICS

Forces Between Currents and Charged Foils

According to the received wisdom, there should be no force between a charged object and a current carrying wire except that caused by electrostatic or electromagnetic induction. This is essentially the theory of magnetism formulated by Ampere, Biot, Savart, Faraday and others.

I carried out a number of experiments that seemed to show that this is not the case; that the electromagnetic force might be a form of electrostatic force. The experiments involved measurements of forces between uncharged current carrying wires and charged pieces of metal, for example oppositely charged metallic surfaces separated by a dielectric. The forces appeared to increase with increasing currents and to reverse direction with a reversal of the direction of the current contrary to the accepted theory that the magnetic force of current carrying wires was independent of the electrostatic force of charged conductors.

These effects are not easy to detect because as the current in a wire is turned on, a momentary current is induced in the nearby small square piece of metal even with slits cut in it to minimize this effect, and so there occurs a brief weak magnetic repulsion between the wire and the piece of metal independent of the direction of the current. Also the charged piece of metal induces charge displacement in the wire and so the resulting constant stronger attraction increases as the separation, between the piece of metal and the wire, is reduced.

But small observed repulsions occurred in spite of such attraction producing inductions when the current was moving in one direction. The experiments involved measurements of small repelling and attractive forces, about 10^{-7to-5} Newtons, between uncharged current carrying wires (900Amps to 25Amps) and a charged cm^2 foil carrying a charge of 2kV.

In another experiment an Ampere Balance in modified form was used. The Ampere Balance was obtained from Cenco, a Chicago supplier of laboratory demonstrations for schools. The Ampere Balance consists of a horizontal wire about one cm in diameter and 30cm long fixed between two dielectric (plastic) supports and connected to a dc power source. Above this current carrying wire is another wire of the same length forming one side of a three sided square wire circuit. The fourth side of the square is a dielectric two by four piece also 30cm long whose ends were metal triangular prisms.

The blade end of each prism rested on a metal step carved into a metal post about 3cm high. So the fourth side of the square and the horizontal U shaped wire circuit could pivot back and forth; weights could also be attached to the opposite side of the dielectric bar so as to position the base of the U at a desired position above the straight wire. When currents were passed through both wires the movement of U shaped piece upward or downward showed the Amperian force between current carrying wires.

By replacing the U shaped wire with thin wooden dowels glued together to produce the same shape and by attaching to the base of the U a pair of thin copper strips separated by a 1mm thick dielectric tape whose long edge faced the equally long straight wire it was possible to test for the existence of a force between a current carrying wire and an electrostatic dipole. That is when the copper strips were charged say to a potential difference of .42 kV we formed a chain of dipoles in the horizontal plane and parallel perhaps to transverse dipoles in the current carrying wire below them. The hypothesis that currents produce electrostatic dipoles transverse to the currents is discussed in detail below

The vertical 1 mg attraction/repulsion of the two sets of parallel/antiparallel dipoles was easily observed. Note that the horizontal torque due to the interaction of the potential difference along the current carrying wire and the chain of dipoles was not possible to observe given the experimental design implemented here.

The observed forces appeared to increase with increasing currents contrary to the accepted theory that the magnetic force of current carrying wires is independent of the electrostatic force of charged conductors.

A discussion of the subject appeared in Electrical Engineering Times (12/28/87). A related patent was accepted by the US patent office (4,355,195). Only one paper of several I submitted was published in the Rev of Scientific Instruments (3/85) and there followed a paper, purporting dishonestly, I thought, to be a duplication of one of these experiments using wires of different lengths, thickness and arrangements and different orders of magnitude of currents and presenting ambiguous results(Rev. Sci. Instr., D.F. Bartlett 10/90).

The hypothesis was proposed that the magnetic force was ultimately an electrostatic force between electrostatic dipoles inside the atomic nuclei and free electrons of the conductors and transverse to the currents. The dipoles are produced by subnuclear and/or subelectronic elliptical orbital systems; specifically by the displacement of the average centers of negative and positive charge inside these systems. The magnitude of the dipoles appears to increase with the distance, r, between any two of a pair of dipoles and decreases as the relative size of the other dipole in the pair considered, increased.

Because the dipoles are not produced by the relative displacement of free electrons and the positive atomic ions and because they are so small and so numerous, all with a common orientation, electrostatic shielding does not shield against this proposed cause of the magnetic force.

Hence their effect on a nearby conductive piece of metal that is not carrying current is less to pull or push the free electrons in the metal toward one side but to attract or repel equally the similarly oriented electrostatic dipoles inside the nuclei and free electrons of a parallel current carrying conductor on the other side of the conductive piece of metal.

To see why this is really not so surprising consider two oppositely charged metallic surfaces on opposite sides of a thin narrow strip of plastic tape.

Suppose the distance between the charged surfaces of the strip is smaller than the distance between the strip, lying horizontally, and a parallel current carrying wire suspended above it, by a factor of approximately three or more, then the charge of these surfaces interacts-according to Coulomb's law- about ten times less strongly with the free electrons in the parallel current carrying wire than it would if the distance between the charged surfaces was the same as that between the current carrying wire and the nearer charged surface. That is, pairs of charged surfaces interact as dipoles with other electrostatic dipoles that may be assumed to exist within the nuclei and free electrons of the parallel current carrying wire. When the oppositely charged surfaces are very close to one another, interaction between the linear array of electrostatic dipoles thus formed and a free electron in the wire carrying current can be less than the force between the total electrostatic dipole of the array and an electrostatic dipole inside the free electron or inside the nucleus of the current carrying wire.

The reason is that any displacement of a free electron in the current carrying wire not in the direction of the sustained potential difference is opposed by pushes from a greater local density of free electrons produced by the selfsame displacement and by pulls from the greater local density of positive charge produced by the same displacement of free electrons.

This does not happen of course when an electrostatic dipole in one conductor acts on a colinear line of electrostatic dipoles inside the nuclei and free electrons of a parallel conductor. The two parallel conductors then repel each other or attract each other. That is, this action whether a push or a pull acts on the electrostatic dipoles inside the nuclei in the same direction as it acts on the electrostatic dipoles in the free electrons which thus tend to move together.

We will show that the similarity between the magnetic force in Ampere’s general formulation and the force of electrostatic dipoles can be made into an identity.

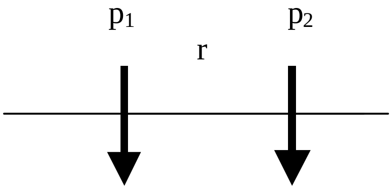
Ampere's Formula and Transverse Electrostatic Dipoles

The obvious analogy between electrostatic dipoles and magnetic dipoles has led physicists on a century long search for a single magnetic pole without result. The underlying significance of the analogy probably lies elsewhere. For example:

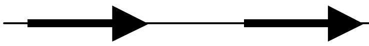
The similarity between the magnetic force between current carrying segments of wire as formulated by Ampere and the electrostatic force between imaginary electrostatic dipoles transverse to these wire segments, ds and ds' can be expressed as follows(fig 1&2, on the first page of illustrations at the end of the book):

$$F=(2)(9)(10^9)/((rc)^2)(ids\ \sin a\alpha\cos\beta)(i'ds'\sin\alpha') - (1/2)(ids\ \cos\alpha)(i'ds'\cos\alpha'))$$

$$G=(3)(9)(10^9)/r^4)(-(pds\ \cos a\alpha\ \cos\beta)(p'ds'\cos\alpha') + 2(p\ ds\ \sin a\alpha)(p'ds'\sin\alpha'))$$



$F_r = + 3p_1p_2/4\pi\varepsilon_0r^4$



$F_r = -6p_1p_2/4\pi\varepsilon_0r^4$

The forces F and G are equivalent except for the placement of the factor "cosβ" if p=ri/c* and p'=ri'/c* where $c^* = (3^{1/2})c$ where c denotes the velocity of light and the currents are denoted i and i'.. It may be that the square root of three factor is related to the fact that we have ignored the two equal transverse dipole components perpendicular to each other and the transverse dipole component we first considered. But it is clear from a glance at the diagrams of these forces in fig1&2 that in summation over a complete circuit, the cosβ factor must be sometimes positive and sometimes negative and these quantities must add up to zero. In the language of vector calculus used in texts on electromagnetism, the curls of F and G are equal although their divergences and gauges may be different.

We should note also that the dipoles p and p' increase with r consistent with observations of magnetoresistance. Later we show that another representation of the dipoles similar in this respect and that gives the same pair-wise ponderomotive force is preferable; that is $p=ri^2/i'c^*$ and $p'=(i')^2r/ic^*$. This says that the dipole in one wire is inhibited by the strength of the current in the other wire. However to make the analysis easier to understand we will use initially the simpler representation. Consider the case of two parallel vertical wires and the transverse force per unit charge from one wire on the second. Here and in other references to the transverse force component we shall mean along a line drawn between parallel vertical current carrying wires. The other transverse component is perpendicular both to the longitudinal current and to the first transverse component; both components are of equal magnitude.

The transverse force of one wire on the other may make the transverse dipole more longitudinal and less transverse according to a process described later. This may reduce the effective size of the transverse dipole in the second wire produced by a given emf field E. Hence the magnetic effect is reduced for a specified voltage V=Ed, where d denotes the distance between any two points along a current carrying wire for which we want to know the voltage. The voltage is the sustained potential difference between these points due to the resistance in the wire.

Similarly for the effect of the second wire on the first. We should note that as r and so rv/c* increases for a specified emf the current flow and, v, the subsequent velocity in the direction of current or electron flow of charge $e=(1.6)10^{-19}$ Coulombs and mass $m=(9.1)10^{-31}$kg. must decrease as a consequence of a reduced time between collisions and so that rv/c* where neAv=i does not increase beyond the distance between lattice ions which is approximately one Angstrom (10^{-10}meters).

Note nevA is the amount of charge flowing per sec through a cross section area, A, of a wire and the dipole, associated with a cross section of diameter equal to the wire diameter and width equal to the distance between atoms, one Angstrom, and denoted ds, is (r)(nevA)ds/c*; n of course denotes the density or number of free electrons per meter cubed in mks units. Suppose that the dipole inside each nucleus and free electron was of length rv/c* and charge e then nAds is the number of such nuclei and free electrons contributing to the total dipole associated with the current segment ds.

This seems at first strange. Over typical values of current and voltage, and for what amounts to a standard distance between current carrying wires when their ponderomotive forces are measured by what is called a galvanometer or ammeter, current is proportional to voltage; also the time between thermal collisions is constant for a range of temperatures. We will discuss this problem later as well as the problem of unique dipoles associated with segments of current when different pairwise forces between three or more current segments occur.

To see that the combined forces of many small electrostatic dipoles in 1) two parallel fairly closely spaced wires and 2) two parallel pairs of oppositely charged surfaces separated by a thin dielectric or 3) one such composite pair of charged surfaces and a current carrying wire, can produce a measurable, ponderomotive force we will consider a quantitative example. Consider a current element, ds, along the direct current carrying conductor of length,s. We project the electrostatic dipole pds=rids/($3^{1/2}$)(c) to obtain, p sinα ds, and on a perpendicular to r to get, p cosα ds. We define in fig 3,p108, the angle between the electrostatic dipole Pds' at point R and the extension of the line r as 90-α' where α' = α. Then the force between the electrostatic dipoles Pds' and pds along r projected on D and integrated over ds is the integral over ds of

$[((3)(9)10^{9})(dl)(-pP(\cos\alpha)^{2}+2pP(\sin\alpha)^{2} \sin\alpha]ds$

Since(r)(-dα)=ds sinα so ds=(r/sinα)dα according to fig 3 , we can write this as the integral over dα of

$[2(9)(10^{9})(3ds) ((\sin 2\alpha - (1/2)\cos 2\alpha) (ri/(3^{1/2}))c)P/r^{3}]d\alpha$

Since rsinα=D according to fig 3, we can write this integral and integrate over possible values of , α, from zero to 90 degrees

$$2K((\sin\alpha)^{2} -(1/2)(\cos\alpha)^{2})((\sin\alpha)^{2})d\alpha/D^{2} = \quad 1.96(9)(10^{9})(i/(3^{1/2})c)Pds'/D^{2}=F$$

The dipole-per-meter length here is P = Qd = CVd = $((1.1)(10^{-11})(A)/ d)(V)(d)$

This seems to account for one of the experiments previously mentioned involving measurements of small attractive forces about $10^{(-7\text{to}-5)}$ Newtons, between uncharged current carrying wires(900Amps to 25Amps) and a charged cm^{2} foil(2kV) and in another experiment, two oppositely charged foils separated by a thin, eg 1mm dielectric(.42kV). The attraction appeared to increase with increasing currents in one direction contrary to the accepted theory that the magnetic force of current carrying wires was independent of the electrostatic force of charged conductors (Note that induced oppositely directed currents cause repulsion).

It is instructive to consider the combined effect of the transverse dipoles produced in a current carrying circular wire in the horizontal plane. We assume that the force producing the current produces the elliptical extension of orbiting charged particles inside atomic nuclei and free electrons in the wire in two mutually perpendicular directions in the horizontal plane that are also perpendicular to the direction of the current producing force. This produces charge polarization along the radius of the circular wire and perpendicular to the plane of the circular wire. The direction of charge polarization is opposite on diametrically opposite points on the wire. But the interaction of one such circular wire with a parallel coaxial wire is one of attraction if the currents in each are in the same direction due to the stronger attraction between pairs of parallel segments closest to each other. Similarly for the case of circular wires with antiparallel currents that repel each other.

The analogy here with a short bar magnet or of a current carrying solenoid with a longer bar magnet is evident. So the poles of a magnet may be regarded as abstract constructs based on the summation of the net effects of many pairwise interactions with electrostatic dipoles in the atomic nuclei and in the molecules of magnetic materials of one bar magnet with those of a second bar magnet. The analogy is not an equivalence because if you place parallel circular wires so that they are not coaxial and such that opposite moving current segments face each other there will be a net repulsion.

One might object to the above theory on the grounds that each pairwise force between one wire segment carrying current i(1) and many other segments would imply different dipoles associated with the same segment; Now it is true that a dipole inside one wire segment cannot at the same time be the product r(1,2)s(1) and also r(1,3)s(1) where s(1)=i(1)/c and the distance between segments 1 and 2 denoted r(1,2)is not equal to r(1,3), the distance between segments 1 and 3. But the actual dipole involved here, r(1)s(1), where r(1) is yet to be determined is equivalent in its effects to the sum of dipole-dipole forces involving different dipoles for the same wire segment The mathematical procedure for determining r(1) etc and the unique dipole r(1)(s(1) etc is as follows: The force on the first of three current carrying wire segments due to the other two wire segments is

$$[ks(1)s(2)r(1,2)^2]/r(1,2)^4 \ +[ks(1)s(3)r(1,3)^2]/r(1.3)^4$$

where k denotes a constant of proportionality and the other terms are as defined above.

We set this expression for the force equal to another expression, in terms of unknowns to be determined, for the same force, namely,

$$[ks(1)s(2)r(1)r(2)]/r(1,2)^4+[ks(1)s(3)r(1)r(3)]/r(1,3)^4.$$

Note this equivalence will only be valid if

$r(1)r(2)=r(1,2)^2$ and $r(1)r(3)=r(1,3)^2$; that is if $r(1)=r(1,2)^2/r(2)$ and

$r(2)=[r(1,3)^2/r(1,2)^2]r(3)$.

The force on the second wire segment due to the first and third gives a similar equation which will hold under similar conditions. Now we have enough to solve

$r(2)^2=[(r(1,3)^2)/(r(1,2)\text{^}2)][r(2,3)^2]$ and $r(1)=[r(1,2)^2]/r(2)$.

Proceeding in this way we obtain r(3) and thus unique dipoles for each segment. The procedure generalizes for many however oriented current segments even if the currents are of different magnitudes.

Orbital Systems Inside Electrons and Nuclei

We have assumed transverse charge polarization inside nuclei and free electrons in a conductor but how does it come about? Such polarization is possible if we assume an orbiting charged particle within the nuclei and free electrons of very small mass 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. (We will also see later that the existence of such a particle does not interfere with other established nuclear particles and reactions but rather helps to explain them.)

Then the force acting for the brief time between thermal collsions is sufficient to produce an elliptical orbit of the small mass such that the average center of charge of the orbiting particle is displaced from the oppositely charged central particle by a distance, a1-R =rv/c = εR/(1-ε) where ε denotes the eccentricity of the ellipse.

Here R denotes the radius of the electron or the nucleus, initially regarded as a sphere, and 2a1 denotes the length of the semimajor axis of the produced ellipse.

With regard to the radius of the electron and the nucleus, according to the 6th edition of Introduction to Modern Physics by F.K. Richtmyer et al, McGraw Hill, 1969, p66 and p668: "Experiments on the scattering of electrons by electrons at high energies have shown that the interactions remains coulomb repulsion down to separations of less than (2)(10^{-16}) meters., so that clearly the classical radius, (9)(10^9)e^2/mc^2 = (2.8)(10^{-15}) meters, is several times too large to be consistent with electron-electron-interactions." "…On the other hand for scattering x-rays the effective radius is of the [same order of magnitude]." "We shall discuss in later sections still other determinations of the nuclear radius as defined in various ways and shall find that all are reasonably consistent with, R=(R0)($A^{1/3}$) where R0=1.1 to 1.5 times10^{-15} and where 'A' denotes the mass number, the total number of protons and neutrons."

The semimajor axis is perpendicular to the force that produces the ellipse and the velocity of the electron, v =(eE)(t*)/m where t* denotes the time in seconds between collisions of free electrons with lattice ions. That is until a collision occurs a circularly orbiting particle inside the nucleus and electron has its tangential velocity increased at one point along its orbit and an elliptical orbit results. We assume the least energy distribution of electrons around the nucleus is such that the net force of these bound electrons on the nucleus is zero. Since the orbital plane at any time could be with equal likelihood of any orientation we refer to the electron as a sphere. The force is regarded as analogous to the force that kicks an artificial Earth satellite from one circular orbit to an elliptical intermediate orbit before being kicked again into the final larger circular orbit.

The idea that electric current could be explained in terms of the velocity of free electrons impelled by a sustained electric field in a conductor due to a power source was advanced in the early 1900s in Germany by Paul Drude. The current, nevA=i was measured in terms of its ponderomotive effects by an ammeter and the voltage, Ed =V, (between the ends of a wire of cross section area, A, and length, d, producing the current) was measured by the voltage or electric field E between parallel capacitor plates of an early version of an oscilloscope connected to the ends of the current carrying wire. These measurements, Drude showed, implied that at room temperature and for common values of current and voltage, the time between collisions was $t^*=(2)10^{-14}$ sec..

Drude's 1900 model is called the free electron model and according to C. Kittel in his Introduction to Solid State Physics, Wiley, 1976, p186 "The nearly free electron model [of Sommerfeld 1928] [where the continuous allowed energy values of the free electron model are replaced by a discrete set of possible values to better explain specific heats, paramagnetic susceptibility and the temperature cooefficient of resistance] answers almost all the qualitative questions about the behaviour of electrons in metals". In the following we assume then for the above reasons, the nearly free electron model in so far as it is consistent with our second assumption that electrons and nuclei contain in each case a charged particle of much smaller mass than the electron orbiting the central core of each at a virtual velocity in excess of the speed of light. It is argued later that this particle's movement does not interfere with neutrons and other particles contained in and emitted by nuclei and that its virtual velocity is an actual velocity.

Kaufmann's Experiment

The apparent increase of a particle's mass as the speed of light is approached is only shown for charged particles in a crossed electric and magnetic field or in a magnetic field only. The increase of the particle's mass is inferred from the decreasing rate of responsiveness to deflection by the magnetic field as the speed of light is approached. We argue that this decreased responsiveness could by interpreted as due to a reduction in the otherwise linear rate of increase of the magnetic property of the speeding electron as some sort of elastic limit is approached. We propose that this magnetic property is attributable to charge polarization inside the speeding electron because of the similarity between Ampere's formula for the magnetic force between currents and the electrostatic dipole formula.

Walter Kaufmann carried out a series of experiments in the early 1900s, using his improved vacuum pump, that demonstrated this decrease in the rate of increase of an electron's deflection by a magnetic field for electrons moving at high velocities near the speed of light.

To obtain these high velocities, Kaufmann placed a small piece of radium at the base of a vertical evacuated bottle so that some of the radioactive emissions of beta electrons would pass up between charged parallel plates 1.775cm apart for 2.07cm and then through a small hole .5mm in diameter toward a horizontal photographic plate. Two centimeters from the hole on either side of the bottle were placed permanent magnets sufficient to produce a field, B, between them of 299 Gauss plus or minus 7.5 percent during the 48 hours of the experiment. The electrons passing between the charged plates with a potential difference of 6.75 thousand Volts were, for 2cm, subject also to the magnetic field and then for an additional 2cm only to the magnetic field.

The trajectory of the electrons that managed to pass between the charged plates and through the hole beyond and then toward the photographic plate were determined by the magnetic field, the velocity of the electron and the electric field. The magnetic field caused a downward deflection of the electrons while the electric field caused a left to right deflection; very fast electrons should have smaller deflections in general but because the magnetic response of the electron should increase with speed, the decrease in the magnetic deflection should be less. And if there is a decreasing rate of increase of the magnetic deflection as v approaches the speed of light, c, as implied by the equations of Lorentz et al, the size of the magnetic deflection should reflect this effect also. And Kaufmann showed that it does although not precisely as predicted using the Voigt-Lorentz transform. The five initially observed (electric,magnetic) deflections were (.271,.0621), (.348,.0839), (.461,.1175), (.576,.1565), (.688,.198).

Giora Hon has written an interesting essay on the opposition to Kaufmann's and Abraham's interpretation of Kaufmann's experiment and the acceptance of Lorentz's interpretation. The essay is very much in the tradition of Isadore Cohen's essay on the opposition to Roemer's so called measurement of the speed of light. In both cases the authors show logical reasons to doubt the verdict of history but conclude for no clear reason that history must be right. I suppose implicitly they are saying that if the accepted views were wrong then wouldn't something have been observed by now that showed the accepted views were blatantly wrong. Perhaps but not necessarily!

We can predict the same results according to the charge polarization expression, krev/c, for the electron and, k*rnev*A/c, for the magnetic field applied to the electron represented as a short segment of wire parallel to the electron's trajectory at one point of its linear or curvilinear trajectory. Note k and k* are measures of the relative strength of the two dipoles. As the velocity of the electron approaches c, the degree of charge polarization in the electron becomes approximately,
$krev/((c)(1-v^2/c^2))$. This is because the force that produces the acceleration and average velocity of the electron between collisions also produces a change in the orbital velocity of a charged particle inside the electron as described below.

In 1905 Kaufmann obtained with a better vacuum nine more points that were slightly but systematically more distinct from Lorentz' predictions than the results of the 1903 experiment but were more accurately represented by Abraham's formula. Abraham assumed that mass was comprised of a transverse and longitudinal component that only became detectable at high velocities; He made no assumptions about space time distortions and distortions in the electron. Kaufmann's results, because they were not consistent with the Lorentz equations and Einstein's theory, gradually came to be regarded as false by most prominent physicists following Planck's vague critique, except Poincare'. Planck argued that it was necessary to modify some of Kaufmann's nine values in the later experiment and then showed that the modified values were slightly closer to those predicted by the Lorentz equations; But the systematic difference was still there. Einstein's formula in predicting mass energy transformation was simpler if not more accurate than Abraham's. Also Einstein's theory gave a rationale for the Lorentz terms that Abraham used and for the longitudinal and transverse mass in terms of spatial distortion of the electron in contrast to Abraham's theory which did not entail such distortions.(see references: A I Miller and Giora Horn)

But one of the great unsolved problems of modern physics is the inability of Einstein's theory in explaining Kaufmann's results and all of the other mass energy transformations implied. The better vacuum in Kaufmann's 1905 experiment should have improved the accuracy of his results; no one could explain what was wrong with Kaufmann's apparatus if anything was wrong.

Experiments designed by Bucherer at about that time and later, 1939 by Rogers et al which are discussed in the Semat text, were designed in such a way as to prevent the measurement of simultaneous magnetic and electrostatic deflections of electrons at sufficiently high speeds (greater than .9c but less than 7MeV) A paper by Zahn and Spees in 1938 discredited some inadequate confirmations of the Lorentz formula and disconfirmation of Kaufmann's results and with updated methods excluded sufficiently high speeds to obtain data closer to the Lorentz formula.

Kaufmann's results clearly showed that the transverse deflection of the electron at specific high velocity by the electrostatic field was not equal in amount to the transverse deflection perpendicular to the electrostatic deflection-and it should have been according to Lorentz and Einstein .

We can perhaps predict Kaufmann's results according to a theory of charge polarization inside the electron. Such polarization gives a rationale for the longitudinal and transverse mass concept in the theory of Abraham.(Although Abraham for some reason thought the electron could not change from a spherical shape and so prevented himself from seeing this possibility.) The charge polarization expression, krev/c, for the electron and k*rnev*A/c for the magnetic field applied to the electron produced say by a short segment of wire parallel to the electron's trajectory at one point of its linear or curvilinear trajectory are the dipoles in the dipole formula. Note k and k* are measures of the relative strength of the two dipoles. As the velocity of the electron approaches c, the magnitude of charge polarization in the electron becomes $krev/[(c)(1-v^2/c^2)]$, approximately. This is because the force that produces the acceleration and average velocity of the electron between collisions with other atoms and other electrons also produces a change in the orbital velocity of a charged particle inside the electron as described below. The result is that the response of the fast moving electron to the magnetic field does not increase as much as the response of the electron to the electrostatic field. The reason: The decreasing rate of increase in polarization inside the beta electron and the inverse square force between electrostatic dipoles in this context compared to the inverse cubed force between an electrostatic dipole and an electrostatic field.

Orbital Systems Inside Electrons and Nuclei (continued)

Let us return now to the explanation of charge polarization inside nuclei and electrons in terms of an orbital model of the electron and the atomic nucleus. Suppose for example that a sustained voltage difference producing a current also acts on a mass m* of charge q inside the nucleus or electron with a force F=qE and that this force is directed from left to right along a horizontal X axis on the counter-clockwise orbiting particle m* for a time 10^{-14}sec = t* between thermal collisions as described above. What is the net force F acting on q that can produce the desired ellipse?

The general equation for the velocity, v, of a particle of mass, m, subject to an inverse square force $k\rho^{-2}$ at some particular point in its path at a distance, ρ, from the source of the inverse square force and at an angle a* from a specified line is derived from the equation

(2.16) $(m\rho^2)(v^2/k\rho) = 1+ \text{å}\cos\alpha$

where, å, denotes the eccentricity of the particle's path. For the electrostatic force, in Newtons, between two particles of charge, e and 2e, in Coulombs, $k=(9)(10^9)(2e^2)$ while for the gravitational force in Newtons between two masses m and M in kilograms. $k = [(6.67)(10^{-11})Mm]$

Thus in the electrostatic case with ρ=R, the classical electron radius, initially and m*, the mass of an orbiting particle, the velocity of the particle when ρ=R and α= 0 is, from equation (2.16)

(2.17) $v^2= (9)(10^9)(2e^2)(1+å)/m^*R$

This equation is derived in some form in most mechanics texts; see for example, Dynamics, by W.E. Williams, Van Nostrand 1975 p41.

We must 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:

(2.18) $F = qE\pm(9)(10^9)(2q^2)/R^2$
and $(F)(x/R) = qE\pm(9)(2)(2.56/2.486^3)(10^{(9-38+30+15)})x \approx qE\pm c^2x$, $q\approx(1.6)10^{-19}$

We assume a slightly different value for R than the the classical electron radius:

(2.19) $R = (9)(10^2)e^2/mc^2 = (2.82)10^{-15}$ meters

Note that with this radius, the total energy of the electron regarded as an orbital system is $9(10^9)2e^2/2R = 8.19(10^{25-38})$ and the rest energy of the electron $mc^2= 81.98(10^{-31+18})$. So if we want these to be equal we must multiply 8.19 times 10 which means the radius R should be 2.82 times 10^{-15}.

We shall discuss the significance of the rest energy and its relation to various experimental estimates of the electron radius later.

Here we are denoting the mass of the electron by, m, and the much smaller mass of a particle of charge, q, inside the electron or the nucleus, by m*; hence the velocity of light, c, can be regarded also as a measure of the elasticity of charge polarization within electrons and nuclei.

(2.20) $Ft^*/2m^* = v1-v = v_0(1+\varepsilon)$^1/2 - $v_0 \approx v_0\varepsilon/2$

according to the binomial approximation. Then from (2.17)

(2.21) $v_0=[(9)(2.56)/(2.82)]^{1/2}(10^{(9-38+15)/2})=(2.85)(10^{-7})/m^{*1/2}$

For example suppose $E=(6.6)(10^{-2})$ V/meter so that the velocity imparted to an electron at rest, the velocity during the time interval $t^*=(2)10^{-14}$ sec is

(2.22) $v_e = (1/2)(eEt^*/m) =(1.68)(.5)(6.6)(2)/9)10$^-19-2-14+31$=(1.23)10^{-4}$ meters/sec..

If for example $r = 10^{-1}$ meters or 1 meter is the distance to an electron as part of a current moving parallel to the first current then $rv/c^*=(1.23/3)10^{-4-8\ -1\ \text{or}\ 0}$ meters. But this must be equal to the distance from the center to the focal point of the ellipse, which from the discussion above is: (ε/(1-ε))R; that is

(2.23) $rv/c^* = (.41)10^{-13\ \text{or}-12} = (\varepsilon/(1-\varepsilon))(2.82)10^{-15}$ so $(\varepsilon/(1-\varepsilon))=(.41/2.82)10^{2\text{or}3}$ =
14.5 or 145

.935/.065=14.4 and .993/.007=142 so that ε=.935 for rv/c*= .41(10^-13) and ε=.993 for rv/c*=.41(10^-12) approximately.

Now qE is 10^{-19-3} Newtons about compared to a centripetal force of $(9)(10^9)(q^2/R^2) =10^2$ Newtons, if q = e; a horizontal, force, F, acting to cause an elliptical distortion of the circular orbit must be equivalent to a force acting tangentially at one point of the circular orbit such that

$Ft^*/2m^* = v1\text{-}v = (v_0)(1+\varepsilon)$^1/2 - $v_0 \approx v_0\varepsilon/2$

The horizontal force acting on the orbiting +e particle at points on the orbit at 12 oclock and six oclock are unopposed by the much stronger central –2e particle and at al points of the orbit there is a tangential component qEsinθ where θ denotes the angle between a horizontal line through the central particle and a radial line to a point on the circle starting at 9 oclock and moving clockwise.

Half of the time this force is in the same direction as the orbiting particle and half of the time it is in the opposite direction. In both cases the effect is increase the ellipticity of the orbit and the distance between the central negative particle and the center of positve charge.

During half of this time, i.e a quarter of the time the exterior force acts to slow down the orbiting mass, m*, and a quarter of the time it acts to speed up m*. Such a combination of forces acting continuously over time is clearly equivalent to another single force acting at a single instant tangential to the orbiting mass. The effect of such equivalent forces is to produce an elliptical distortion of the circular orbit of eccentricity ε such that the major axis of the produced ellipse is perpendicular to a specific tangential force.

And while this is going on, there is another force transverse to E, originating in the dipoles produced in the other parallel wire, and this force produces an ellipse transverse to the one produced by E. The result is less of an ellipse produced by E.

In the above example, the ellipticity ε is .99 or .999 and

(2.23) $eEt^*/m^* = .99v_0/2 = (.99/2 \text{ or } .999/2)(2.9)(10^7)/m^{*1/2}$

(2.24) $eEt^*/m^{*-1/2}=(1.602)(10^{-19})(4.5)(10^{-3})(10^{-14}) = (7.2)(10^{-36}).$
$= (.5)(2.9)(10^{-7})(m^{*1/2})$

which implies that approximately

(2.25) $m^*=[(4.8)10^{-29}]^2 = (10^{-56.4})$kg.,
$v_0 = 2eEt^*/m^*= (14.4)(10^{-36+56.4}) = 10^{22}$meters/sec. ;
the escape velocity kinetic energy is, $.7(10^{-12})$ Joules or 7MeV according to various texts e.g. Richtmyer's Introduction to Modern Physics, "the threshold for pair formation is $T= 2mc^2 =1.022$ MeV [where T denotes the total energy, m, denotes the rest mass of an electron and c, the speed of light]". Hence pair production provides independent support for this model if we allow such enormous speeds are possible. (Note if $rv/c=10^{-11}$ then $ε=10^{-4}$ and so T must have become large enough to compensate for the reduction in t*, the time between collisions. The magnetic force associated with a given current and the time between collisions associated with the dipole parameter, ε=.99 or .999, have together determined the estimate of m* and shown that this estimate is essentially independent of ε except in so far as this influences t* and is dependent on the assumption of t*)

The equivalence between the total rest masses of the electron and positron and the energy of the gamma radiation supposedly producing them can be understood by first noting that the kinetic energy expended in one complete orbit of the proposed small charged mass around the much larger charged core mass of an electron or positron is equal to the product of the duration of the orbit -the reciprocal of the frequency of the orbit- times the instantaneous kinetic energy of the orbiting particle; and that this product is analogous to the one for the orbit of an electron around the hydrogen nucleus which is equivalent to Planck's constant, $h \approx 10^{-34}$, in mks units.

When we multiply, h, times the frequency of the hydrogen electron's orbit, about 10^{16}, we obtain the instantaneous kinetic energy of the hydrogen electron in its orbit. The corresponding constant for this much smaller faster orbit with a much smaller mass, $m^*=10^{-56}$ kg is

(2.25.1) $((1/2)\, m^*v^{*2})(1/f^*)=10^{-56+44-36}= 10^{-48} = h^*$

and when we multiply this constant times the much faster frequency $f^*=10^{36}$ we obtain the same instantaneous kinetic energy, $(1/2)\, m^*v^{*2} = 10^{-12}$ for the very small mass we would obtain by multiplying Planck's constant, h, by some value $f=10^{22}$ in this case because $10^{-34+22} = 10^{-12}$ and measuring not the wave length corresponding to f, but the kinetic energy, hf of particles produced as in this case or from secondary radiation.

Note that $m^*v^{*2} = mc^2$. That is, the real significance of the speed of light is that the square of the speed of light is equal to the quotient of the kinetic energy of the mass of an orbiting object or group of objects inside the electron or atomic nucleus divided by the mass of the electron or atomic nucleus.

Also Einstein's concept of rest energy, m_0c^2, (from that of rest mass $m_0/(1-v^2/c^2)$) is an approximation of the concept of the energy of an orbital system inside the electron. As the electron speed is increased, so is the speed of, m*, increased to v*+(some value) and and a wider elliptical orbit is produced and so the internal kinetic and then the internal potential energy of the electron is increased (to a smaller negative value as the average distance between the core and the orbital particle is increased).

The resulting charge polarization in the electron is manifest as an increase in the response of the electron to an applied magnetic field. As the speed of the electron is increased to values above ninety percent of the speed of light there is a noticeable decreasing rate of increase in the response of the electron to the applied magnetic field. From this point on, the increase of internal energy of the electron is interpreted as a conversion of the outer energy of the electron (its mass times its velocity squared) into mass. That is the increase in the force producing the velocity does not continue to produce the same increase in velocity or magnetic responsiveness of the electron. When the electron is at rest there is no elliptization of the orbiting part but there still is the energy of the orbital system which could be regarded as the binding energy of the electron.

The subsequent small increases in the internal energy of the electron, as the electron moves at a greater velocity, are ignored or attributed to magnetic energy radiated away and absorbed in the aether and surroundings. As the electron approaches the speed of light and the electron mass increases to values noticeably different from m_0, to $m_0/(1-v^2/c^2)$, then this energy is recognized as it is transformed into mass.

But these earlier increases in elliptization and polarized charge are what produce the magnetic deflection in a magnetic spectrometer and the same polarized charge also interacts with the electrostatic fields. For example if an electrostatic field pulls an electron upward against the gravitational field, there is an additional pull upward or downward of about one tenth the strength of the expected effect on the electron's point charge, due to the dipole in the electron. The direction of the dipole and depends on the direction of the electron's initial velocity.

Recall that since $[10^{-56}kg.][v^2/R]=9(10^9)2e^2/R^2$ then if $R= 10^{-15}$, $v=10^{22}$ and the escape velocity is $2^{1/2}$ times this and the kinetic energy of the escaping particle
is 10^{44} times 10^{-56}or about 10^{-12} $=10^7eV =m_0c^2$ about. That is, the rest energy of the electron is the binding energy of the electron.

It is assumed that at any given speed, electrons, protons, and various combinations of protons and neutrons, (also positrons, and pi mesons and mu mesons etc) respond the same way to a magnetic field as they pass through spectrometers, or magnetic analysers or to the electrostatic fields involved in these devices and in various absorber materials used for range measurements. Estimates of mass based on this assumption may be consistent but not necessarily correct.

It may be necessary to reassess the rest energy concept that is used in describing the nucleons and to reassess the binding energy involved in the formation and breaking up of atomic nuclei. That is the total mass of a permanently stable nucleus is the sum of its parts minus the mass equivalent of its binding energy. Just as it takes 13.6eV to ionize a Hydrogen atom, an amount of energy equivalent to the binding energy must be added to, for example, a 1n1p nucleus to break it up into a separate neutron and proton. So the mass of the 1n1p nucleus is the sum of the mass of a proton plus the mass of a neutron minus the mass equivalent of the binding energy.

Thus the energy applied to break up the 1n1p nucleus is observed to be 2.225MeV and the difference between the sum of the observed masses of a separate proton and neutron and the observed mass of 1n1p atom is this observed energy of dissociation divided by the speed of light squared.

The Hydrogen analogy and the inner (orbital system) energy of a moving electron suggest an orbital system of some sort for the 1n1p nucleus. One such system is two protons orbited by an electron since the mass of a proton is $1836.1m_e$ and a neutron is $1838.6m_e$ when measured outside the nucleus. That is the mass of two protons and an electron would be about same as a proton and neutron and the disparity could be attributed to the binding energy and other factors.

There are problems with this model: the magnetic moment of the nucleus being smaller than the sum of the magnetic moments of protons and electrons and the Bose Einstein statistics problem if the nuclei consisted of protons and electrons with a total being an odd number and implying a half integral spin.

But the main problem is that the electron would come apart at the required supraluminall speed in such a small orbit.

Also it would not explain the force that holds the neutron and proton together without the added strong force premise which then also explains what holds the protons together.

Another possible model is that the 1n1p nucleus consists of two proton cores of charge +2e and one –e particle of mass 10^{-56} kg. is between the +2e particles at the center of the figure eight and another –e particle of mass 10^{-56} kg. are at the extreme ends of the figure eight, the +2e particles in the centers of two circles formed by the figure eight do not repel each other. And then around the figure eight which has a positve charge of +2e, a third negatively charged particle of mass 10^{-56} kg.could move in a circular path so that the net charge of the nucleus would be that of a 1n1p nucleus. The net charge is +e as required and elliptization of this outer orbital as the proton is accelerated through a magnetic field and is deflected by the magnetic field etc gives the observed magnetic responsivity of the proton.

Then due to acceleration or collision of a sufficient energy, the nucleus splits apart and this model explains the daughter particles produced: a neutron with two -e particles orbiting one of the +2e cores and one –e particle orbiting the other. Also one of these daughter particles appears heavier because it is not deflected as easily in the magnetic field as the other daughter particle.

Also, the gamma radiation that produces pair production and is the result supposedly of the immediately-after-occurring pair annhilation is of a much higher frequency than previously thought. Also the production mechanism may sometimes be the effect of a resonant sympathetic oscillation of charge on charged particles of much smaller mass than the electron or positron inside a neutral composite similar to the electron.

There are still problems with this analysis: First, we have accepted a 10^{-14} sec. interval between collisions of free electrons and lattice ions. The force of these thermal collisions -according to kinetic theory $(3/2)kT=(1/2)mv^2$ where $k= 1.38(10^{-23})$ Joules per degree Kelvin - produces velocities of 10^5 meters/sec for free electrons (and smaller recoil velocities for the heavier lattice ions.), an order of magnitude less than the outer orbital electron velocities of atoms and so forces that are much greater than the drift velocity forces. Hence they should produce greater ellipsoids which results in what we have assumed to be a sphere of radius equal to the classical electron radius.

(According to Sommerfeld's modification of the kinetic theory applied to nearly free electrons in a conductor, the force of thermal collisions produces velocities of 10^6 meters per second.)

Hence the radius of the electron in the context of lower temperatures and lower thermal velocities should be much smaller and our assumption of the radius of a sphere might be modified to be of a classical electron elliptical

semi-major axis of
10^{-15} m. for free electrons between thermal collisions at room temperature but less at lower temperatures.

Another problem is the enormous speeds assumed. As stated above, a reinterpretation of the Kaufmann experiment suggests that mass does not increase to infinity as the speed of light is approached. Rather there is a decreasing rate of responsiveness of a rapidly moving charged mass to a magnetic field and then at the speed of light an expulsion of the even smaller charged mass orbiting inside the rapidly moving charged mass. The elliptical distortion of this orbit is the cause of the responsiveness of the larger charged mass to a magnetic field. Unless the expelled smaller charged mass is captured by an oppositely charged particle it could travel at the rate of 10^{22} meters per second the length of the 28 known galaxies (a distance of 2.5 million light years since one light year is 9.4698 times 10^{15} meters) in one second. The occurrence of such trajectories imply that there has occurred the splitting of an electron, a positron or an electron-sized neutral particle inside an atomic nucleus. Note pair production as well as beta emission seems always to occur in the vicinity of an atomic nucleus.

Thus when a gamma ray is observed when an electron and positron make each other disappear, it may simply be that a neutral orbital system is formed of the parts of each and that in the process the movement of small orbiting charged particles that are involved produce the observed gamma radiation.

It should also be noted that the allowed discrete energy levels and absorption-emission energies that Bohr and Sommerfeld added to Drude's original model may be in part explained in terms of energy transformations inside electrons and inside lattice nuclei involving the proposed particle m*

The question also arises as to the composition of protons and neutrons and all atomic nuclei made up of protons and neutrons. That is, could a proton or neutron have the same basic two elements as an electron but with a radius,R_p, that is 1/1836 or 1/1838 of the electron, R_e, and with a positive core of charge +2e etc.? Such a possibility would give the rest mass of the proton and the neutron by using Einstein’s formula $E=mc^2$, can be written for various particles as follows.

The energy of particles at rest is $m(x)c^2= (9)(10^9)e^2/R(x)$, x=electron or proton or positron or etc. See also Feynman v2 28-3.

If we think of the electron as an orbital system with a core of charge -2e and an orbiting particle of charge +e and a proton as just the reverse we have in general

$$m(x)c^2= (9)(10^9)(2)e^2/R(x)$$

Thus the mass of the electron and the mass of the proton determine their radii and vice versa. The same may be said for the neutron except that one of the orbiting particles in the neutron may itself be the orbital system which we call the electron. Then when the neutron decays into an electron and a proton and a neutrino, we see where the electron came from. That is, the central particle of the neutron may have charge +2e and one particle orbiting this is a charged mass of 10^{-56}kg. and charge –e while the other orbiting particle is an electron of charge –e. The electron of course is an orbital system with a central mass of charge –2e and an orbiting mass of 10^{-56}kg of charge +e. And the total mass of this particle is determined by the radius and Einstein's $E=mc^2$ equation.

Measurements of the scattering of alpha particles by various atomic nuclei suggested an average size about half of the classical electron radius. But the model of nuclei used here does not include orbiting negative particles in the 1p and 2p2n nuclei, etc.

It may be that when this is taken into account the scattering experiments are consistent with such a smaller radius for the proton than the electron.

The attractive mass of particles can be ascribed to residual charge polarization within atomic nuclei so that on the Earth, the charge polarization along atomic radii is about 10^{-18} meters on average and a larger denser object of atomic nuclei with more protons and neutrons would be heavier than other objects. Such a polarization of charge would give the gravitational field of the Earth and the gravitational force between two such nuclei equal to the electrostatic force between two such dipoles oriented along the same line with the negative pole of one dipole facing the positive pole of the other(see section III). Hence if the results of collisions involving protons permit, the proton and neutron may be composed of the same parts as the electron and positron but of smaller radius.

If it were not for the various instances of fission and neutrons and protons being ejected from nuclei etc., then larger and large nuclei might readily be viewed as similar to the deuteron but with smaller and smaller radii of the continguous circles making a figure eight around the two proton cores.

It seems more feasible to consider the larger nuclei as being composed of many proton cores and many orbital particles of 10^{-56}kg. If neutrons and protons are added larger and larger atomic nuclei can be formed and their masses are due to the number of such neutrons and protons

The magnetic responsivity of a proton moving at speed v through a magnetic field is given by roughly by rv/c as is an electron but the force needed to accelerate the heavier proton to the speed v, is greater. But so is the force needed to produce the same ellipticity of the orbiting negative charge of 10^{-56}kg as it orbits around the core of the same mass as the electron but with a smaller radius in a tighter orbital system. That is $rv/c = R_p[\varepsilon/(1-\varepsilon)]$

The magnetic responsivity of a nucleus consisting of a collection of protons and neutrons could involve the elliptical distortion of an outer negatively charged 10^{-56}kg particle with respect to the inner combination and net charge. Or a shared elliptization of the other 10^{-56}kg particles with respect to the proton cores such that greater forces are needed to obtain a specific eccentricity and a specific velocity.

Quarks

Since the mid 1970's, high energy accelerators have produced evidence of negative charge inside protons and neutrons. A complex structure is suggested by the scattering pattern produced by high energy electrons. After being accelerated to a high speed these electrons apparently penetrate the orbital shell of atoms of hydrogen, deuterium, carbon, aluminum etc and bang up against protons and neutrons and scatter. The electron and proton should attract one another; they do until they are very close and then they apparently repel each other violently.

One possible interpretation is that the electron and an proton are orbital systems as described and that the repulsion is due to a positive charge perhaps in orbit around the negative core of the electron, that is repelled by the positive core of the proton etc. The scattering of the beam particles caused by interactions within the target clearly demonstrated that protons and neutrons are complex structures that contain pointlike charged objects, which were named partons because they are parts of the larger particles. But what the structure is and how it changes over time remain unanswered questions. Beyond the name partons and the possible identification of quarks with partons and theoretical reasons for not being able to observe quarks apart from the observed nucleons composed of quarks, little else has been derived from the scattering patterns.

It is ironic that Gell Mann took the name Quarks from James Joyce's Ulysses where Joyce apparently coined the word for a nonsense rhyme. But Joyce,an English teacher in Zurich for many years, took the word, perhaps unknowingly, from German where it has a definite meaning, namely, curd, or in German slang, offal.

The idea of particles of fractional charge, quarks, inside protons, neutrons, mesons etc made possible explanations of nuclear forces and reactions. For example the strong force holding the proton and neutron together, the proton becoming a neutron during beta decay etc. Regarding beta decay, two 'up' quarks (charge of +2e/3) and one 'down' quark(charge of -1e/3) is a proton which is said to become a neutron when (1) a down quark becomes an up quark and (2) a virtual W particle, whose interchange between neutrons and beta electrons maintains the weak force attraction between them, just as the exchange of photons supposedly explains the electromagnetic force, is transformed into a beta electron and emitted from the nucleus containing the proton under consideration. An interchange of virtual gluons between quarks mediates the strong force holding neutrons and protons together while virtual photons moving between electrons and positrons mediate the electrostatic force.

We will see later that the nuclear forces may not be usefully explained by axioms defining exchange forces involving virtual particles; that an orbital shell-like model is more direct and may be more useful in solving practical problems eg the problem of radioactive waste disposal and cleaner forms of nuclear energy (The exchange force assumption is that two particles will attract each other if the energy pattern ie wave function, describing the entire system does not change sign when the spatial coordinates of the two particles are interchanged)

An Alternative to Quarks

The apparent obstacle to the orbital shell theory is that the speed of particles in such small orbital shells inside atomic nuclei and inside electrons would exceed the speed of light. But we have shown that the apparent increase of mass to infinity of beta electrons for example as the speed of light is approached is really attributable to a decreasing rate of increase of the response of the beta electron to an applied magnetic field at speeds just under the speed of light. The cause of this change in response is not necessarily an increase in the beta electron’s mass. We have also noted that experiments showing mass increase are always of charged particles in the presence of an applied magnetic field.

It would follow then that speeds in excess of the speed of light are possible and that they do not necessarily entail infinite mass or a conversion of mass into disembodied energy; that small masses moving at speeds in excess of the speed of light exist inside all atomic nuclei and electrons. That is as the electron is made to move faster the same force causing this increase in the electron’s speed could cause an increase in the transverse elliptical path of an orbiting charged mass inside the electron. This in turn could cause a transverse polarization of charge inside the electron. We have shown that this could account for the magnetic responsiveness of the moving electron. As the elastic limit of further elliptization and charge polarization is approached, the response to the magnetic field becomes less linear. That is the faster electron is more deflected than the slower electron but not as much as one would expect given previous deflections at lesser but increasing speeds.

One does not need a high energy accelerator to observe phenomena that suggest the existence of charged particles inside atomic nuclei. In fact very common phenomena like the magnetic force between current carrying wires can be interpreted as due to charge polarization inside atomic nuclei, and free electrons. The direction of polarization is transverse to the current.

One might object that the electron is indivisible and that the force between short segments of current carrying wire eg parallel segments, is an inverse square force discovered by Ampere while the force between electrostatic dipoles is an inverse fourth power force.

Regarding the electron’s indivisibility, Weiskopf and others thought they had found that the force attributable to polar moments inside the electron is negligible; but this is after the magnetic force effects of the moving electron, attributable to its spin, has been taken into account; if the magnetic force effects and spin are identified with polar moments, these polar moments cannot be negligible. (See, "The electric dipole moment of the cesium atom,a new upper limit to the electric dipole moment." By Weiskopf , M.C., Carrico, Gould, Lipworth and Stein, Physical Review Letters 1968,vol21,p1645). We will show later that spin can be so interpreted and that the concept of spin is an unnecessary circumlocution to avoid directly stating the existence of a mass orbiting a central point in any circle on an imaginary sphere of radius about 10^{-15} meters moving as a spinning surface would have to move at velocities in excess of the speed of light.

A further advantage of regarding spin as electrostatic dipoles is that the evidence, from the emission spectra of ammonia, for nuclear quadropoles as part of the nuclear force of N14 in addition to the point charge or Coulomb force can be more systematically represented as the uninterrupted Taylor expansion of the potential of an unknown distribution of charge inside the nucleus up to the third terms (see Coles and Good in the Physical Review of 1946). That is we do not have to throw out the dipole term in the Taylor expansion.

Regarding the difference between the magnetic force and the electrostatic dipole force: It is well known that currents in a magnetic field experience magnetic resistance in addition to Ohmic or thermal resistance. Assume tentatively that transverse electrostatic dipoles are produced by the force driving a current through a wire, eg a car battery or an electric generator. Assume further that these dipoles produce a field of force on a second parallel wire that inhibits the expansion of transverse dipoles in the second wire that would otherwise have been produced by the force driving current through the second wire. It is feasible that the inhibiting force is greater the smaller the distance between the two wires. That is the size of each electrostatic dipole is proportional to the distance between the two wires. In this way the inverse fourth power force is reduced to an inverse square force.

We have indicated how the electrostatic dipoles are produced inside atomic nuclei by the electric field driving the electrical current; that the mechanism is the kicking of a charged orbiting particle inside the nucleus into a wider more elliptical orbit transverse to the electrical field driving the electrical current.

We have discussed the grounds for these assumptions, the possible equality between the electrostatic dipole force and the magnetic force, the relation between the constants in the force equation, the orbital mechanics of charge polarization inside atomic nuclei, electrons etc., in great detail . It is important to note here that a greater understanding of the charged particles within atomic nuclei eg Gell Mann's quarks or something else, can come from consideration of such phenomena outside the analysis of cloud and bubble chamber photographs and electronic images of high energy collisions involving alpha particles, neutrons, protons etc..

For example, consider an atomic nucleus consisting of a proton and a neutron, the deuterium isotope of hydrogen. The proton and neutron are not directly observed when they are in the nucleus but when the nucleus comes apart after experiencing a sufficient acceleration or after a sufficiently energetic collision, the proton and the effects of a neutron can be measured.

In the proposed model the nucleus contains three 10^{-56}kg particles that each have the same negative charge as an electron,-e, that are moving in a figure eight orbit around two positively charged particles of charge +2e, that each have the mass of a proton approximately. The average placement of these particles is along a line so that the leftmost particle is negative the next most left particle is positive etc., and the particles are equally spaced.

Such a model explains electrostatically, the fact that the two positive particles do not repel each other because they are as strongly attracted to the midway point between them as they are repelled by each other. There is no need to posit an additional premise, the so called strong force.

Such a model also indicates how the neutron and proton are formed when the nucleus splits apart.

The measurement of the mass of the proton etc. is also a measurement of charge polarization inside it and not just of its mass. The mass of the protons and nuclei is typically measured in mass spectrometers , magnetic analysers and electrostatic analysers after having passed through a specific material of a specific thickness.

In all of the these procedures the measurement of mass is confounded with a measurement of the response of the particle to a magnetic field and an electrostatic field. That is the charge polarization inside the accelerated particle that is proportional to this acceleration except in the limit as shown by Kaufmann's experiments etc, this charge polarization produces the deflection by the magnetic field and enters into a dipole-point charge interaction with point charge sources of electrostatic fields eg the electrons in materials through which the protons and nucleons are propelled before reaching the test chamber.

Fixing Bohr's Theory: The Cause of Quantum Jumps

A major benefit in recognizing charge polarization inside electrons and atomic nuclei is to show that Bohr's planetary model of the hydrogen atom can be explained in classical non quantum terms; also that the planetary model can equally well explain the spectra of helium, lithium and the rest of the elements as Bohr had hoped, that is, without the circumlocutions of Schrodinger, DeBroglie, Dirac, Heisenberg, Pauli and others.

Mathematician, J.W. Nicholson replied(Phil Mag S.6.Vol 27 No.160, April 1914 p542) very soon after Bohr's first paper in 1913, that according to Bohr's theory with circular orbits, the outer electron in lithium for example would not be able to maintain a steady orbit with constant angular momentum. Bohr answered that the orbits might not be circular and that he was not requiring that the observed emission frequencies were the average of the frequencies between quasi steady states etc.. Rather to be consistent with Planck's theory the emissions would only take place if sufficient energy was available.

But another possible answer is that the emission frequencies are indeed the average of the boundary frequencies and that the orbits are circular or elliptical but that the force equation includes dipole unipole and dipole dipole interaction terms as well as the unipolar Coulomb forces. The result is a stronger attraction of electrons to the nucleus and a lesser repulsion between electrons on the same side of the nucleus. Also the difference in energies between states is approximately equal to the average energy between states: $(hf1+hf2)/2 = (hf2-hf1)+$ error where 'error' is smaller than the measurement error.

The cause of quantum jumps in blackbody radiation, emission and absorption spectra, the photoelectric effect etc. is now evident: The force that accelerates an orbiting electron to a wider semi-stable orbit or to an escape orbit, also increases the charge polarization inside the orbiting electron and so the attraction of the electron to the nuclear core. Further increases in the force and/or its duration are then required to make the electron overcome these newly awakened forces to achieve a wider semi-stable orbit.

The most obvious problem with Bohr's theory was that it could not explain the first ionization potential of helium of 24.6eV and the fact that the sum of this and the second ionization potential 54.4eV, ie 79eV is less than the calculated sum of the total energies of the two electrons, 83.16eV. The 83.16eV calculation is based on Bohr's basic assumption that $mvr = nh/2\pi$ where h is Planck's constant and n is an integer and the assumption that the two electrons follow the same circular orbital path and are diametrically opposed to each other so that their attraction to the nucleus is reduced slightly by their repulsion from each other.

But now, with the additional attraction of the two electrons to the nucleus caused by charge polarization inside the orbiting electrons and with changes in this polarization produced when the electrons are ejected, this difference can be explained

To see how, lets consider Hydrogen again. The total energy of the Hydrogen ground state is the sum of 1) the interior energy of the nucleus and 2)of the electron when the electron is in orbit about the nucleus as well as 3)the exterior kinetic and potential energy of the orbital atom of radius r. The interior electron energy, when the electron is in orbit, is greater than the interior rest energy of the electron m_ec^2 which can also be represented as $9(10^9)(2e^2)/R_e$ where R_e is the radius of the electron necessary to make this an equality. We have assumed that the electron is composed of an orbiting charged particle of +e and a central core of –2e. This yields a value in meters for R_e of 5.16 times 10^{-15}.which is similar to the various values of the radius making various assumptions about the mass being entirely electromagnetic.

The rest energy of the nucleus, here, a proton, and the possible increase in this energy when the nucleus is orbited by an electron and the electron is exerting a force on the nucleus, can be described in a similar way. That is, $m_pc^2 = 9(10^9)(2e^2)/R_p$ where R_p is the radius of the proton. The masses of the deuteron and larger nuclei
may be viewed as combinations of these proton cores orbited by 10^{-56}kg particles of charge –e so as to produce the observed net charge. For example Helium could contain four proton cores of charge +2e and six 10^{-56}kg particles of charge -e

When neutrons and more protons are added as in 1p1n hydrogen, 1p2n hydrogen and 2p1n helium and 2p2n helium etc, the orbital systems may involve more than one particle in an orbit, orbits within orbits as in atoms and figure eight orbits etc where adjacent cores share the orbiting particles as in molecules etc.

But the behavior of copper atoms in copper wires and the charge polarization that could explain the magnetic force between such wires, suggests that there is an outer orbiting particle in the copper or other conductive metal atomic nuclei. And that this mass is 10^{-56}kg so that the potential difference associated with a current can produce an elliptization of the orbit sufficient to produce the required dipole in each nucleus.

The difference in energy between the rest states of the nucleus and electrons and the state where the electrons are in orbit about the nucleus should give the total energy needed to ionize the electrons. This applies to Helium with two orbital electrons as well as to Hydrogen with one orbital electron

The observed ionization energy of the first electron to be ejected plus the observed ionization energy of the second electron to be ejected should equal the above difference.

Note the closer an orbital electron to the nucleus, the smaller the radius, r, the more negative the potential energy, $–ke^2/r$ and so the total energy, $–ke^2/2r$ where $k=1/4\pi\varepsilon_0$. The same is true if we change the force between the core and the orbiting particle from $–ke^2/r^2$ to $-ke^2/r^2 – kse^2/r^3$ where 's' times 'e' gives the dipole and s/r is about rv/cr = .01 where v is such that, $mv^2/r = -ke^2/r^2 – kse^2/r^3$;

That is $v^2 = -kre^2/mr^2 –(v/c)kre^2/r^2m$ and we can for a first estimate ignore the second term to obtain v.

Now Bohr had said that we might explain the hydrogen spectra by assuming that they were due to transitions between discrete hydrogen orbits and that the angular momenta of these orbits, mvr, had to be integral multiples of Planck's constant h/2π;
So we can mutiply our above formula for v^2 by mr and obtain:

$$mvr/r^2 = -ke^2/r^2 - kse^2/r^3$$

This leads to a value of r for n=1 of $r_0=(h/2\pi)/[(1.01)kme^2] = .52396$ Angstrom's instead of .5292.

Essentially we have modified the quantum states as required, and as provided by, the Goudsmit and Uhlenbeck spin correction with Dirac's added correction. We have also shown that this corrected spin may have some physical meaning, namely charge polarization inside the electron.

With this new value of r, we have a new ionization potential, $Ze^2/2r$, times (-2 +1/2) where the -2 term describes the fact that the charge on the nucleus is twice that of hydrogen and the +1/2 term describes the fact of the repulsion by the other electron at a distance 2r from the first electron. If we now add to this expression a dipole-point charge attractive potential of $-2Zse^2/4r^2$ we can determine s to yield the required difference between Bohr's estimate of the ionization potential, 20.37eV and the observed value, 24.6eV. Note that 1J/mole or 1J per 6.02 (10^{23}) atoms implies $.602(10^{-23})$ J per atom where $1.6(10^{-19})$J = 1eV; An electron of mass 9 times 10^{-31}kg or an ion of mass $1.67(10^{-27})$ kg moving at speed v at temperature T has energy $(1/2)mv^2 = 1.38\ (10^{-23})$ J and room temperature T=290. As we show later the value of, s, is consistent with other values of polarization proportional to the speed of electrons and currents with regard to magnetism and electromagnetic induction.

Quantum theory offers no explanation of the lack of radiation from the ground state orbits of atoms or the quasi stable excited orbits, transitions between which produce the familiar radiation of atomic emission spectra.

However if we think for a moment about the least energy principle and the orbital movement of the electrons around nuclei, it is possible that the orbital movements of adjacent atoms will arrange themselves so as to minimize any loss of energy due to their proximity to each other..

That is, if we have two hydrogen atoms next to one another such that their single orbiting electrons are in the same plane, then the electrons should move in such a way as to oppose each other's orbital motion as little as possible and to help each other's orbital motion as much as possible.

If for example one electron is moving in a circular orbit in a counter clockwise direction from 3 oclock to 12 oclock then the adjacent atom's electron should be moving in a counterclockwise direction from 9 oclock to 6 oclock. In this way they are pushing each other in the same direction as the force maintaining their orbits is pushing them.

Now as the electrons continue their counterclockwise motion from 12 to 9 and from 6 to 3 they will be pushing against each other's orbital motion. They will be losing as much energy as they gained in the previous motion.

Hence such a dynamic arrangement will insure that as much energy is gained as is lost in terms of the electrostatic forces between the electrons in the different atoms.

Also such an arrangement will insure that the radiation from one atom is cancelled by the radiation from the other atom.

Hence we can conclude that if the atoms have time to arrange themselves in a least energy dynamic arrangement, that their electrons will move so as to produce self canceling radiation; that is to all appearances, no radiation. A corollary to this is that if the atoms do not have time to so arrange themselves, as when the electrons are moving between stable and semi stable states, they will produce radiation that is not self canceling.

Resistance and Magnetoresistance

We have used the expression, rv/c, for the length of the dipole which in this model is the distance between the focus and the center of an ellipse. The question arises as to why a greater distance between the currents should increase the dipole lengths associated with each current.

The proposed model suggests that the transverse polarization associated with one current carrying wire segment produces a transverse force on the circularly orbiting mass, m* inside the nuclei and free electrons of a parallel current carrying wire segment as well as on the nuclei and free electrons comprising the wire itself. This force produces longitudinal elliptization in addition to the transverse elliptization but against ever increasing opposition. That is the subsequent time between thermal collisions of the free electrons and lattice ions is reduced because of the increased size of the free electron relative to the average space between lattice ions. A similar argument applies to the increased size of the nucleus with respect to the inner 'shell' of orbiting electrons. The result is a reduction in the net transverse dipole from what it would be if the transverse force originating in the other wire was smaller.

Let's examine the specific mechanics of this process. The time between collisions of free electrons and lattice ions increases as the cross section area of the free electrons increases while the cross section area between the much larger lattice ions remains the same. Most of this increase in electron area and reduction in time occurs thanks to thermal collisions. But additional small increases in electron cross section area say from pi or 3.1416 times $(10^{-15})^2$ to pi times $(10^{-14})^2$ means a slight increase in the relative frequency of collision per unit time between the free electron and the lattice ion both regarded as spheres and so a reduced average time between collision. The increases in the cross section area of the free electron, beyond that due to thermal collision, occur due to the longitudinal emf field and to the transverse field due to the transverse dipoles in an adjacent or far removed parallel vertical current carrying wire.

As the transverse dipole field, inversely proportional to the cube of the distance r, decreases with decreasing r, the force that increases the size of the free electron but that does not contribute to the magnitude of the transverse dipole also decreases. Hence one would expect an increase in the transverse dipole with a decrease in the transverse dipole field due to another current carrying wire.

What is the exact relation between the average time between thermal collisions and the size of the free electron? Consider the free electron and the ion as spheres that we can move together so that the surfaces of the two hypothetical spheres touch. The radius of the ion R(ion) is much larger than the radius of the electron, R(el). Also the ions are vibrating at infrared frequencies and small amplitudes that push and pull on surrounding ions because of their electrostatic forces on one another so that the amplitude of their vibrations is restricted to a small region surrounding the ion. At greater temperatures the frequencies and amplitudes one would assume would be greater also. Let us now consider the radius of a sphere equal to the sum of these radii and define the cross section area of this sphere as the collision cross section area:

(2.26) $(R(ion))^2 + (R(el))^2 = A^*$.

Now imagine the free electrons moving like the particles in a gas through a lattice of fixed ions. A collision of a free electron and a lattice ion will occur when the center of the free electron passes 'through' a cross section area, A*. The probability of a collision as a free electron moves a distance, ds, through the wire assuming the free electrons are distributed uniformly over the total cross section area of the cylindrical wire is proportional to the ratio of the total collision cross section area to the the total cross section area, A:

(2.27) $[nAds][A^*]/A = nA^*ds$

where n is the number of electrons per meter cubed, the density in the the wire.

Let us now define L as the average distance an electron moves between collisons so ds/L is also the probability of a collision in these terms where L= t*v(av) where t* is the average time between collisons and v(av) is the average speed between collisions due to the force driving the current and the much stronger forces associated with thermal collisions and the resulting change in the free electron's momentum, 2mv(th), for elastic collisions.

(2.28) $v(av) =((v(th))^2 + v^2)^2$ where $v = eEt^*/m$

is the drift velocity. Half of the time v(th) will have a component in the direction of v and so v(av) will be slightly greater and half of the time slightly less than the thermal velocity v(th) Thus we have

(2.29) ds/L = nA*ds so 1/L = 1/t*v(av) =nA*

and hence a relation between (1)the average time between collisions of many free electrons and lattice ions and (2)the average size of the free electrons.

We assume the ellipsoidal free electron has a semimajor axis, produced by a sustained longitudinal field E, The semimajor axis then is

(2.30) a=(R(el))/(1-ε(tr)) where eEt*/m* = ε(tr)((v(th))/2).

and we have assumed the charged particle inside the electron and nucleus that is made to move in an elliptical path has the same charge as the electron. The field, E, also drives the free electrons at a speed, v, but the cross section area, A1, of the free electrons has become slightly larger.

(2.31) v= eEt* /m. and $A1 = (a^2 + (R(ion))^2)^{1/2}$

Consider the forces associated with thermal collisions - the reversal in direction of lattice ions as they vibrate and the reversal in direction of free electrons as they move in random directions within the lattice in large part in regions where opposing forces from the lattice ions cancel. Since these forces are electrostatic they decrease with the square of the distance of separation between the colliding masses. As the time between collisions increases the effect of these reduced average forces- the velocity and charge polarization inside the nuclei and free electrons, and the reduced amplitude and frequency of the lattice ion vibrations -also decreases. Thus as the time between collisions increases the temperature decreases; according to the kinetic theory

(2.32) $(3/2)kT=(m(v(av))^2)/2$, $k=(1.38)10^{-23}$J/(molecule-degK)

so that at 290 degrees K the average kinetic energy of translational as opposed to vibrational and rotational motion is $(3/2)(4)(10^{-21})$ Joules or (3/2)(.025) eV. So if free electrons behave like elastically colliding, otherwise noninteracting particles in constant motion in a box their average velocity is about 10^5 meters per second. And the average force between collisions, F*, acting for t* seconds produces the average velocity between collisions. As heat is added due to radiation or collisions with surrounding molecules the average speed of the free electrons and oscillations of the ions between collisions increases, and the size of the free electrons and nuclei increase and the time between collisions decreases due to both of these causes.

The observed changes in temperature of conductors at various levels of temperature, their thermal conductivity, and decrease in resistivity with temperature were not correctly predicted by the kinetic theory and the idea that the electron could change in size and absorb energy as an orbital system like the one described was not considered. However Sommerfeld in 1928 proposed that free electrons were like Bohr's bound electrons in atoms and Planck's quantum oscillators in a radiant blackbody and Schroedinger's standing wave oscillators limited as to the energy they could absorb and that no two electrons could occupy according to Pauli's exclusion principle the exact same energy state. It was possible with a few ad hoc adjustments of the parameters of this theory to predict the specific heat of conductors etc., better than the classical kinetic theory but the average velocity of the free electrons became about 10^6 meters/sec..

Sommerfeld perhaps following DeBroglie's 1924 Phil Mag article p446, had associated with each electron in the conductor a non translational and therefore oscillatory energy with frequency,f, namely,

(2.33) $hf = (1/2)Mv^2$ + (the oscillatory potential energy).

But instead of regarding the oscillating mass, M, as m*, the mass of a particle inside the electron and the frequency, f, as its orbital frequency and v=v** the velocity of m* inside the electron, he regarded M differently. He regarded M as m, the mass of the electron, and the parameter, f, as the set of possible standing wave frequencies associated with the electron as determined by the regular change in potential energy along the lattice due to the lattice ions; also he regarded,v, as the velocity of the electron.

We can now see some physical basis for the rhapsodic mathematical speculation of DeBroglie, aside from the interactions of the free electrons with the oscillating lattice ions and the periodically changing potential due to the lattice ions. If we now add the change in size property to the oscillating energy absorber property attributed to the free electron it is possible that we could predict a more feasable mean free path of 10 atomic layers instead of Sommerfeld's 100 atomic layers for free electrons between lattice collisions in copper at room temperature. Also as the temperature decreases the size of the free electron and of the nucleus should diminish greatly according to the newly proposed model in accordance with the observed decrease of resistivity in proportion to the absolute temperature. This gives a more physical basis for the observed phenomena than the purely wave mechanical interaction of lower energy free electrons with the reduced oscillations of the lattice ions.

As temperature increases the average value of F* increases producing a greater velocity in a smaller time but the force, eE, associated with a longitudinal field E, and a current, I = nevA, now acts for a shorter time and so produces a smaller drift velocity, v, and a smaller transverse dipole. Even if heat is not added from the outside the small increase in average velocity and size of the free electron due to an initial increase in E from zero produces a slightly reduced time between collisions from that in the conductor before current was passed through it, that reduces such effects (drift velocity and transverse dipole) during the next and successive times between collision t* of the sustained value of E or further increases in E. Further increases in E lead to increasing current and temperature and reduced times between collisions due to the increased size of the free electrons.

In this context we can consider the effect of two parallel current carrying wires on one another's transverse dipoles. The effect on wire 2 from the transverse field of the dipoles in wire 1 is the first question.

The transverse dipoles in the two wires produced by the longitudinal fields E(j) are from 2.25 above

(2.34) $(r)(v(j))/c^* = p(j) =[\varepsilon(j)/(1-(\varepsilon(j))][R], \ \varepsilon(j)=(e)(E(j))t^*/m^*v_0$

The combined effect of all of the elementary dipoles, p2, on wire 1 and the combined effect of the similar elementary dipoles p1 in wire 1 on wire 2 is the next question.

The expression for the force between parallel currents i1 and i2 in wire segments, ds1 and ds2 namely, $(kri1ds1ri2\ ds2)/((r^4)(c^2))$ implies that the transverse dipoles per unit length are such that their product is $ri1\ ri2/c^2$. But this implies that the dipole per meter length associated with i1 is ri1/c or $(r)((i1)^{1/2}))((i2)^{1/2})/c$ or $(r)(i1)^2)/(i2)(c)$ or etc., and similarly for the dipole per meter length associated with i2.

A mechanism that would lead to the third of these possibilities is as follows: If we are considering parallel wires of a few decimeters or meters in length that are fairly close together, the combined effect of the dipoles in one wire on one point in the the other wire becomes an inverse square force instead of an inverse cubed force. The reasons are similar to the geometrical reasons explained above in the description of the interaction of charged parallel capacitor plates and a current carrying wire a few millimeters away from and parallel to the edges of the charged capacitor plates.

Consider the other extreme case of parallel wires of such a length, L, and cross section area A, many meters or kilometers, r, apart carrying currents, i1, and, i2. Then $kq1(nA\ L\ p2)/r^3$ is the force per charge along a line joining the point charge q1 in wire 1 and the dipole nALp2 composed of many elementary dipoles p2 in wire 2 where rl. As in the case also where the wires are not far apart, this transverse force-per-charge vector and the longitudinal force-per-charge vector, E1, produce a diagonal resultant force-per-charge vector. The effect on free electrons is the Hall effect; the effect on the smaller orbiting charged mass inside each of the free electrons is to produce a dipole transverse to the resultant force whose component transverse to the wire is less than it would otherwise be were it subject only to the longitudinal force per electron charge E1.

The reason is that the greater combined force produces a greater dipole but due to the consequent reduction in the time between collisions the greater dipole is slightly less than it would have been without the reduction in the time between collisions. Hence the dipole component transverse to the wire is less than it would have been if all of the force had been longitudinal. This effect should increase with the transverse dipole field from the dipole, p2, namely, $kp2/r^3$. The exact value of, p2, is unspecified but we know it is proportional to, E2, and hence, i2. Hence the transverse dipoles in wire 1 are greater the greater the voltage per meter E1 driving the current, i1, and the greater this is with respect to $i2/r^x$. The reason for the exponent x instead of 3 is that we are allowing for the mutual action of the transverse dipoles in wire 1 and wire 2 on each other. This back and forth mutual action could modify this exponent.

Hence the formula for the transverse dipole in wire 1, $ri1^2/(i2)(c)$ and a similar dipole in wire 2 is compatible with the above proposed mechanism and with the mathematical equivalence of Ampere's magnetic force between current segments and the force between electrostatic dipoles transverse to the current segments - if x=1

The argument is valid as it stands but let me elaborate a little on the hypothesized mutual action between the transverse dipoles in the two parallel wires. Assume that the dipole component in wire 1 and transverse to wire 1 and due to, E1, only, would have been, p11, but due to the increase in collision cross section and time between collisions we obtain p12 the moreso the greater $Kp21/r^3$ is relative to E1 where kqnAL =K. The field of the reduced dipole then acts back on wire 2 changing, p21, to, p22, in the same manner. Because of this back-and-forth process, we conclude that the total reduction effect is greater than, $Kp11/r^3$, and, $Kp21/r^3$, and could involve the double integration over, r, yielding, 6Kp11/r, and, 6Kp21/r. Also since the longitudinal fields and the transverse dipole fields are both proportional to the currents, the dipole in wire 1 is proportional to (i2/r)/i1 and i1 and so to their product namely i2/r and similarly for the dipole in wire 2.

The question arises can the transverse dipoles in these wires increase indefinitely with increases in the distance of separation. Clearly the dipole per electron or nucleus rv/c or $rv1^2/(v2)(c)$ etc. cannot increase beyond the lattice constant - about one Angstrom. However increases with r of rv/c can occur at the expense of decreases in v so that the lattice constant is not exceeded, and the question becomes can this process continue indefinitely. The answer is obviously no because increasing restriction on the movement of the free electron implies a restriction of the increasing ellipitization of the orbit of the small mass of charge q, perhaps +e, around the hypothetical core of the electron of charge then perhaps, -2e. But the question as to the exact extent of the opposition and the question as to the exact physical limit to the ratio $rv1^2/(v2)(c)$ are more difficult.

The influence of the surrounding magnetic field due to other sources with other values of r and the temperature or energy and frequency of thermal collision etc could be the basis of a limiting value for $(r)(v1^2)/(v2)(c)$. A computer calculation of the Coulomb forces or the wave mechanical periodic potential between the bound electrons and the small orbiting charge inside an electron at various points in a region between the lattice ions at various temperatures could be the basis for determining the pattern of opposition from the lattice ions as the electron becomes larger and more elliptical.

In Ampere's series of experiments confirming his formulation of the magnetic force, the distances between current carrying wires whose repulsions or attractions explained Ampere's experimental results, these distances r, were on the order of centimeters or decimeters. For larger values of r the ponderomotive forces between current carrying wires for typical currents is too small to demonstrate and measure by direct means.

The amount of charge accumulating per second on the electrode of a chemical cell or the plate of a capacitor provide a measure of current and the factor neAv while the ponderomotive effect measured by an ammeter provides a measure of, rneAv/c, but since the r here is cancelled by the denominator in the complete expression for the pairwise force the the two measures are equivalent.

However, in the context of the induction of alternating currents at great distances the electrostatic dipole formulation of Ampere's force becomes necessary and indirectly measureable. That is, the delay or speed of light can be shown to be attributable to changes in the transverse and longitudinal polarization of charge inside the atomic nuclei of the receiving antenna wire. More specifically, the delay necessitates a mechanism.

If the movement of a physical field in space is not the mechanism then perhaps the mechanism is the interaction of changing transverse and longitudinal dipoles in the receiving antenna. That is the emitting antenna at any instant produces an instantaneous force on the charges in the receiving antenna and as this is being done transverse polarization is also being produced inside the atomic nuclei and free electrons. Then the associated changes in the transverse forces produce a longitudinal force and a movement of free electrons etc.. All of this involves some delay because of the inertia of the reacting charged masses.

A measurement of this delay is an indirect measurement of charge polarization inside the free electrons and atomic nuclei in the receiving antenna.

Before describing the details of this mechanism, perhaps it is first necessary to show that such a mechanism is feasible. To do this it is necessary to show that Roemer's so called measurement of light may be due to other factors affecting changes in the visibility of some of Jupiter's moons as changes in the distance between the Earth and Jupiter occur. If this can be shown to be the case and if the other measurements of the speed of light can be shown to be consistent with the interpretation of cumulative instantaneous forces, then the proposed mechanism would be at least worth considering.

MEASUREMENTS OF THE SPEED OF LIGHT

Space Probe Communications and Light Speed Assumptions

Before discussing at length the historical measurements of the speed of light, lets consider again the lack of validation of this assumption in tracking spacecraft, in radar reflections from Venus and more distant planets and their moons and observations of red shifts in stars and quasars.

The radar measurements involve waiting minutes or hours for a reflection but the data they supposedly receive result from a statistical analysis of noise starting at different points in time nanoseconds apart. The time series of voltage variations that does not contradict what is otherwise observed and expected is chosen as data describing the surface of the planet or moon.

Modern oscilloscopes can directly record millivolt changes over successive nanosecond time intervals but cannot record systematically increasing microvolt changes against a noise background of random changes of the same magnitude. Smaller time intervals can be inferred in the measurement of small frequency differences associated Doppler shifts etc., but the weakness of the received signals is still a problem. Statistical methods for analysing an apparently random sequence of such magnitudes and ferreting out a subsequence that has a periodic pattern of increasing amplitude are used by

NASA in interpreting radar signals bounced off the moon and nearby planets and their satellites. See for example one of the earlier papers by Pettingill. et al., at MIT: A Radar Investigation of Venus in The Astronomical Journal of May 1962 v67: “Individual runs consisted of transmitting a simple train of uniformly spaced pulses for a time approximately equal to the expected round-trip echo delay which varied 283 to 449 sec. over the course of the experiment[given the Earth and Venus orbits and the assumed speed of light]. Shortly before the first pulse of the train arrived back, the transmitter was shut down and the antenna connected to the receiver. The receiving frequency was adjusted for the Doppler shift and integration in the computer was begun. Since the individual returning echo pulses were much weaker than the overall system noise, they could not be seen. In general five minutes of integration were required to render the echo visible.”

When one looks at this data, it is obvious that one can pick and choose from a large number of time series vectors, any one of which may represent the echo. So long as the one chosen is consistent with other non radar observations and theories about the moon are planet targeted, who is going to complain?

Communications to and from distant spacecraft are determined in part by computer interfaces. That is communications to the spacecraft may reach the spacecraft in a few seconds, not minutes or hours after leaving the Earth but the computer on the spacecraft may delay execution of a sequence of communicated commands that are to be executed in some specific temporal sequence. The counter or clock time on the spacecraft is compared to the Earth time stamp on the commands received from the Earth and if this comparison is not consistent with the assumed speed of light delay, the spacecraft computer delays execution of the first commands until the time consistent with this assumption.

In some cases, commands to the spacecraft may be executed immediately or without such a specific delay and the results of such commands may be observed as data sent to the Earth. The computer on the Earth may delay the display of this data if there is reason to believe the data arrived sooner than would be expected based on the light speed delay assumption and the time the commands were sent and the expected time it took before the data was sent from the spacecraft.

The location of a distant spacecraft is determined by several different methods and a least squares or sequential computer algorithm that in effect throws out any estimate that doesn’t agree with the majority. The main method is a Newtonian estimate of position at any time based on the initial acceleration and mass of the spacecraft and the effects of the Earth’s gravity, the Sun’s gravity and the gravity of other planets and subsequent changes in the thrust given to the spacecraft.

The following is an email response to my question as to whether or not NASA only assumes but does not test the speed of light assumption in its computerized tracking of spacecraft:

"When a spacecraft is launched, typically from Kennedy Space Center, it so happens that we at the Canberra Deep Space Communications Complex(CDSCC) are often the first to "see" the spacecraft after separation from its launch vehicle. This is due to our specific geographic location, as all spacecraft are launched to the east to take advantage of the acceleration provided by the Earth's rotation. Consequently, newly launched spacecraft rise over our western horizon. At launch, a set of data known as "Improved Inter Range Vectors" (IIRV) are calculated based on the launch vehicle's thrust, total mass and launch radar returns. The IIRVs include a prediction of where to point our antenna to intercept its transmission and the time of expected acquisition. Attached to the antenna we use for this function, is a small antenna with a relatively wide beam, called and "acquisition aid" (acq-aid) antenna Captuing the spacecraft in the acq-aid beam is usually easy and the acq-aid antenna is designed to indicate where in its beam the spacecraft is located. The actual spacecraft position is then transferred to the main antenna, that can then lock on and follow the spacecraft.

Once we have acquired the spacecraft, we commence range and Doppler measurements. Most spacecraft two-way radio communications is operated in what is known as the coherent mode. That is to say, the radio carrier transmissions of the upling to spacecraft and the downlink from spacecraft are locked together in phase. Consequently, it is relatively easy to measure the Doppler shift of the downlink carrier, which in turn provided a measure of the spacecraft's radial velocity. In addition we will transmit a ranging signal to the spacecraft. This signal is immediately returned by the spacecraft's ranging transponder, so we begin at this early stage to measure the spacecraft's range by measuring the time of flight of the ranging transmission [I was told that in the case of the Mars Lander, the Doppler estimate was very different than the ranging estimate and that in hindsight they should have gone with the Doppler. According to the proposed view, the ranging values should never exceed a few seconds and the Doppler would indicate a different speed than the standard formula. It is not obvious that given the other methods and the computer interface, that the ranging values actually take longer than a few seconds to be sent and received or that this method is used at distances that would imply such delays or longer delays.]

As the tracking antenna is now following the spacecraft, we also obtain data from the antenna axis encoders that provide a measure of the spacecraft's trajectory relative to the ground.

The final result is that by combing the Doppler, ranging and antenna pointing data an accurate and precise determination of the spacecraft's trajectory may be obtained. Of course this trajectory will have already been estimated quite well and our data is used to refine the initial predictions. All of this requires little more than the application of Newtonian laws of motion. As the spacecraft continues on its course, we continually measure Doppler and ranging and collect antenna pointing data.

All of this data is used to refine the coefficients of the spacecraft's trajectory model residing the navigation teams computer. The trajectory model in turn, is used to generate new predictions for the position of the spacecraft and in fact Doppler corrected receiver tuning data as well. This interative process continues for the life of the spacecraft.

There are some additional processes that are employed at various times to improve the precision of spacecraft navigation. One is called "conscan". This is short for conical scanning and involves causing the Earth station antenna to trace out a cone centered on the predicted position of the spacecraft. If the predicted and actual positions coincide, the spacecraft signal strength will be a constant at all points around the circumference of the cone. If there is an error between the two, the signal strength will vary as a sine function and the true position of the spacecraft can be determined. Any such error can then be incorporated into the trajectory model to improve its accuracy. Another process used with spacecraft possessing imaging instruments is called optical navigation(opnav). In this case the spacecraft's camera is used to image a background star field, which can be superimposed on a similar star field imaged from Earth. This provides a very accurate measure of the spacecraft's position at the time the image was taken. Strangely enough, triangulation is a process rarely used in spacecraft navigation, although it can be employed for those periods when the spacecraft is in simultaneous view of two of the Deep Space Networks' ground stations.

The rate of contact with any given spacecraft depends on the criticality of its current mission phase and programmed activity. A number of spacecraft receive near constant communication, such as Galileo and Cassini. Others vary from daily to every two or three days to maybe once a week. As an example of the numbers we deal with, the Voyager 1 spacecraft is the farthest from Earth at present and had a round trip light time in January of 21 hours, 17 minutes and 39 seconds. Its distance from Earth at that time was 11,490.7 million kilometers.

I hope this information helps to answer the specific questions asked"

Bradley

Roemer's measurement, based on observations of Jupiter's moons was not widely accepted until after Bradley's more accurate measurement based on observations of stars above the plane of the Earth's orbit around the Sun. So we will first examine Bradley's measurement in some detail.

Bradley's description of his observations of stellar aberration is clearer and more thorough than any textbook version and except for a few astronomical terms is accessible to the non-astronomer. I will try in the following to define these astronomical terms and give some background material that may be helpful. But let me first give a brief summary explanation of Bradley's method.

Summary

Bradley observed a number of stars near his zenith at different times of year and argued that their slight changes in position(relative to two hair thin wires placed at right angles in the focal plane of his telescope) at these different times as each of the stars crossed his meridian could be explained in terms of the rapid orbital motion of the Earth and telescope and the observer's retina toward or away from each such star relative to the speed of light. Note the meridian of any observer is an arc drawn from the north point of the observer's horizon to the south point of his horizon. From the precise position of an observed star on the meridian and the precise time of crossing the meridian the position of the star on the celestial sphere can be determined. Note also that a line perpendicular to the Earth’s orbital plane through the observer’s position on the Earth at about 50 degrees latitude north etc is between the observer’s zenith and his north horizon.

Suppose the observed stars were located above the plane of the Earth’s orbit about the Sun and preferably directly above the little ellipse forming the Earth’s orbit. (A scaled drawing is difficult because the nearest star is about 250 000 times more distant from the Earth than the Sun .) Then a line from the Earth at one point in its orbit to the star would be to some extent at right angles to the direction of the Earth’s orbital movement. And there would be another point on the opposite side of the Earth’s orbital path where a similar line to the star could be drawn but the movement of the Earth here would be in the opposite direction to its movement at the first point

If there was a delay in the excitation of the rods and cones in the retina that corresponded to different positions in the field of view then the excited rods would have moved a certain distance in opposite directions in these two cases before they registered the light from the star. This would make the light from the star appear to be coming from different directions when observed from these two points. The preferential excitement of some rods in the retina -a small scale replica of the celestial hemisphere- over others indicates the positions of the stronger light source in the relatively dark field of view as limited by the telescope tube.

Bradley found the maximal difference in the apparent direction of the star to be about twenty seconds of arc, 20/(180)(3600), of the meridian arc on either side of some average value; This implied that the cross hair of the telescope eyepiece and the Earth had moved about .0002 meters in opposite directions in each case before the light from the star registered on the rods of the retina. If then the Earth's orbital speed about (2.99)(10^4) meters per second (67,275mph) times the duration, t, of this movement equals .0002, it follows that, t, is about three nanoseconds which is about the time it takes light to travel one meter according to Roemer's quite different method of measurement.

Bradley interpreted the difference in apparent direction at opposite times of the year as being due to the relative speeds of the Earth and the light. But one could equally well interpret the implied delay as due to the reaction time of the rods of the retina. That is light from the star reached the retina's rods after equal unknown delays in both cases and then after equal additional delays of about 3 nanoseconds while the Earth moved .0002 meters in opposite directions became manifest. Bradley's method unlike Roemer's did not require an explicit estimate of the distance to the source and unlike Roemer's did entail constant exposure to the star as it first appeared and then passed through the view of the telescope while the Earth rotated on its axis and moved in its orbit about the Sun.

Background

Bradley says that he observed the phenomena of stellar aberration using a 12.25 ft. telescope. The telescope's objective lens of unspecified diameter probably about two inches; this was the size of Flamsteed's lenses at the Greenwich observatory in 1676 according to A. Pannokoek' History of Astronomy, Interscience 1961. The objective convex lens bends the light rays to a point, the focus, an unspecified distance from the objective which then pass to the smaller convex lens the eyepiece again of unspecified but smaller distance from the focus. Bradley summarizes the magnifying properties of such an arrangement by saying that they are such that he can observe points of light of a half a second in arc length. One such advantage of this arrangement, attributed to Kepler, over the earlier one of Galileo, was that it is possible to put wire cross hairs in the focal plain which are seen sharply in focus together with the image of a celestial object; by comparing them small distances or sizes can be measured.

As the Earth spins, different stars pass into and out of view between dawn and dusk. As the Earth takes up different positions each night, in terms of its orbital path about the Sun, the region of the celestial sphere that is visible, between dawn and dusk on any given night from any given latitude and longitude on the Earth, changes slightly from one night to the next. One may think of the celestial sphere as the inner surface of a sphere whose diameter is many millions of times greater than the diameter of the Earth's orbit about the Sun.

As a rough approximation the stars may be thought of as painted on this inner surface at fixed positions. We can ignore in this approximation the fact discovered in 1929 by Edwin Hubble that the sphere is constantly expanding; that the furthermost stars are receding the most. The Sun moon and planets are seen at different days and times at different positions with respect to the background of fixed stars.

We would like to ascribe position coordinates the stars that do not change with the position of the Earth as it rotates on its axis and orbits the Sun. To this end imagine extending the plane of the Earth's equator when the Earth is at any point along its counterclockwise course around the Sun and the plane of the Earth's orbit so that they intersect the celestial sphere in circles called respectively the celestial equator and the ecliptic. Note that the plane of the Earth's equator is tilted at an angle of 23.5 degrees to the plane of the ecliptic. Thus if one is looking down at the circular face of clock representing the Earth's almost circular orbit around the Sun, when the Earth is at nine o'clock going counterclockwise, its axis is tilted with the north pole toward the Sun at the center of the clock's face; at three o'clock it is tilted with the north pole away from the center. The ecliptic and the celestial equator intersect at two points called the vernal and autumnal equinoxes which provide fairly stationary reference points for the positions of the stars on the celestial sphere. The ecliptic is a plane determined by the path of the Earth about the Sun; The celestial equator is a plane passing through the equator of the Earth and extended to the celestial sphere.

For example suppose like Bradley in the Eighteenth century we are, in the present century, on some March 21 at 51 degrees latitude and 0 degrees longitude and that our telescope is lined up in the plane of our meridian the 0 meridian; that is the plane of a 180 degree arc between the north and south points of our horizon passing through our zenith or point directly overhead. Note a wall a few feet high extending along our meridian would cast greater shadows than an otherwise oriented wall as the Sun moved along its east west path perpendicular to the north south direction of the wall. At the time of no shadow, which we define as noon, the Sun is crossing our meridian.

If we could see the background of stars beyond the Sun we would see our meridian circle intersect the point of intersection of the celestial equator and the ecliptic. We define the right ascension as zero at this point. Our meridian circle, that is the circle where our meridian plane extended to the celestial sphere cuts the celestial sphere, takes up different positions along the celestial sphere as the Earth continues to spin and move in its orbit.

If the Earth only spun and did not move in an orbit around the Sun, when our meridian circle again intersected the point of intersection of the ecliptic and the celestial equator, it would be noon again. That is the Sun again would be transiting our meridian. However the Earth does move in a counterclockwise orbit and so the Earth must spin a little more in its counterclockwise direction of spin before the Sun transits our meridian. That is the line between the Sun and the Earth lies on the meridian plane.

We define the time between these transits as 24 hours or one day. We observe the time it takes the Earth to make a complete orbit- the time between successive vernal equinoxes - as 365 days so defined. Hence in 24 hours the Earth will have moved 360/365 degree in its orbit which is about one degree so the Earth will have to spin about one degree more than the 360 degrees of one complete spin before we can say 24 hours has passed. Since 24hours/361 degrees is about 1/15 of an hour per degree this is the added time, 4 minutes, the Earth must spin before we can say 24 hours has passed.

Since the time to the next vernal equinox is 365 of days so defined, we know that the Earth has made a complete orbit after 365 days. Of course we can't observe the Sun against the background of the equinoctial point on the celestial sphere. Rather we can determine these points the way it was done in ancient times. Early calendrical monuments suggest that the equinox was fixed by noting the position of the rising or setting Sun of the solstices.

For example two poles are placed in alignment with the southwesterly setting Sun of the winter solstice. One of these poles is further from the setting winter Sun than the other. Later at the time of the summer solstice, a third pole is aligned with the northwesterly position of the setting summer Sun and the pole aligned with the winter solstice and furthest from the setting winter Sun. Bisecting the angle between these two lines gives the point on the western horizon of the vernal equinoctial setting Sun. Using this observation and interpreting it according to the Copernican theory of the Earth orbiting the Sun we can infer that our meridian circle on the celestial sphere generally on March 21 at 12 noon intersects the point of intersection of the ecliptic and the celestial equator.

But on the next day March 22 at noon if we could see the background of stars beyond the Sun we would see a slightly different background. If we extended our meridian plane now to intersect the celestial sphere it would form a great circle intersecting the celestial equator one degree or four minutes in a counterclockwise direction from the vernal equinox, that is the right ascension of the Sun on this day is 0h.4min.0sec., as expressed in units of time where twenty four hours represents 360 degrees.

That is if the Earth's orbit around the Sun is represented by the numbers around the face of a clock with the Sun at the center and the Earth at the time of the vernal equinox is positioned at 12 o'clock, then as the Earth moves counterclockwise to a position one degree to the left of 12 o'clock a person on the Earth would view the Sun on its meridian now against a background of the Earth's orbital path on the opposite side of the clock one degree to the right of six o'clock. Extending this line of view to the celestial sphere one would see stars 1 degree along the ecliptic to the right of the vernal equinoctial point. Hence the term right ascension.

It remains to specify the altitude of the Sun or star in units independent of an observer's position. First we find the altitude angle of the Sun or star above our horizon when it is on our meridian. Secondly, we find the angle between a line to the zenith and a line parallel to the equator. Since the line to the zenith is just a continuation of the Earth's radius where we are standing, this angle is simply our latitude, 51 degrees. The difference between these angles is the desired angle of declination - a negative angle denotes a position south of the celestial equator.

By using a flexible support for his telescope and finely threaded screws Bradley could move his telescope through very small angles up and down along the meridian and on either side of the meridian. Thus he could by positioning the telescope so that a star was positioned at the cross hairs of his eyepiece he could read off the angular position of the telescope and its axis from a micrometer that marked small gradations of angles. From these observations and the time of day he could compute the right ascension and declination.

For example suppose he observed at 8 51 PM on February 2 a star transiting his meridian at an altitude above his horizon of 46 degrees. The declination then is 7 degrees north of the equatorial plane. With regard to the right ascension: There are 46 days to March 22 and the vernal equinox during which time the Earth moves 46 times 360/365 or 45 degrees. But 45 degrees in the time scale is 45/15 or 3 hours. So the right ascension of the Sun on feb 22 is 24 -3 = 21h. This means at noon on Feb 2 the plane of Bradley's meridian extended out to the celestial sphere and the meridian arc so produced there, this arc intersects the celestial equator at 21h. As the Earth continues to spin in a counterclockwise direction at 3 o'clock the meridian arc passes through the celestial equator at 24h.= 0h. and so at 8:51 PM on Feb 2 cuts the celestial equator at 5h.51min., the right ascension.

We have explained the declination and right-ascension coordinate system that Bradley refers to. Bradley also uses the terms, longitude and latitude meaning celestial longitude and celestial latitude. The celestial latitude of a star is the angle above or below the plane of the ecliptic. The celestial longitude of the star is determined like the right ascension from the vernal equinox but along the ecliptic. Since this point slowly retreats 50.25 seconds of arc per year, the longitude of any star increases by 50.25 seconds per year. Hence the longitude of a star is easily calculated for a date in the past say 25 B.C.

So much for the special terms and techniques Bradley and astronomers then and since use. The purpose of Bradley's observations was to find evidence for parallax. That is to observe a star from diametrically opposite points on the Earth's orbit about the Sun and to find that the two vantage points gave different coordinates for the same star. Then knowing the diameter of the

Earth's orbit and the two different angles to the stars he could calculate the distance to the star based on the difference in points of view, i.e, parallax. This same principle had been employed earlier by Giovanni Cassini to determine the diameter of the Earth's orbit from the position of mars viewed in Paris and in Cayenne on the northern coast of South America. Then from Copernicus's calculations of the relative distances of the planets to the Sun even without Kepler's corrections for the eccentricities of the orbits, he was able to achieve an estimate of the distance between the Earth and the Sun very close to the present estimate.

Bradley says his first hint of stellar aberration instead of parallax came from observations of the brightest star in the head of the dragon constellation. This star is in a part of the celestial sphere north of the celestial equator and the ecliptic. Regarding stars on the ecliptic the Earth is almost a quarter of the time moving toward them and a quarter of the time moving away so that during these times no evidence of parallax is possible. However regarding stars at the celestial poles that is on the celestial sphere directly above the Earth and the Sun, the Earth is always moving at right angles to them that is to a line from these stars to the Earth.

The less the Earth is moving directly toward or away from a star and the more it is moving at right angles to a star the easier the observation of possible parallax. I think Bradley is referring to this phenomena when he explains small changes in the observed position of the star in the Dragon constellation in the first part of his paper: "This sensible alteration the more surprised us, in that it was the contrary way from an annual parallax of the star."

He goes on to find exactly the same degree of movement in many other stars which he comes to ascribe to stellar aberration. That is that when the Earth is moving in its orbit toward the star, or rather toward a line dropped from the star to the plane of the Earth’s orbit, at a specific orbital speed, light in the assumed form of particles or wave fronts hits the eye and eyepiece of the telescope sooner than when the Earth is moving away from the star. Bradley's clear explanation is given in the appendix

Halley and Roemer Versus Cassini

Roemer's too quick inference in 1676 of the speed of light from seasonal variations in the occultation or eclipse times of some of Jupiter's moons was used by Halley later to buttress Bradley's derivation of the speed of light from the phenomenon of stellar aberration. Halley had to justify Roemer's view against expert criticism by Giovanni Cassini, the chief astronomer of Louis XIV. If Cassini was right and Halley's objections were wrong it would not negate Bradley's completely different argument- although it could have led Bradley to a different form of description of what he had observed- but at the time Roemer's paper gave credence to Bradley's observation-interpretation and vica versa.

I argue here that Cassini's objections to Roemer's view in 1676 were well founded and right and that Halley's zealousness may have helped the ideas of Bradley in 1720 to gain acceptance, just as it did earlier in 1687 for the ideas of Newton on light and gravity, but ironically by wrongly opposing Cassini he steered the science of physics in the wrong direction.

Roemer inferred the speed of light from seasonal variations in the times of disappearance or reappearance of one of Jupiter's moons behind Jupiter. The difference of time when the Earth was closest to Jupiter compared to when the Earth was furthest from Jupiter, Roemer determined from his observations, to be about twenty two minutes. This was attributed to the greater time it took for light to travel the diameter of the Earth's orbit. This diameter had been inferred just recently then from Copernicus' clever determination of the relative distances of the Earth to the Sun and some accurate measurements of the distance between the Earth and Mars made possible by Giovanni Cassini. Cassini and his assistants did this by comparing observations from Paris and those from the northern coast of South America. The estimate of the mean solar distance of 21,600 Earth radii has since been improved upon but it yielded an estimate of the speed of light of the same order of magnitude as Bradley's later measurement.

Roemer compared the time between two successive disappearances of Io from behind Jupiter when the Earth was moving mostly toward Jupiter and again two successive disappearances when the Earth was moving away from Jupiter. As you see from Roemer's paper reprinted in the appendix and one can see in Roemer's correspondence with Huygens the differences between the roughly 42.5 hour long revolutions of Io around Jupiter measured in this way were fractions of a minute. But when forty revolution periods, when the Earth was mostly moving toward Jupiter, were added together and compared with the sum for forty revolution time periods when the Earth was mostly moving away from Jupiter there was a sensible difference “in proportion of 22 for the whole interval HE[= 2AU]”

Roemer cites one prediction based on multiplying the observed time between successive emersions on some unspecified day in August 1676 by the number of such intervals of time intervening between that day and Nov 9, when the Earth was much closer to Jupter; he showed that the disappearance occured ten minutes later than predicted from his observations in August. This prediction implied that the Roemer estimate of the time it takes light to travel from the Sun to the Earth is about eleven minutes.

We have referred to the disappearances of the moons of Jupiter as if they were objective facts with specific objective times of disappearances behind the rim of Jupiter (occulatation) or at some distance from the rim falling into the shadow of Jupiter(eclipses). Of course one person with one telescope might disagree as to the exact time of such an event with another person with the same or a different telescope and of course differences in atmospheric conditions and relative positions of the Earth and Jupiter if they don’t completely obscure the events will have an effect on the time estimates for these events.

Roemer’s claim in the last paragraph of his brief paper that the differences he observed were wholly attributable to the speed of light is not supported by his evidence here; anyone who has looked through a telescope only a few times would be skeptical of such claims. Cassini explained that there were many factors contributing to Roemer’s observations. For example changes in the vantage point(angle) from the Earth to Jupiter at different points in the Earth’s orbit etc and changes in the velocity component of the Earth parallel or antiparallel to Jupiter and changes in the intensity of the light from Io and contrast when the view of Io is impeded by the greater distance the Earth is from Jupiter when on the opposite side of the Sun and by the light of the Sun, all of these factors have an influence in producing the small systematic reduction in the observed revolutions of Io between successive points of disappearance when the Earth was nearer to Jupiter and the differences between Io and the larger satellites in this regard.

Perhaps the most important objection to Roemer's claim was Cassini’s objection at the time that the same systematic reduction in the observed revolutions or time between disappearances did not occur for the other Galilean moons. Halley later in order to show confirmation of Bradley’s measurement said that Cassini’s data was wrong although modern data seems to support Cassini as can be seen by comparing it to Halley's figures given in the appendix..

Even Bradley accepted some of these differences but interpreted them in a way that supported his measurement: “It is well known that Mr. Roemer, who first attempted to account for an apparent inequality in the times of the eclipses of Jupiter, by the hypothesis of the progressive motion of light, supposed that it spent about 11 minutes of time in its passage from the Sun to us: but it hath since been concluded by others, from the like eclipses, that it is propagated as far in about 7 minutes. The velocity of light therefore deduced from the foregoing hypothesis, is as it were a mean betwixt what had at different times been determined from the eclipses of Jupiter's satellites."

What Bradley means by "like eclipses" may be the eclipses of some other moons of Jupiter, for example, of Europa which are more variable than those of Io when the Earth is closest or furthest from Jupiter and Jupiter is still visible at night. This vagueness and lack of precision on Bradley's part is uncharacteristicly unscientific.

That is, to average the maximal differences in disappearance times for two different moons as if one were averaging many observations of one and the same event subject to random differences of some sort is incorrect. But despite these lapses, there was a bandwagon effect as described by I.B.Cohen in his classic paper on Roemer in ISIS v31(1940) p327: "Bradley's work led to the final acceptance of the finite propagation of light. Even the Cassini family had to give in. Maraldi who, like his father began his career in the Cassini tradition by denying the "mora luminis" of Roemer published a paper in 1741 in Acad. Roy. Sci, Memoires pp1-10 in which he showed that the equation of light explained much of the irregularity in the motion of the third satellite."

But the only possible scientific conclusion is that Roemer's observations are probably due to several factors, which might or might not include the progressive motion of light. This conclusion, although it may not have helped Bradley's claim then to have measured the speed of light or the delay in the perception of a dim light source, does not detract from the validity of Bradley's measurement when later terrestrial measurements of the same phenomena are taken into account.

It does however detract from Bradley's interpretation of his measurement as being of the speed of a moving particle or of a wave disturbance or of some other mysterious entity relative to the orbital movement of the Earth. This mistaken view has led, it seems to me, to the increasing number of conundrums of relativity and quantum mechanics, the difficulties in explaining supraluminall quasars etc..

One of Bradley's contemporaries, Jonathan Swift, had something picturesque to say about the conservative human tendency to stick with assumptions that are reasonable in some of their implications but not others. Perhaps he had Bradley's "measurement" in mind. A false opinion must needs create many more: it is like an error in the first concoction which cannot be corrected in the second; the foundation is weak and whatever superstructure you raise it must of necessity fall to the ground. Like the dog in the fable lose the substance in gaping at the shadow [reflection in the water of the dog with a piece of meat in its mouth].” And so we continue two hundred years later to gape at mathematical tensors, wave functions and various self contradictory or “non intuitive” implications of quantum theory and relativity. We have lost sight of the substance.

As noted above, Bradley interpreted the difference in apparent direction of starlight from the same stars at opposite times of the year as being due to the relative speeds of the Earth and the perhaps moving light. But one could equally well interpret the implied delay as due to the reaction time of the rods of the retina. That is light from the star reached the retina’s rods after equal unknown delays in both cases and then after equal additional delays of about 3 nanoseconds while the Earth moved .0002 meters in opposite directions became manifest. Bradley’s method unlike Roemer's did not require an explicit estimate of the distance to the source and unlike Roemer's did entail constant exposure to the star as it first appeared and then passed through the view of the telescope while the Earth rotated on its axis and moved in its orbit about the Sun..

Despite these differences; perhaps because of these differences, Halley hoped to show by Roemer's paper independent support for Bradley's interpretation of the small regular movements of star images that could not be accounted for by precession, nutation or combinations of regularities attributed to these or other causes. Halley felt he had to justify Roemer's view against expert criticism by Giovanni Cassini.

One can conclude fairly quickly from the polemic tone of Halley, his respect for Cassini's expertise, and the tentativeness of some of Halley's objections to Cassini's claims that there is at least some reason to doubt the validity of Roemer's method of measurement. Cassini's basic objection was that what Roemer observed for one moon did not apply to the other Galilean moons of Jupiter. This is explained in Jacques Cassini's textbook and is referred to by others such as I. Bernard Cohen quoted above in his short booklet, The First Determination of the Velocity of Light also published in ISIS(v31,p327,1940) that includes quotations of G. Cassini: “M. Romer... does not examine if his hypothesis is accomodated by the other Satellites which would require the same inequality of time[for reaching the Earth when Jupiter was nearest and farthest and observable]’(Anc. Mem. v8, p391). Also, “the time of a considerable number of immersions(the moon is not visible when the Earth is moving toward Jupiter) of one and the same Satellite is sensibly shorter than that of a like number of emersions(the Earth is moving away from Jupiter), which can be explained by the hypothesis of the successive movement of light: but that does not appear to the academy sufficient to convince that the movement of light is in effect successive, because we are not certain that this inequality of time may not be produced either by the eccentricity of the satellite, or by the irregularity of its movement or by some other cause so far unknown which could be clarified with time.” (Anc. Mem. v8 p 47).

Cohen on p 27 writes that “Cassini perceived that the successive propagation of light explained the irregularities in the eclipses of the first satellite when the Earth was in different positions of her orbit. But finding that it did not account in an equally satisfactory manner for the irregularities of the other satellites, he rejected it altogether, and instead of it he used in the table of the first satellite an empiric equation depending on the relative postions of the Earth and Jupiter”

Halley's rejoinder is that that some of Cassini’s data is incorrect. ‘A second Inequality[differences between the orbital periods of Io at different positions of Jupiter wrt the Earth] is that which depends on the distance of the Sun from Jupiter, which he says Monsieur Romer did most ingeniously explain by the Hypothesis of the Motion of Light; to which yet Cassini by his manner of calculus seems not to assent, though it be hard to imagine how the Earth's Position in respect of Jupiter should any way affect the Motion of the Satellites{but what of the perception of eclipses etc].

This Inequality he makes to amount to two Degrees in the Satellite’s Motion, or 14'10" of Time, wherein he supposes the Eclipses to happen so much sooner when Jupiter Opposes the Sun, than when he is in Conjunction with him[recall that when Bradley invoked Roemer’s measurement as support for his, he says that whereas Roemer measured 11 minutes for the Sun's light to reach the Earth, others have measured 7 minutes and that his, Bradley’s, is as it were a mean].

The distribution of this Inequality he makes wholly to depend on the Angle at the Sun between the Earth and Jupiter, without any regard to the Eccentricity of Jupiter, (who is sometimes 1/2 a Semi-diameter of the Earth's orb farther from the Sun than at other times) which would occasion a much greater difference than the Inequality of Jupiter and the Earth's Motion, both of which are accounted for in these Tables with great Skill and Address. But what is most strange, he affirms that the same Inequality of two Degrees in the Motion, is likewise found in the other Satellites, requiring a much greater time, as above two Hours in the fourth Satellite: which if it appeared by Observation, would overthrow Monsieur Romer's Hypothesis entirely.[unless the 2 plus degree inclination of their orbital planes to Jupiters orbital plane etc might have the reverse effect]” I would be interested to know what astronomers today making the same sorts of observations would say about Halley’s claims. It is by no means clear that Halley's claims are completely valid and certainly they are not objective in tone. But they are sufficient to at least suggest that Roemer's method might not be faulty and hence Roemer’s implicit measurement of the speed of light might confirm Bradley's method and result.

In short, Roemer's measurement of 22 minutes, as the the time required for light to cross the diameter of the Earth’s annual orbit of the Sun, is not as clearly valid as Bradley's measurement of the time it takes for light to register on the retina while the eye and the Earth are moving. The time it takes is about three nanoseconds.

The details of the observed movements of Jupiter and its satellites are given in the papers of Halley quoted in the appendix using the methods described in connection with Bradley's paper. Some still more fundamental details on Jupiter are quoted here from Sky and Telescope magazine and drawn from Astronomy textbook by W.Protheroe, E. Capriotti, and G.Newsom called Exploring the Universe, Merrill 1989: S&T July 91:

"Jupiter shines to the lower right of Venus at dusk and you may need binoculars to spot it by midmonth." August: "Jupiter in conjunction on Aug 17 is altogether out of sight behind the Sun." September: "Jupiter is at Venus's left at dawn where Venus rises during early dawn at the beginning of September." February 92: Jupiter stands high in the south in the middle of the night and in the West at dawn. Opposition is on Feb 28."

The Earth's semimajor axis is (1.5)(10^8)km. while that of Jupiter is (7.78) (10^8)km. Jupiter's diameter is 142,796 km. while Io's orbital semimajor axis is 422,000 km., Europa, 671,000km.; Ganymede, 1,070,000km.; Callisto, 1,883,000km.. From this one can compute the angles of view. The respective periods are in days 1.77, 3.55, 7.15, and 16.69. The respective eccentricities and the inclinations of the orbital planes to the planet's equator:.004,0^o; .009,$.5^o$; .002,$.2^o$; .007,$.5^o$.

Current Ephemeris data and data going back to the time, when Halley had the policy changed from recording observed to average times, cannot decide between Cassini's view and Roemer's view; namely, whether or not Roemer's interpretation of a reduction in the time of reappearance of Io from behind Jupiter when the Earth is mostly approaching Jupiter compared to the time when the Earth is mostly moving away from Jupiter is due to the speed of light is not supported by equivalent disparities for the other Galilean moons; Cassini had shown that such observations could be due to the decrease in the intensity and contrast of light from Io more than from the larger satellites as the Earth moved away from Jupiter to the opposite side of the Sun etc.

I interpret this to mean that since the Earth, according to Roemer moves 210 Earth diameters, about $(2.7)10^6$ km. during a 42.5 hour period toward or away from Jupiter at quadrature and that the observed small differences in the compared revolution times of Io could be due to the time it takes light to travel $(2)(2.7)10^6$ km. that the time it takes light to travel forty times this distance would be forty times a typical individual difference and that if his estimate of 2AU is 22/40 of $(40)(2)(2.27)10^6$km.= $(1.816)10^8$ km versus the accepted value of $(2.99)10^8$ km. =2AU, that would explain his multiple, "22". That is Roemer's estimate of 2AU etc. may have been about one third of our estimate. The translation of Roemer's French paper that appeared soon after in the

English Philosophical Transactions is included in the appendix. Following this is Halley’s paper criticizing Cassini.

If one had access to a small observatory telescope and a video camera and enough clear weather,one could obtain timed photographs of eclipses and reappearances of Europa throughout the year for several years. In this way one could confirm Bradley's observations that led him to conclude "from like eclipses it [light from the Sun to the Earth] is propagated as far in about 7 minutes"

Roemer’s measurement of the speed of light required that light be a wave front or a group of moving particles while as we have indicated, Bradley’s and Fizeau’s light speed measurements allowed light to be interpreted as the cumulative effect of instantaneous forces at a distance.

Fizeau, Foucault and Michelson

While Maxwell was developing his theory of light, Fizeau, in 1849, showed with a rotating toothed wheel that light reflected from a mirror appeared to suffer a delay in reaching an easily observed intensity as observed through the gaps between the teeth of the rapidly rotating wheel. The light had been emitted through one such gap and after its reflection had returned through another such gap.

Fizeau's brief clear description of his ingenious and simple experiment, that no one before had been able to devise, is included in the appendix. A source of light is introduced through collimating lenses inside a tubular connection to, and at right angles to, a horizontal tubular telescope. The light is directed by these collimating lenses to a plate of glass inclined at 45 degrees to the axis of the telescope.

The light is reflected by the glass and comes to a focus at a point on the rim of the toothed wheel which cuts through the main telescope tube. If the point on the rim of the wheel is a gap, the light continues and emerges through the collimating lens at the end of the telescope. The light rays move then toward the distant station where a lens focuses the light onto the center of a curved reflecting surface, which is part of the surface of an imaginary sphere whose center is the center of this lens.

The reflected light retraces this same path and comes to a focus at the same point on the rim of the toothed wheel and then passes through the inclined glass toward the eyepiece of the telescope. When the apparatus is properly adjusted, the image of the object glass of the reflecting system is formed in the principal focus of the observing system and vice versa.

Fizeau's toothed wheel was 2 meters in diameter and had 720 teeth and gaps, .44 cm. each. When it turned at say 25.2 turns per second the time to move the .88 cm distance between adjacent gap centers was .00005566 seconds. The gaps then allowed the light to pass through but the teeth blocked the light during most of this time interval. The light came from a light source, a gas flame, with lime powder thrown on it to increase the intensity, and it passed through the unpolluted night sky of Paris at these times to a mirror situated in a another apartment window five miles across the city.

In Fizeau's experiment if the disc turned at a certain rate the maximum intensity of the reflected light was observable in the telescope eyepiece; the time it took for a point on the rim of the disc to move .88 cm was .00005566 seconds; this was the time the light took to make the round trip, hence a light speed of 17.266 km/.00005566 sec = 310,204 km/sec..

The intensity of the light returning to Fizeau’s viewing telescope is much weakened by transmission through the apparatus and by reflection at the partly reflecting and partly transmitting inclined glass plate so that the image seen is unavoidably dim even when at its maximum brightness. Extraneous illumination in the field of the telescope is produced by reflection from the teeth of the wheel; that is when the wheel rotates, the light when not passing between the teeth is reflected back into the field of view, and produces a general illumination that makes it more difficult to distinguish differences in intensity that the measurement is based on. In later versions of the experiment by Young and Forbes the teeth were beveled so that light reflected from this part was directed to the blackened sides of the telescope. They also smoked the wheel to further reduce the extraneous light reflected.

The delay was consistent with the delay indicated by Bradley's stellar aberration measurement of the speed of light. Subsequently Foucault, Cornu, Michelson and others improved the design of this experiment, using rotating mirrors instead of a toothed wheel, but all summarily dismissed the effect on the evident delay in the transmission of light of reflection and the interaction with the atoms of the mirrors used or of the atoms in the observer's eye.

Suppose that forces from the source glass reflecting the light through a gap in the wheel are allowed to act only for a short time on the distant reflecting surface.

Suppose, then, there is a delay before these forces can produce an oscillation of charge in the reflecting surface or mirror of sufficient intensity and that such an oscillation is self sustaining even when the source of the forces is blocked by a tooth of the turning wheel. And that the oscillation continues as the tooth moves and permits the observer's eye to be exposed to the sustained oscillation in the distant mirror.

If the eye is exposed to the distant mirror too soon before the oscillation in the mirror has had time to become intense enough, then the eye will not observe the reflection.

If the eye is exposed too late after the oscillation in the mirror has diminished too much to still be visible then the eye will not observe the reflection.

But the idea that the mirror or the eye could have something to do with the delay or speed of light was not seriously considered thanks to Roemer's measurement.

For example in the famous paper reprinted here, Michelson says only "Cornu in answering the objection that there may be an unknown retardation by reflection from the distant mirror says that if such existed the error it would introduce in his own work on account of the great distance used and of there being in his own experiments but one reflection instead of 12 would be only 1/7000 that of Foucault. In my own experiments the same reasoning shows that if the possible error made a difference of one percent in Foucault's work (and his result is correct within that amount[1/100 instead of 1/7000])then the error would be but .00003 part."

The fallacy here is the unwarranted assumption by Cornu and Michelson in the 1870s that the reflection effect if there is any is independent of the distance effect. That is the delay of reaction in the receiving antennae- the mirror(s) and the eye- is greater the weaker the strength of the source's effect at the receiving antenna, which strength is partly a function of distance from the source. Hence Foucault using multiple reflection would have the first individual delay shorter than the second, the second shorter than the third etc. though never more than Cornu's delay with one mirror and a greater total distance and the total in both cases should have been a function of the total distance in each case- as it was.

But since the parameter, 'strength of source', was not varied independently of the parameter 'distance from source' the seat of the delay could have been the mirror(s) and the eye of the observer in each case just as much as it could have been the intervening space.

A modern version of the Foucault-Michelson method is used in high school and college physics laboratories along with a method involving the interference of oscillating forces that are in phase , out of phase, or somewhere in between. In both methods of course there is no attempt to control for variations in light intensity independent of distance. As a result, the measured delay is applicable to starlike levels of intensity at the receiver and the distant mirrors and of course there is no reason to interpret the delay as being due to travel through the intervening space instead of as being due to interactions in the mirrors and the receiver retina.

The measurements by Fizeau, Foucault, Cornu, Young, Forbes, Newcombe, Michelson and others of the delay in the transmission of light used deflected and reflected light beams over distances of 20 meters to twenty two miles where the perceived intensity of the source decreased with distance as did the delay times from 60 nanoseconds to 120 microseconds. None of these experiments at least as reported, controlled for the possible effects of the intensity of the received radiation independent of the effects of distance!

Now lets consider Foucault's 1850-1862 experiment(Comptes Rendus, tome 30 p551, 1850 and tome 55 pp502,792, 1862) which was much improved upon by the lifetime work of Michelson. Wheatstone in 1834(Phil. Trans. p583, 1834) and Arago in 1842 (Annuaire du Bureau des Longitudes pour 1842, p287) has suggested a similar method to determine the speed of light as that actually carried out by Foucault. The method differed of course from that of Fizeau in that instead of obstructing a reflected beam of light when it might be expected according to Bradley's stellar aberration measurment and comparing the brightness of the light at these times with that of the unobstructed reflection, instead a reflected beam of light is deflected slightly when a rotating mirror doesn't reflect it in the right direction exactly at the time the beam impinges on the rotating mirror so that the beam is not reflected exactly back to where it came from. This indicates the rotating mirror is moving too slowly or too quickly relative to the time it takes the light to reach the mirror.

Picture a triangle on its side at the bottom of a page with the apex, denoted S, at the far right of the page and the base, denoted L, of the triangle one third of the way to the left side of the page. Draw two parallel horizontal lines from the ends of the base to the far left side of the page. Draw a line here almost vertical but with the upper part left of the lower part and crossing the two horizontal lines; denote this line R. From the points of intersection of the horizontal and almost vertical lines draw a triangle that is tilted upward toward the center of the page where the apex point M meets an oppositely slanting short curved line representing a fixed mirror.

Now S denotes the light source, solar light transmitted through a rectangular aperture S, which falls upon an achromatic lens L, and afterwards upon a plane mirror R, which can be made to rotate rapidly round an axis perpendicular to the plane of the page. A concave mirror denoted by the apex point M is fixed at a specific distance. The surface of this fixed mirror is spherical and its radius is equal to the distance RM, while its spherical center is at R on the axis of rotation of the moving mirror. First suppose the mirror R is at rest where the light reflected from it comes to a focus at the fixed mirror M and produces there an image of the slit S. The pencil reflected from M returns along its former path, is reflected from R, traverses the lens a second time, and comes to a focus at S, forming an image superposed on the slit. Now suppose that a half silvered plate of glass is placed near S in the path of the beam of light and inclined to it at a 45 degree angle. The pencil reflected from M when returning to S meets the plate where it is in part reflected, and forms an image of S at a, which is observed through an eye-piece. A fine wire may be placed across the center of the slit parallel to its length, so that the image at, a, is crossed by a dark vertical line, over which the fiber of the eye-piece can be accurately placed in making the measurements.

Now suppose the mirror R is caused to rotate slightly to R' so that the line representing the mirror now has its top part even more to the right forming an angle of say five degrees with the previous line representing the mirror R.Let T be the time required by the light to go and return along the distance RM=D then vT=2D. But during this interval the mirror R has turned through an angle (omega)(T)= five degrees where the angular velocity (2)(n)(pi) = omega where n denotes the number of revolutions per second. The axis of the pencil returning through the lens to, a, will thus be rotated through an angle, two times omega times T, that is twice the rotation of the mirror.

To understand this, suppose for simplicity that R is not a slanted line but rather a vertical line and that light from M to the right of R impinges on R at p where Mp is a line 20 degrees above a horizontal line perpendicular to R at p and extending from p to the right below Mp. Now consider a line perpendicular to R' also at the point p; this line will be five degrees below the horizontal line extending from p while the line of the reflection produced by the incident line of light, Mp, and the the mirror position R will be another 15 degrees below this. Consider the reflected line associated with the incident line Mp if produced by the mirror position R'. This line will have to be 25 degrees below the line perpendicular to R' or ten degrees (twice the angle between R and R') below the reflected line associated with the incident line Mp and the mirror position R;

The image, a, will consequently be displaced to some point, a' and the image of S not on top of S but to some other position, S', where SS' = aa' = x. The distance x, about 1/40 of an inch in Foucault's experiment, is measured by means of the micrometer attached to the eye piece.

The light returning from M is reflected from R and appears to come from a point situated at an equal distance behind R so that the pencils forming the images at S and S' appear to come from sources s and s' behind R, so that RS=Rs=D and lines joining S and S' to a point in the center of the lens, L, pass through s and s' respectively. Let the distance of S from L be denoted, alpha, and the distance of L from R , beta. Then since the angle SLS' is very small, SS' is to alpha as ss' is to beta plus D. Also ss' is approximately 2 times theta times D. Putting these two facts together we have SS'/(alpha) =[(2)(D)(theta)]/((beta)+D) where theta is omega times the time T it takes for light to go the distance D from R to M and back at speed v=2D/T. Hence the speed of light can be determined from known values v=(8)(π)(n)(alpha)(D^2)/[(x)((beta)+D)] where x denotes the distance SS' measured as described above. Note that if L is put between M and R and we let alpha be the distance between S and R then we can simply remove beta from our equations above. If 2 times alpha is the distance between the newly placed lens L and the fixed concave mirror M and if this is the focal length of the lens,L, then the point image at M will be returned by reflection to the point image at S.

In Foucault's final experiments the Sun's light was collected by a device called a heliostat that changed position with time according to a clockwork mechanism so as to constantly pick up the Sun's rays and focus them in a specific direction through an aperture S. A piece of silvered glass with lines etched in it .1mm (.003937inches) apart was placed over the aperture so that the image of this scale and its displacement was what was observed. The revolving mirror was a piece of glass silvered and polished on one face. This was supported in a strong ring frame, and its diameter was 14mm (.55inches); the radius of curvature of the concave fixed mirror M was 4 meters so that with only one fixed mirror the distance D would be 4 meters. But in Fizeau's experiment D was increased to 20 meters by having five fixed concave mirrors. To do this M was turned a little to one side, so that the strongest light reaching it from the revolving mirror was not reflected directly back to R as described above but to another fixed mirror of equal radius of curvature. From this it was reflected to a third, and then to a fourth, and finally to a fifth, which received it and returned it along its previous path to the revolving mirror, and from there to the field of the observer's eyepiece as described before. The lens, L, which had a focal length of 1.9 meters(6.23feet) was placed between the revolving mirror and the fixed mirror for the following reason. When the lens is placed between the revolving mirror and the slit the amount of light returned by M to R varies inversely as the distance, D. Thus with a concave mirror of one decimeter diameter placed at a distance of one kilometer the light returned to the revolving mirror would not be as much as 1/60000 of the light reflected from it. This quantity is further reduced by atmospheric vibration, the lack of uniform curvature of the mirror etc.. However when the lens L is placed between the revolving mirror and the fixed mirror instead of between the revolving mirror and the slit source the lens prevents the light from M from spreading and if the revolving mirror R is placed fairly close to the slit source, the spreading and weakening of the light is further reduced. But as D is increased the value of x can be made larger but the brightness of the light and the exactness of the image will be diminished. Foucault obtained as we said with D=20 meters and some value for n turns per second a value of x = .7mm or .0276 inches. (Note with n=207 turns per second; alpha = 2meters, v is about 24 times 207 times 20 divided by 1/1000 which is about 10^8 as required. Foucault obtains 2.99835 times 10^8 meters.)

To repeat this experiment one would have to make the 14 mm diameter ring frame holding the.revolving mirror turn at a specific rate. To determine this rate Foucault used a finely divided toothed wheel and placed it between the observing eyepiece and the reflecting glass plate so the the image of its toothed edge appeared in the field of view. The wheel was driven by clockwork at a uniform speed, which could be accurately determine. Note that the beam of light entering the field of view is not continuous but intermittent. It is composed of a succession of flashes, each flash corresponding to a complete turn of the revolving mirror R. If the beam of light were continuous, the teeth of the revolving disc would be seen rapidly crossing the field at a speed depending only on the rate at which it is driven and when moving fairly fast they could not be distinguished in passing. With the intermittent beam, however, the teeth are illuminated once during each revolution. If the wheel turns so that the next tooth moves to replace the position of the previously illuminated tooth there will be no change in the observed illumination and the teeth will appear to be stationary. The ring frame holding the revolving mirror was driven by an air turbine so that its speed could be controlled, and during an observation this was so regulated that the image of the toothed wheel appeared to be stationary in the field of view.

In modern versions of this method an electric motor that can rotate at as much as 440 cycles per second which creates a hum that sounds like the note A on a tuning fork can be used

Michelson

The chief objection to Foucault's experiments is that the deflection was too small to be measured with sufficient accuracy, and to remedy this defect Michelson used a lens with a longer focus eg 150 feet compared to 1.9meters(6.23feet) Also Michelson used light from the Sun near Sunrise and Sunset when the light was more steady and subsequent improvements in such a way that the return image was displaced through eventually 133mm or about 200 times that obtained by Foucault.

The present accepted value of the speed of light I believe is based on Michelson's method using a vacuum and its close agreement with the ratio of the electric to the magnetic force.

Interference Measurements of the Speed of Light

We now see historically how the idea of light as a wave or a particle propagated through space over time took root and was not questioned. Instead there were endless arguments over the wave or particle nature of light. The wave nature of light became the dominant view until Einstein's discovery of the photoelectric effect suggested that at least for ultraviolet and higher frequencies light appeared to be propagated more like a particle than a wave. Roughly speaking at these frequencies there was less dissipation of energy in the intervening aether than the otherwise adequate wave theory of Maxwell and Lorentz predicted and the light would only be absorbed by a specific absorber if it was of the right frequency and therefore of the right energy content. The accepted wisdom now thanks to Feynman and others is that light is a probabilistic particle whose position at any time can only be specified probabilistically. This view seems to meet all the wave criteria but avoids the wave particle duality.

Prior to Einstein's discovery, however the wave theory of light suggested another method of measurement of the speed of light different from those of Roemer and Bradley and based on the principle of wave interference. Indeed the phenomena that suggested a description of light as analogous to ocean waves instead of as, in the Newtonian theory, analogous to cannon balls was as follows: Light from a candle or a light bulb falls on an opaque screen in which there is a narrow slit. The light that passes through this slit falls on a second opaque screen in which there are two closely spaced slits a few millimeters apart. The light that passes through these slits falls on a third screen where it is observed as a pattern of ten to twenty alternating bright and dark lines. This phenomena was discovered and explained by Young and Fresnel in about 1800 as follows:

Light is regarded as analogous to an ocean wave. Light from a slit in an opaque screen proceeds along equally long lines to two slits, A and B in second opaque screen; when the ray of light through A, regarded as the first wave peak, of a train of wave peaks, arrives at a specific position on a third opaque screen- r meters from the slit in the first screen after r/c seconds- say $1/(3)(10^8)$ -the amplitude of the wave here is not as great as it is 1/f, say $1/10^{14}$ seconds later when the first peak from the second slit having left at the same time and so in phase with the first and traveling at the same speed, c, but from a slightly greater distance also reaches the same position on the screen; that is, the delay associated with the more distant source is equal to the time it takes for the nearer source to produce at the same position on the screen a complete oscillation of charge and to start again to make another complete oscillation.

Then if the greater distance entails a delay which is just equal to 1/f seconds or some integral multiple of 1/f seconds then successive peaks from the two sources arrive together in successive 1/f second intervals or n/f second intervals in each case, the amplitude of the combined peaks remains greater than the amplitude of one peak alone. This corresponds to the bright lines on the screen. When a wave peak and a wave valley meet the amplitude is zero. This happens when the greater distance entails a delay of 1/2f seconds or n/2f seconds. This corresponds to the dark lines on the screen.

Now if a transparent material is placed in front of slit A, primary radiation from slit A mixes with secondary radiation from the interposed material; the resulting interference pattern on the third screen is due to wave trains that leave from slit A and points in the interposed material at different times that is with different phases and travel slightly different distances entailing slightly different delay times to the same point on the third screen r meters from A assuming the speed of the wave trains is the same.

It is possible, however to analyze the resulting interference pattern as if it were due to one wave train from A leaving at the same time as that at B and so in phase but traveling at a greater or lesser speed the exact distance r, thus entailing different delay times for this reason.

Clearly such analysis in terms of the speed of light are of interest but they also can be misleading . The details of such an analysis can be found in most elementary physics texts like Feynman’s Lectures on Physics vol 1 (Addison Wesley 6th prt. 1977)which describes how the carrier wave(the phase) can proceed faster than the speed of light but that modulations of the wave comprising the signal(the group) cannot: “It is this advance in phase which is meant when we say that the ‘phase velocity’ or velocity of nodes is greater than c. In fig 31-4 of Feynman’s text we have a schematic idea of how the waves might look for a case where the wave is suddenly turned on to make a signal. You will see from this diagram that the signal(i.e., the start of the wave) is not earlier for the wave which ends up with an advance in phase.”

That is, faster than light movement of X-rays through carbon, for example, and sub cutoff frequencies of microwave radiation in wave guides are explained in terms of their interference patterns. The group velocity of interference nodes of waves of phase velocity greater than the speed of light must be always less than c. But this description applies to the steady state of the received oscillation, not to the transient increase of amplitude at the location where the oscillation is received.

Perhaps it is less misleading to think of the transmission of light in Young’s experiment and such similar ones just referred to simply in terms of more fundamentally observed phenomena. That is, oscillations of charge of a specific intensity, of a specific group of frequencies, of about the same phase produce opposite oscillations of charge after some delay in a receiver antenna. This increases with distance for distances of centimeters or decimeters while the relative and absolute intensity of the oscillations produced at points along the receiving screen decreases also with the distance of the points from the two slits or sources.

Since the intensity of the radiation from the two slits is the same it is possible that the times of delay vary with the intensity of the oscillating charge in the receiving screen. That is the relative delays associated with different positions on the receiving screen could have remained the same but the absolute delays or speed of light could vary with the absolute intensity of the received oscillation.

Using the observations of Young, Bradley and Roemer on the speed of light, Maxwell formulated a theory of the speed of light that ignored the possibility that the delay varied with intensity of the oscillating field at the receiver - a possible interpretation of the observations of Young and Bradley but not of those of Roemer.

Instead Maxwell concluded in deference ultimately then to Roemer that all light and all other frequencies of oscillating charges produced opposite oscillations of charge at great distances after a delay that depended only on the distance, r, and not also on the strength of the source, specifically the delay was r/c seconds where c denotes the speed of light.

This is the generally accepted view at the present time although it applies to photon like transmission as well as wave like transmission. (And the combination of photon and wave like transmission can be represented in terms of probabilistic photon like transmission.) Of course there are certain esoteric implications of quantum theory -(Bell's theorem and experiments by Clauser and Aspect) -and relativity (tachyons) that suggest the possibility of supraliminal speeds and there have been difficulties in explaining quasars with supraliminal recessional velocities as determined from Doppler shifts. Also as described above there are artificial observations of a supraliminal phase velocity or advance of phase, for radiation which has passed through certain materials whose natural frequencies are less than the frequency of the transmitted radiation.

An interesting discussion of these matters is found in a book by Nick Herbert called Faster than the Speed of Light. He seems to accept the conclusions of Clauser and Aspect but Glashow and other experts seem to reject these conclusions. The Bell's theorem solution and the various solutions to supraliminal quasars may suggest some underlying deficiency in the present concept of a finite speed of propagation of light but the solutions that have been suggested are different than the one proposed here .

The explanation proposed here is that the effect of a source of electromagnetic radiation on a distant receiving antenna kicks in immediately after exposure of the receiving antenna to the primary and secondary source antennas; that energy propagation through vacuous space described in Maxwell's theory with this time delay can equally well if not better be described in terms of unobserved energy changes in a receiving antenna initiated by oscillations of charged particles in the source. The proposed energy changes are unobserved because of their small size and small duration. More specifically, the propagation of energy through, and energy absorption by, vacuous space can be interpreted as instantaneous electrostatic forces at a distance from a source antenna and previously unobserved continuous cumulative changes in energy states within atomic nuclei and electrons. These changes occur before the 'observed' changes in the relative positions and motions of free electrons and lattice ions in the receiving antenna.

The delay in the received radiation is then due to the strength of the source as well as to the distance from the source to the receiver. We will show below that the delay before a certain intensity of received radiation can be roughly formulated as $[K][(jfr)^2][E/(kr^3](1\text{-exp-}ct/jr)\sin ft$ where j denotes the relative strength of the received field E at time t to the inducing field, k is a measure of the focusing characteristics of the source and K is a measure of attenuation from various causes, and c denotes the speed of light and r denotes the distance between the source and receiver. Note that for stars etc where r is astronomically large, j is very small and may be roughly equal to 1/r in which case the above formula reduces to $[((jf)^2)KE/((k^3)(r))](1\text{-exp-}ct)\sin ft$. But for terrestrial values of r, j should tend toward one or some fraction of one. Of course for larger and larger distances in terrestrial light measurement experiments the emitters are more and more powerful so the fraction may be the same for these various distances.

Thus when one looks at stars in the night sky or bounces radar signals off nearby planets or receives transmissions from satellites launched from the Earth, it is possible to regard what we see or receive through dish antennas and radio amplifiers as received instantaneously. But the instantaneously received effects are not raised above a threshold of background radiation and random thermal oscillations in our receivers until some time has passed for the natural or electronically improved amplifying process of a particular band of frequencies to work. This time period cannot exceed the time of exposure of our eye or other receiving antenna to the source. The greater the distance from the source and the weaker the power of the source and the lower the frequency of oscillation, the weaker the induced oscillation and the greater the time needed for a particular bandwidth to increase to its maximum intensity.

If however the received initial oscillation is sufficiently smaller than the thermal oscillations at that frequency or band of frequencies- the Johnson noise-, then even with repetition the signal carrier will not rise above the Johnson noise. An amplifier, which amplifies the noise along with the signal carrying oscillations of the same frequencies, produces the familiar experience of fading and audible noise in radios and other receivers. The weakness of the source ultimately prevents our receiving any amplitude or frequency modulations of the emitted periodic oscillations.

Clearly measurements of oscillations of very small voltages e.g. microvolts, is difficult and in general unnecessary so the early stages of amplification are not noticed. The source of the carrier waves could be for example a star, a radio emitting antenna, or as in Michelson's terrestrial measurements of the speed of light, powerful lamps situated at a distances of from 4 to 22 miles from the place of measurement. Note the intensity of the received light in these cases was about as faint as starlight and so varied over a small range of low intensity. Similarly for radio and radar although the range of low intensity of received radio radiation involves a wider range of very low intensities.

In words the intensity of the source of the perceived starlight must be great enough to induce changes in the receiver antenna according to the model described later. In this model the induction process and delay is influenced by the extent of interference by electrostatic dipoles transverse to the inducing current on similar dipoles transverse to the induced current. That is in this model, wherever there is an electrical current due to the same emf forces, there are produced electrostatic dipoles inside the atomic nuclei and free electrons of the receiver antenna transverse to the current. These dipoles are greater the greater the induced current but they are also more inhibited and smaller the greater the dipoles of the inducing current and the nearer the inducing current.

That is the inducing current produces transverse dipoles jrev/c in the receiver’s atomic nuclei where j is smaller the greater the strength of the inducing current relative to the induced current; so c/jr not merely c/r is the coefficient of, t, in the exponent.

The proposed theory also implies that prior to typically two thirds of the asymptotic maximum there exists a constantly increasing amplitude of the oscillating charge which is in general too small to be observed or recorded by oscilloscopes. And it allows the possibility in this context that more intense radiation could reach a measurable level a few nanoseconds, in general, before less intense radiation.

A Modern Version of Fizeau’s Experiment

One of the problems with terrestrial measurements of the speed of light, essentially modifications of Fizeau's rotating toothed wheel method, was that the transmissions and obstructions of the emitted light were not varied independently of one another and the intensity of the light received was not varied independently of the distance between the emitter and receiver.

Fizeau's source was an oxygen lime flame collimated by telescope lenses; his modulator was a rotating toothed wheel, a light chopper, and his receiver was the human eye. A way to overcome the shortcomings of Fizeau type experiments is to use lasers for the source and voltage controlled modulators for the rotating toothed wheel, and photodiodes in place of the human eye. I recently carried out such an experiment and reported in Nov 1996 vol.1 issue 5 of Optical Testing Digest, a publication of SPIE available on the internet at www.spie.org Kerr cells, glass containers of nitrobenzene typically , were also used in this way as fast acting electrooptic shutters to measure the speed of light. In 1925 Gaviola used Kerr cells as described in Fundamentals of Optics by Jenkins, F. A., and White,H.E.; Fundamentals of Optics 1950 and 1976). Also Karolus&Mittelstaedt, Huttel, (see Ditchburn, R.; Light; 1953 and 1990) and later Anderson(1941, J of Opt. Soc. Amer. v31,p187). The Kerr effect 1875 and the Pockels effect 1893 became, when combined with polarizers, a way of blocking light through an electro-optic material and a polarizer unless a voltage was applied to the eletro-optic material transverse to the beam.

(How does the Pockels effect work? A laser is oriented so that a beam of polarized light of a specific, say, visible frequency from the laser is polarized at an angle of 45 degrees to the vertical and that the beam proceeds through a transparent Pockels crystal. The amplitudes in oscillations of charge in a receiver eg and observers eye, a photodiode etc. describe a sine curve of a frequency on the order of 10^{14} oscillations per second. We can analyse the oscillations as made up equally of a vertical component and a horizontal component.

We draw a sine curve that goes above and below a horizontal line on a piece of paper and then, using the rules of perspective we draw another slanted elongated sine curve of the same period that starts at the same point but that comes toward us as the first sine curve goes above the horizontal line and then slants away from us as the first sine curve goes below the horizontal line. Both sine curves have the same period but they are perpendicular to one another.

We can represent the amplitude of the first hump of the first sine curve by a vertical arrow going up and the amplitude of the first hump of the second sine curve by an arrow of the same length starting at the base of the first arrow and going to the right. The vector sum of these two arrows is a vector starting at the common base of the first two arrows slanting upward to the right at a 45 degree angle. The amplitudes of each of these sine curves decreases from this maximum together and the associated vector arrows become smaller and smaller to zero and then they reverse direction and become larger and larger until we have a large vector arrow drawn vertically downward and an arrow starting at the base of the first arrow extending the same length to the left.

The sums of these pairs of orthogonal arrows are arrows making always an angle of 45 degrees to the vertical and to the horizontal. The result is a set of diagonal vectors of varying length and direction all on a line slanting downward from the right to the left at 45 degrees to the vertical and to the horizontal.

Now suppose that a voltage is applied to this transparent Pockels crystal and that this causes the vertical component of the light beam to have a different refaction index than the horizontal component and so to appear to move more slowly than the horizontal component. And suppose that the length of the crystal is such that as the beam emerges from the crystal the vertical and horizontal components are of opposite phase. That is, when the vertical component is at a maximum (positive) the horizontal component is at a minimum (negative). In our vector representation the vertical arrow is directed upward and the horizontal arrow is directed to the left. And so the sum of these vectors and of all the others in each period of the sine waves is a family of vectors along a diagonal line slanting downward from left to right.

That is, the polarization of the light emerging from the crystal is now shifted 90 degrees from what it was with no electric field applied to the crystal.

One way of thinking about the slowing down of light or one of two orthogonal components of light in the crystal is to assume that there are primary oscillations of charge in the laser source and secondary oscillations of charge in the transparent crystal that act in concert on points beyond the crystal. These points may be an observer's eye, a photodiode, etc..

Each of the two mutually orthogonal component oscillations of charge in the eye, photodiode etc will have a phase shift from that which is observed if the light or light component was not passing through a crystal. The phase shifts of the two components are different when an electric field is applied to the crystal. The phase shifts are a function of distance from the source and the refractive index of the crystal for each component and the length of the crystal.

Typically light from the laser is vertically polarized and the mutually perpendicular axes in the crystal for which polarized components of light may move at different speeds, these axes are 45 degrees from the vertical. Applying the same argument as above, a vertical polarizer placed beyond the Pockels crystal would effectively block light emitted by the laser when the appropriate voltage is applied to the crystal and rotates the light polarization as it were ninety degrees from the vertical to the horizontal.)

The first useful Pockels cell was developed by B.H. Billings in 1949 from a crystal of potassium dihydrogen phosphate(KDP) and utilized by I.P. Kaminow in 1961 to produce the high frequency modulation needed for a broad band digital on-off modulation system(see Scientific American, June 1968, p17)

The measurements prior to that of Anderson by Gaviola used two Kerr cells, one for the outgoing light and one for the returning light To avoid the difficulty,in 1941, of matching the characteristics of the two Kerr cells, Anderson used only one. (We shall see below that there are other ways of avoiding this difficulty now.) Unfortunately to do this Anderson had to measure an interference effect and so the group or steady state velocity rather than the phase or wave front velocity. That is a light beam was sent through a slanted half silvered mirror, a beam splitter, to two different sets of mirrors and so traveled two different distances before returning in phase or somewhat or completely out of phase at the beam splitter and then passing on at some intensity to the photocell. Similar experiments were carried out by Palmer (see Amer J of Physics 1955p40-45). A later version of the experiment by Bergstrand,described in the Jenkins and White text, improves upon the Anderson method but is also a measurement of the steady state group velocity rather than of the phase or of the wave front velocity.

With the Pockels cell, modern pulse generators and oscilloscopes, it is possible to avoid the difficulty of matching the characteristics of two Pockels cell shutters and to make the more direct measurement of the velocity of light in terms of the velocity of the wave front. Of course the Pockel cell shutter speed taking less than a nanoseconds to open and close, is not as fast as the oscillation period of visible light which is about one ten thousandth of a nanosecond so direct measurements of an advance in phase etc are not possible but since the wave front or first bunch of photons are supposedly traveling a foot a nanosecond we should be able to directly observe the movement of this wave front.

Fizeau's source was an oxygen lime flame collimated by telescope lenses; his modulator was a rotating toothed wheel, a light chopper, and his receiver was the human eye. A way to overcome the shortcomings of Fizeau type experiments is to use lasers for the source and fast acting voltage controlled modulators for the rotating toothed wheel, and photodiodes in place of the human eye.

The fast response time of the photodiode can be viewed on a 500Mhz oscilloscope. The added advantage of these devices in place of Fizeau’s mechanical shutter and the human eye is that the transient increase of received light can be observed, the wave front’s, or first several photon’s, arrival as it were.

The rest of an updated version of the experiment is described at
http://www.bestweb.net/~sansbury/Pockels.pdf
with a diagram at
http://www.bestweb.net/~sansbury/sketch.pdf

Radiation and Inductance

We have now the theory and the experimental background to explain the induction of a varying or alternating current in terms of a sequence of electrostatic inductions. Lets first consider the static inductive effect of a distribution of charge along a powered wire- perhaps in the form of a coil -on a passive parallel wire or coil of the same length. There is a variation of the field in the powered wire over time and so at a distance r meters from the powered wire in a parallel passive wire a field exists and changes.

But we further assume that this force per unit charge, initially produces charge polarization inside the nuclei and free electrons of the passive conductor transverse to the initial drift velocity of the free electron in the parallel passive wire segment.

We have shown above such polarization is possible if we assume an orbiting charged particle within the nuclei and free electrons of very small mass 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. Then the force acting for the brief time between thermal collsions is sufficient to produce an elliptical orbit of the small mass such that the average center of charge of the orbiting particle is displaced from the oppositely charged central particle by a certain distance along the semimajor axis of the produced ellipse. The semimajor axis is perpendicular to the force that produces the ellipse and the velocity of the electron.

We have thus shown that a current element can be associated with an electrostatic dipole. In 1868 Enrico Betti claimed that an oscillating electrostatic dipole could be associated with a current element but Betti's dipole was colinear with the current element. Soon after the magnetic force of current carrying wires was first discovered, there were other attempts by Weber, Gauss, Riemann, Neumann, Betti and others to explain the magnetic force in terms of the electrostatic force and electromagnetic induction by electrostatic induction. Despite the importance to the logical structure of physics theory of avoiding unnecessary added premises, these attempts were discredited by Helmholtz and Clausius on theoretical but not experiential grounds.

In Maxwell's discussion of these critics and later Whittaker's and Tricker's discussions, questions arise about the validity or relevance of the Helmholtz and Clausius criticisms; but the major problem for Maxwell was the inability of these electrostatic theories to explain the well documented delay in the process of electromagnetic induction. (see Whittaker, E., A History of the Theories of Aether and Electricity, Harper and Row 1960 etc.)

But Maxwell and the others mentioned did not know as much about atomic nuclei etc as we do now. Had they known more of such things and had they had a better understanding of the light speed measurements of Roemer, Bradley, and Fizeau, the delay in the process of electromagnetic induction, might then have been sought in this direction.

The effect of transverse polarization of charge on free electrons (the effect is greatest on those electrons that have just emerged from a thermal collision) that are along a transverse line across a longitudinal segment of conductive material is a line of many dipoles about one Angstrom, apart This transverse line of transverse dipoles produces at any point on the line a transverse force per unit charge. The transient rise in the free electron drift velocity in the powered source after power is switched on and the subsequent steady state oscillation of charge in the powered conductor means constantly changing values of the field acting on the passive conductor,namely. This in turn implies changes in the transverse force per unit charge and changes in the distribution of charge within nuclei and free electrons; that is a transverse flow of charge. The result of this form of transverse current and uncancelled transverse force are longitudinal dipoles. The result is a force per unit charge in the longitudinal direction.

I will try to show in more mathematical detail how the assumptions outlined above explain and predict the alternating current produced in a receiving antenna. The source is an alternating longitudinal dipole DQsinft in a vertical powered source antenna, where $f=2\pi\omega$, produces in a parallel passive vertical antenna of length D also at time t, r meters away a field: $E_0 = DQ\sin ft/4\pi\varepsilon_0 r^3$. Note Q=neAs where n is the density of free electrons and A is the cross section of the wire antenna and s denotes the maximum displacement of charge of the average electron ie of all the free and loosely bound electrons and e denotes the charge of an electron and n denotes the density of charge in the material and $1/4\pi\varepsilon_0 = 9(10^9)$.

As negative charge builds up at one end of the antenna and positive charge builds up at the other end, the pull of opposite charge and push of ever denser similar charge on the free-to-move charged particles increases.

A rigorous argument given below shows that this imples
$E_3(t,r) = -[(1\text{-}a^*\exp\text{-}ct/r)]\ [(j)(rf/c)^2][(9)(10^9)DQ/(r)^3]\sin ft$ where c denotes the speed of light; j the relative strength of the induced current to the inducing current and DE(t) is the induced voltage at time t at a distance, r where r is many times the length,D. a* is experimentally determined.

In Maxwell's theory, e.g. as described by Richard Feynman in vol 2 eq. 21.26 of his Lectures on Physics, the first bracketed term does not occur and the field at the receiver given by the rest of the expression occurs not at the same time, t, but at, t+r/c seconds later and the factor j, explained below, equals one. That is

$$E_M(t,r)=[(rf/c)^2][(9)(10^9)DQ/(r)^3]\sin f(t-r/c) \; =(f/c)^2[(1/4\pi\varepsilon_0)(DQ)/r]\sin f(t-r/c)$$

In Maxwell's theory this value of the field is applicable to values of r greater than f/c, the so called wavelength, and for smaller values there is another expression which is the "corrected" static dipole moment at a picosecond,nanosecond, microsecond, or millisecond etc earlier before the influence of the dipole is felt a wavelength away.

The corrected static dipole field is approximately equal to the Coulomb static dipole field and is in the reverse direction of the field that after r/c seconds becomes dominant beyond a few wavelengths ("Thus so long as we are beyond a few wavelengths,(29.1) is an excellent approximation to the field. Sometimes the region beyond a few wavelengths is called the "wave zone""(Feynman's Lectures v1p29-3))

In the proposed theory, the Coulomb static dipole field is instantaneous and rapidly becomes, the larger r is, smaller than the 'Maxwell' field.

We will assume that the receiving antenna is parallel to a vertical emitting antenna, r meters away of the same length D and cross section area A and that the force on a free electron of charge,e, at time t for initial values of t is merely $9(10^9)eP\sin ft/r^3$. That is the antenna can be viewed as the sum of lots of small dipoles, es, of average length s and there are nAD of these dipoles P=(neAD)(s) where as above "n" denotes density and "s" denotes the maximum displacement of charge of the average electron and is greater, the greater the power of the antenna transmitter.

For example, suppose the unmodulated carrier power in a transmitting antenna is 100 Watts = V_{eff}^2/R and the antenna resistance is 1 Ohm so that V_{eff} =10 and I_{eff} =10 and 14.44V is the peak voltage. Also suppose the copper antenna cross section area A is $1cm^2$ and length is 10 meters =D, about. Then a 14.44V voltage difference between the ends of the antenna regarded as the plates of a momentary capacitor with charge $CV=\varepsilon_0 (A/D)V=Q=10^{-11-4-1+1} = 10^{-15}$ Coulombs. If we set QD=(neAD)s then $s=10^{-15+1-28.9+19+4}=10^{-19}$about.

The basic premise from which the proposed equation is produced is that as an electrical current varies or alternates, transverse electrostatic dipoles inside atomic nuclei and free electrons are produced by the forces producing the flow of current or free electrons. These transverse dipoles also vary and alternate. This effect produces a longitudinal force in the opposite direction of the varying Coulomb longitudinal field that rapidly becomes stronger.

There are three basic steps to the argument.

1)Ampere's formula for the force between two parallel wire segments both l meter long carrying i and I amps and separated by r meters is equivalent to the force between colinear electrostatic dipoles $(i^2/I)lr/([3^{(1/2)}][c])$ and $(I^2/i)lr/([3^{(1/2)}][c])$ perpendicular to the segments. i=nevA where v is x'(t) denoting the first derivative of x, where x(t) denotes displacement of electrons etc..

The equivalence can be generalized for all relative orientations in two complete circuits. Such transverse dipoles can be produced inside the nuclei and free electrons of a wire by a longitudinal emf acting on orbiting particles of small mass (that though unnecessary for the argument here, is shown later to be 10^{-56} kg.) . Under this influence, the orbiting particle inside such a nucleus or such an electron becomes increasingly elliptical increasing the distance between centers of opposite charge but at a decreasing rate as the elastic limit is approached. At the same time the longitudinal force produces a velocity component,v, of free electrons in the direction of the applied field.

The apparent increase in the electron's mass to infinity as v approaches c through a magnetic field is as has been noted above actually a decreasing rate of responsiveness to deflection by the field as the elastic limit characterized by c is approached.

The transverse force per unit charge produced by a chain of such transverse dipoles along a line across the width of a wire is

$E_{chain} = (p/(1/4\pi\varepsilon_0)(2/a^3)(2 + 2/8 + 2/27 + \ldots) = (p/\varepsilon_0)(.383)/a^3 = .383np/\varepsilon_0$ $=10^{40}p$ about where $n=1/a^3$ and $p = es=evjr/3^{1/2}c$ and j = i/I where I denotes the rms current in the source antenna and I=nevA denotes the rms current in the receiving antenna. (see Feynman v2 p11-6). Since 's' is not larger than 10^{-11} meters, E_{chain} is less than 10^{10} Newtons and typically orders of magnitude less. That is the force on an electron or other charged particle at a point along any such chain is eE_{chain}.

Note that the transverse field produced by a horizontal chain of dipoles inside each atomic nuclei on a horizontal line is the result of dipoles to the left and right of the atom in question giving fields in the same direction.

Note also that if we add in the effect of horizontal lines of dipoles above the line in question and below the line in question where these lines are also a distance, a, from the line in question we obtain $-.05p/\varepsilon_0 a^3$ so that in this case $E_{chain} = np/3\varepsilon_0$.

2) Hence the horizontal field E_1 at time t, due to the horizontal lines of atomic dipoles produced here by the current $I(t) = neAx'(t)$ is $E_1 = (n/3\varepsilon_0)[(jre/3^{1/2}c)x'(t)]$ where x(t) denotes the displacement of the average electron in the vertical direction at time t.

The effect of such a transverse field at any instant of time t, is to produce a displacement of charge by a distance, s_h, in the horizontal direction that exactly cancels the field, E_1. It is analogous to transferring charge from one plate of a parallel plate capacitor to the other. The potential difference of the plates becomes $E_1 s_h = V$.

Now if all of the transverse chains along the wire of longitudinal length, D, cause this to happen, you have a build up of charge dQ_h on a plate of area $DA^{1/2}$ where A is the lateral cross section area of the wire and $DA^{1/2}s_h = dQ_h$. And the capacity of the plate is $C = \varepsilon_0 DA^{1/2}/s_h$ and $CV = CE_1 s_h = [\varepsilon_0 DA^{1/2}/s_h][\varepsilon_0 DA^{1/2}/s_h]$ $[(n/3\varepsilon_0)[(jre/3^{1/2}c)(ex'(t)][s_h][s_h]$ But CV is also equal to $dQ_h = nDA^{1/2}s_h$.
So $[\varepsilon_0 DA^{1/2}/s_h][(n/3\varepsilon_0)[(jre/3^{1/2}c)(ex'(t)][s_h] = nDA^{1/2}s_h$.

Simplifying we obtain $(1/3)(jr/3^{1/2}c)(x'(t) = s_h$.And taking the derivative of both sides with respect to time we obtain the unit current in a transverse horizontal direction $(e)(ds_h/dt) = (1/3)[(jre/3^{1/2}c)(ex''(t))$

The nuclear dipole associated with this unit current is,
$p = (1/3)(jr/3^{1/2}c)(ex''(t))$ and it is transverse to the transverse horizontal dipole and so in the longitudinal direction.

The field of a chain of these dipoles is
$E_2 = [(n/3\varepsilon_0)(1/3)(jr/3^{1/2}c)^2(ex''(t))$

3) The total force on an electron in a receiver at time t at distance r can be written by adding the various forces together. That is the force of the Coulomb static dipole field, $9(10^9)ePsinft/r^3$, the restoral force on an electron displaced a distance x(t), from its equilibrium value, a thermal resistance force proportional to the speed of the electron in the direction of the applied force, and a force proportional to the rate of change of the initial speed of the displaced electron:
$9(10^9)ePsinft/r^3 - (ne^2/\varepsilon_0)x(t) - (k_2)e^2x'(t) - (ne^2/3^{3/2}\varepsilon_0)(jr/c)^2x''(t)\} = mx''(t)$
where k_2 is determined from the transverse force produced.

That is, there is a force in the transverse direction on free electrons and charge inside nuclei and free electrons; the force magnitude is from the field produced by the transverse dipoles, $(jr/c)(n/3\varepsilon_0)(e^2)x'(t)$, but it is in the transverse direction. Considering this, we can write tentatively
$k_2 = (2jr/c)(ne^2/3\varepsilon_0)$. That is, k_2x' is an apparent force proportional to the velocity of the free electrons and also to the size of the transverse dipoles because as the velocity of the free electron increases, the times between thermal

collisions of free electrons and lattice nuclei is reduced and so the duration of the longitudinal force on the free electrons; this is tantamount to saying the duration of the force remains the same but the force is reduced by a specified amount proportional to the same factors. We will see later that the specific value for the resistance that is assumed is consistent with other confirmed properties of this resistance.

We have assumed the restoral force is $-(ne^2/\varepsilon_0)x$ based on the equation of motion of a displaced electron, $mx''=-(ne^2/\varepsilon_0)x$
If we bring the negative terms of our force equation to the right of the equal sign and collect terms and divide by $m^*= m+(ne^2/3^{3/2}\varepsilon_0)(jr/c)^2$ we obtain the equation for a forced harmonic oscillator with damping:
$F/m^*=x''+(k_2/m^*)x'+(k_1/m^*)x$. where $k_1=(ne^2/\varepsilon_0)$ and $k_2=(2jr/c)(ne^2/3\varepsilon_0)$. If m^* was really equal to m, the mass of the electron as in the standard case, them $(ne^2/m\varepsilon_0)=10^{29-38+30+11}$ or 10^{32} which is the order of magnitude of the square of the plasma frequency,f_0, of metals.

But with these new assumptions, we have to add to m, $(ne^2/3^{3/2}\varepsilon_0)(jr/c)^2$ which for typical values, like $jr=10^4$ is $10^{29-38+11-8} = 10^{-6}$ or in a range typically of 10^{-10} to 10^{-4} and in any case so much larger than $m=9(10^{-31})$, that we can ignore the m term.

The familiar solution to this equation(Feynman v1p23-4), given $F=F_0\sin(ft+\theta)$ is $x=F/m^*[(f^2-(k_1/m^*)^2)^2+(k_2/m^*)^2(f^2)]^{1/2}$

This then implies a different natural frequency of oscillation that kicks in when the force is removed; namely, $f_0=((ne^2/\varepsilon_0)/[(ne^2/3^{3/2}\varepsilon_0)(jr/c)^2])^{1/2} = jr/c$. Since in the expression, $\exp-(k_2/m^*)t/2$, $k_2/m^*= c/jr$, the decay is $K\exp-ct/2jr$ times $\sin f_0t$ and the increase is $(K)(1-\exp-ct/2jr)$ times $\sin f_0t$ where $K=F/m^*$.

Thus the dominant field at the receiver in jr/c seconds is no longer the Coulomb field due to the source, $9(10^9)Pr^{-3}\sin ft$, but rather $-(fjr/c)^2(9(10^9)Pr^{-3}\sin ft)$. And we have accounted for the delay in terms of what happens in the receiver and not in the space between the receiver and the source.(Note that in our force equation $eE=9(10^9)eP\sin ft/r^3$
$= (ne^2/\varepsilon_0)x(t)+(2jr/c)(ne^2/3\varepsilon_0)e^2x'(t)+(ne^2/3^{3/2}\varepsilon_0)(jr/c)^2x''(t)$we can multiply AD/AD times the right hand side and multiply D times both sides to obtain
$eED=e[(neAD/A\varepsilon_0)x+(2jr/c)(neAD/3A\varepsilon_0)x'+(jr/c)^2(neAD/3^{3/2}A\varepsilon_0)x'']=$
$eV=e[(1/A\varepsilon_0)q+(2jr/c)(1/3A\varepsilon_0)q'+(jr/c)^2(1/3^{3/2}A\varepsilon_0)q'']$where $C=A\varepsilon_0$
$L=(jfr/c)^2(1/3^{3/2}A\varepsilon_0)$, and $R=(2/3^{1/2})(jr/c)/3A\varepsilon_0$ and $R/L = (2)c/fr$))

For example suppose the source oscillator is a radio antenna broadcasting a 1GHz carrier oscillation such that each nanosecond sine oscillation is subject to some sort of amplitude, frequency, phase shift or other modulation from the transmitter. For example each successive carrier oscillation is a different amplitude.

Suppose also that there is only one receiving antenna 2000 miles away so that after r/c=2/186.2 or approximately .01 seconds later a modulated nanosecond sine oscillation followed by others are detectable and amplified.

More specifically, the emitting antenna of height D produces a succession of electrostatic dipole fields where the dipole moment is the (DneAx)sinft where x denotes the average displacement of an electron in the source antenna at time t.

These forces comprise a constantly changing longitudinal force on free electrons in the receiver so that between thermal collisions, these electrons are caused to move in the direction of force and at the same time transverse charge polarization is caused inside the nuclei and inside,the free electrons.

One of the implications of the proposed theory is that the delayed signal is stored not in the space between the emitter and receiver but rather in the atoms of the receiver antenna. And of course there is a finite number of these atoms (10^{23}per cc approximately) and this limits how long the delay can be.

For this storage and increase of signal we require a feedback mechanism and a storage and separation mechanism between successive voltage changes and their feedback increases so that the received voltages and changes in voltage do not disturb the increase of previously received voltages and changes in voltage and that none of these disturb each other.

The feedback mechanism is that the change in transverse dipoles produces longitudinal dipoles and changes in longitudinal dipoles produce transverse dipoles.

The separation and storage mechanism depends on the fact that the forces, say the force from the applied field, produce the largest effect on electrons and lattice nuclei that have just emerged from a collision.

Also that the combination of many of these along say a single chain of lattice ions produce a field that is more enduring than the field of a single dipole that lasts only for the 10^{-14} seconds or so between thermal collisions.

A pair of adjacent horizontal dipole chains would have a negligible influence(see Feynman v2 ch11) on each other but gaps in a chain would permit the chain field to produce a longitudinal dipole in the gap and the longitudinal dipole would exert a force on the next particle in its column in the adjacent horizontal chain of transverse dipoles that would increase a transverse dipole.

Some such specific mechanism could produce the feedback mechanism leading to increases in the dipoles associated with the initial voltage change due to the source.The next influence from the source would be weaker than the fields produced in this pair and have a neglible effect on this pair but on other particles with lesser dipoles etc the effect would be greater.

And so a sequence of partial pairs of rows would develop; all independently of one another and increase to threshold in the order in which they were initiated and according to the equations developed above and so consistent with Maxwell’s prediction.

The resultant force in the receiving antenna is the sum of the forces from the source antenna and this induced Maxwell force and after a while the induced Maxwell force is much greater.

For example, a 10MHz carrier oscillation from a satellite, 22,500 miles away, ie from a geostationary satellite, would not rise above noise in the receiver on Earth before .12 seconds after the time of emission. That is,ten million successive amplitude or phase modulated carrier oscillations occur in the source in each successive second and they produce these varying fields at the receiver which produce a stronger reverse oscillation in the receiver according to the mechanism described above. And these fields at any instant produce a stronger effect on free electrons just emerging from a thermal collision than on free electrons acted on by the field at a previous instant..

Maxwell's formula suggests that the energy given off by the oscillator is always the same at successive distances, r. That is the same total energy is spread out more thinly over imaginary spherical surfaces of imaginary spheres of successive radii, r. This suggests that the energy flowing from the source does not diminish. According to later developments of Maxwell's theory, the energy moving per second out of an imaginary surface of $1cm^2$ area for example through a thin layer of even a vacuum is less than the energy moving in, so that in this sense some energy is absorbed -by the expansion of space as it were.

The energy flowing per unit area per unit time is shown to be $(c\varepsilon_0)(<E_r^2>)$ where $<E_r^2>$ is the time average of the square of the electric field during a complete oscillation at a distance r from the source. The proof of this, originally by Poynting, is described in Feynman's Lectures on Physics v1 sections 30 through 32 .

The new proposed formula, however, implies that the energy of radiation from an oscillator is absorbed first inside the atomic nuclei and free electrons of various intrinisically responding surfaces and antennae and then after r/c seconds for various r less than some still undetermined value, the oscillations of charge are transferred to the oscillation of free electrons relative to the lattice nuclei. This results in a detectable oscillation of charge distinct from noise at these various distances r.

The responding surfaces, but not a hypothetical surrounding aether, absorb and may reflect or scatter to an antenna under consideration so that the energy available at this antenna is less but that would mean that the amplitude of the oscillation of charge in the source has decreased and this loss of energy has not been made up by the transmitter.

But the amplitude of charge in the receiver antenna is q*D*=V*/R where D* is the length of the receiver antenna

Now the energy accumulated in the antenna after r/c seconds according to the proposed theory is about r/c times $<E_r^2/2$ and the energy delivered over this time according to the Poynting Maxwell theory for the first r/c seconds is zero but for the next r/c seconds is (r/c times $(c\varepsilon_0)(<E_r^2)$). However according to the proposed theory the energy is the energy expended in the oscillator against the thermal resistance of the antenna and the energy delivered to the antenna as it were during this time is just r/c times $<E_r^2$.

Thus in the proposed theory, the objections to Maxwell's theory as being unable to explain the photoelectric effect are avoided. As Richtmyer says in Introduction to Modern Physics 6th ed. P.162: " ..the time required for a photoelectron to absorb the maximum energy of emission $mv_n^2/2$ from faint light of sufficient intensity [and of the right frequency] from sodium would be more than 100 days. The situation is improved if the electron is assumed to vibrate inside the atom in exact resonance with monochromatic light , since it can be shown that the electron can then manage to absorb as much of the incident energy as falls upon a considerable fraction of a square wavelength. Even so however the calculated time exceeds 1 min.. Thus if the electron obtains its energy by an ordinary process of absorption, there should be an appreciable lag between the beginning of illumination and the start of the photoelectric current. Precise measurements showed, however , that, if such a lag exists, it is less than 3nanoseconds. [presumably at distance of a meter or less from the source]"

According to the proposed theory, the oscillation of charge initiated by the faint light begins instantaneously inside loosely bound sodium electrons or those of some other photoactive material and after enough repeated oscillations for a given distance from the source, produces oscillations of one (or more) of the loosely bound electrons as a whole of sufficient amplitude to escape the surface of the material

That is according to the proposed theory, with a smaller charged mass than the electron, inside the electron, and an earlier initiation of the process of energy absorption, we explain the mechanism of photon absorption which the quantum properties of the photon did not. And in fact there is no need to assume a particle with the quantum properties of a photon. And so no need to believe in a God who plays dice, which of course was Einstein's objection to quantum mechanics in general.

Regarding visible light Q above is n*e and D is about 10^{-9} meters and n* is the total number of electrons involved; This follows from the energy hf* of a photon of frequency, f*= 10^{14}, where h=10^{-34}, being equal to the kinetic energy of an electron of mass 10^{-30} about so v^2=hf*/m=$(10^5)^2$. If we think of the electron in a circular orbit then $(2\pi r)/v$ =1/f* implies 2r= D=10^{-9} approximately. The oscillation occurs within molecules excited by other radiation, thermal effects, etc.; the orientation of the oscillator can be vertical, horizontal or anything in between. Similarly for other frequencies.

Regarding photons then for any polarization and for any degree of coherence from a specified point, there corresponds an oscillation as specified above. I understand that the human eye can detect short bursts of 10 photons. Photomultipliers can be shown to detect single photons as a consequence of a single electron ejected from a photoemissive surface generating 10^9 secondary electrons in 2nsec which then produces a current of .5 times 1.6 times $10^{(9-19+9)}$ Coul/sec which times 50 ohms is 4 volts produced across a 50ohm resistor which can be viewed on a 500MHz oscilloscope. This is the other extreme of the intensities used in the laser Pockels cell experiment suggesting light is the cumulative effect of instantaneous forces.

Since R=(1.7)(10^{-8})D/A for a copper wire of length D meters and cross section area A meters^2 as in this example but not carrying a alternating current instead carrying a direct current, it follows that (r/c)(2/3)(1.1)(10^{11})=(1.7)(10^{-8}). which is approximately the case if r = (the distance between lattice ions in copper) = $10^{-9.65}$. That is as current increases in the filaments of the passive antenna the proximity of the parallel currents in the same wire increasingly inhibits the expansion of transverse dipole lengths inside the nuclei and free electrons of neighboring filaments in the same wire.

We have discussed above the principle of superposition of electrostatic forces as applied to the effect of current carrying wires at various distances from one another on the expansion of transverse dipoles in each of the current carrying wires. In this context our previous discussion suggests that the effects of distant transverse dipoles associated with a radiation source on a passive conductor are initially dominant but as the current increases in the passive conductor the filaments in the conductor have an increasingly stronger effect. But at all times the total effect of various influences on the passive antenna and the filaments of current in the passive antenna is the sum over each of the individual influences taking into account their relative strengths; Their strengths being greater the closer they are and the stronger their current flow.

In the case of two parallel direct currents in wires separated by a few millimeters or centimeters the transverse dipoles in the two wires ri1/c and ri2/c are superimposed on the dipoles produced by the filaments within each wire on one another and determining the currents. That is we can consider the effect of the parallel filaments in the same wire on one another to have occurred; the time between collisions based on this effect has been determined without taking into account the effect of a second wire r meters distant say a few millimeters or centimeters, and carrying current of say a few hundred milliamps. Since the principle of superposition applies to electrostatic forces, the effect of the parallel filaments in the same wire combined with the effect of a second wire r meters distant is the sum of the two effects. If the effect of the parallel filaments has already been determined then to obtain the combined effect we need only apply the second effect to the results of the first effect.

In the proposed theory of inductance applied to the case of two widely separated wires the cause of an induced current is cumulative longitudinal charge polarization in the nuclei and free electrons of the passive wire opposite to the varying static fields from the powered wire. What happens in the case of parts of one and the same wire acting on one another in a similar way?

Notice that when the cross section area A is approximately $(3.1416)(r/2)^2$ - as if one side of one wire one meter long was interacting with the other side of the same wire - that
$L = ((9)(10^9))(1/3.14)(1/9)(10^{-16})(1/3)(.88)(10^{11}1) = (.3)(10^{-7})$. This value is very close to the standard value for self inductance in a straight wire one meter long $(1/2)(10^{-7})$ Henrys per meter derived from Maxwell’s equations assuming a uniform distribution of current in a wire; ie no skin effect which increases at high frequencies in which case the current is concentrated at the outer rim of the wire. Note the proposed value for the inductance is based on the same parameter, namely the ratio of the electrostatic force to the speed of light squared here in mks units.

By changing the capacitance and inductance of the passive antenna or a secondary antenna circuit coupled to the passive antenna we effectively change the length and so the natural frequency of oscillation of the passive antenna. The effective length factor is common to the specific resistance,capacitance and inductance components of the passive antenna. In determining the time constant R/2L or RC this factor cancels. However if we change the resistance without changing the effective length factor common to the resistance and to the inductance and capacitance then of course this factor does not cancel and the time constant as in the wide variety of time delay circuits can be any other value

The above theory can be regarded as an alternative interpretation of Maxwell's theory that allows other delays; namely, that the c/r second delay in the arrival of light from a source r meters distant may be much less depending on the surrounding 'magnetic' fields and the intensity of the source relative to that of the receiver(during the transient increase of intensity in the receiver as well as the steady state). That is there is from the instant of exposure some degree of oscillation in the receiver due to the source, a weak but repeated pushing and pulling of charged particles in opposite directions in the receiver due to the source which rapidly produces an increasing amplitude of oscillation in the receiver if not opposed by opposite phase random thermal oscillations at the same frequency known as Johnson noise.

The means of storing and accumulating the energy of the repeated pushing and pulling due to the source has been described. The amplitude does not increase indefinitely according to this description but over a limited period of time to a maximal value above or below a threshold of measurement or observation. This proposed process is consistent with the measurements by Fizeau, Foucault, Cornu, Young, Forbes, Newcombe, Michelson and others of the delay in the transmission of light using interrupted light beams over distances of 20 meters to 22 miles where the perceived intensity of the source decreased with distance as did the delay times from 60 nanoseconds to 120 microseconds.

If we extrapolate, the same increase of delay as a function of distance, to the stars, we cannot require of course constant exposure. But if we could account for the increase of delay in terms of the perceived intensity of the source due in part to distance and in part to the intrinsic strength of the source, we would require constant exposure; which however might not exceed, typically, a fraction of a second for visible light but which could be several minutes as in the case of ccd images of a specific direction in the sky where the telescope camera is made to move opposite to the Earth's movement to remain focused on the desired direction.

The Doppler shift of spectra formed from the light of stars is used to determine the distance to the stars. The question arises: Can you make meaningful Doppler shift measurements if light delay at distances beyond $c=2.994(10^8)$ meters/sec times one second increases asymptotically to some limit so as not to exceed 1 or a few seconds? The answer is yes because the mechanism described above that produces the delay also produces a shift in frequency if the distance between source and receiver is changing at a specific rate.

The (1+v/c)(f) Doppler shift of 'f" for electromagnetic radiation from a transmitter to a receiver in relative motion, v, can be explained in terms of the effects of this motion on the production of transverse dipoles inside the receiving antenna. That is, increasing(decreasing) transmitter-receiver distance will decrease(increase) interference with the production of transverse dipoles by the oscillating field in the receiver in proportion to this speed v=dr/dt..

The transverse dipoles are produced by forces acting tangentially on orbiting charges inside nuclei and free electrons.

When such forces act at right angles, e.g., the movement of the antenna is at right angles to the oscillating electric field inside, then there is a reduction of an elliptical tendency by a circular tendency. That is, the oscillating applied field produces smaller dipoles or larger dipoles than otherwise as the receiving antenna moves toward or away from the transmitter etc..

Thus, to obtain the transverse dipoles produced in the receiving antenna by the field of the transmitter, $K=K^*sinft/r^3$, f=2pif*, instead of r/c times dKsinft/dt = Kfcosft, we have a(v)r/c times Kfcosft where a(v), when the receiver is moving away at speed,v, produces a dipole per unit velocity less than r/c, the less so the greater v is. When the receiver is moving toward the transmitter at speed v, this means a dipole per unit velocity greater than r/c, the moreso the greater v is.

One function that satisfies these conditions is a(v)=(1+v/c) where it is understood that v is negative and the dipole per unit velocity is less than r/c when the receiver is moving away from the transmitter.

If we write (1+v/c) inside the original sine function as something multiplied times f, and then take the derivative of this sine function as in the case where the transmitter and receiver are stationary and multiply this by r/c, we obtain the desired change in r/c and if we take the derivative again and multiply this by r/c we obtain the desired frequency shift and the observed Maxwell amplitude but without assuming waves in a massless medium or probabilistic photons and without assuming that the reason for the Doppler frequency shift of em radiation is the same as Doppler’s explanation of the frequency shift of sound waves in air or water etc..

That is, the operation r/c times the d()/t gives first transverse dipoles (and current) associated with the changing Coulomb field from the transmitter. And repeating this operation on the current and transverse dipoles gives longitudinal dipoles and a longitudinal field that is opposite to the original field and magnified $((1\text{-}v/c))^2$ times r^2/c^2 times the original Coulomb dipole field.

Thus, we can assume that the r/c delay is never more than a second even if the distance is numerically much larger than c, say r=1000c, and that the frequency shift, say for the case of the receiver moving away from the transmitter, is not due to an increase in an r/c=1000 second delay for example to (r+vt)/c=1000.01 seconds but due to the effects described above.

Maxwell and his generation might be forgiven for not considering that the delay in the speed of light might have nothing to do with the movement of a particle or wave front through space but rather have to do with interactions with inert matter on an atomic scale. Although by 1860 the atom and its constituents were gradually becoming familiar concepts and factual, such entities were not comfortably grasped. And thanks to Roemer and the wave-like and moving-particle-like properties of light discovered by Newton, Young, Fresnel and others, there was no longer any habit of thought resembling Aristotle's idea. Aristotle's idea was that light was instantaneous like water turning to ice everywhere at once. Aristotle’s Arabic disciple, Alhazen improved upon this idea by saying that only the interaction of light with matter as in the eye involved a time delay but that there was no time delay in the movement of light from its source to the observer's eye. See for example A.I. Sabra's book Theories of Light from Descartes to Newton. Cambridge U Press,1981)

In the standard Maxwell Lorentz theory of electromagnetism, electric force fields and magnetic force fields are very closely related. But from what we have said, the relationship is even closer than Maxwell envisioned. The magnetic force though an apparently separate force is a form of electrostatic force.

According to Maxwell, a changing electric field produces a magnetic field ie a changing magnetic field which in turn produces an electric field ie a changing electric field and these fields are radiated through space at a speed, the speed of light, which characterizes the relationship between these two basic forces in this context ie the elasticity and inertia of the aether medium in which these force fields are radiated.

Maxwell updated Descartes' vortices into an invisible massless machine of small and large ball bearings that transmitted the forces from the source antenna to the receiver- more slowly than Descartes' vortices (But ironically according to Descartes the speed of light was infinite.) The speed of light according to Maxwell was equal to the square root of the ratio of the elasticity to the inertia of this invisible massless material or machine which in turn was equal to the square root of the ratio of the electromagnetic force to the electrostatic force.

But we see now that the relationship between the electric and magnetic force and the effect this has on the speed of light is not mediated by the aether but by the charged particles inside the atomic nuclei and free or loosely bound electrons in the emitter and the receiver. It is the inertia of these particles and the elasticity of the orbital systems of which they are a part that determines the relationship between transverse and longitudinal electrostatic forces that Maxwell was trying to describe in terms of electric and magnetic fields.

THE MAGNETIC EFFECTS OF GRAVITY

The linkage between gravity and electrical forces as formulated here is related to the linkage formulated differently in other theories including Einstein's general relativity. Before discussing General Relativity and other ways of interpreting the data confirming it, I think it is interesting to note the historical interest in such a linkage which culminated to some degree, before Einstein's general relativity in the work of Mossotti, Zollner and Debye on polar molecules and the attraction thereby of neutral particles suggesting that the gravitational force between neutral particles might be ultimately due to electrical causes .

In his 1882 book, Explanation of Universal Gravitation through the Static Action of Electricity and The General Importance of Weber's Laws, Fredrich Zollner writes, in the introduction,. "... we are to conclude that a pair of electrical particles of opposite signs, i.e. two Weberian molecular pairs attract each other. This attraction is Gravity; it is proportional to the total number of molecular pairs." Now one could regard the molecular pairs as polar molecules as described by Debye or one could regard them as part of the then less well understood atomic nuclei and free electrons in the current carrying wires. Elecrostatic dipoles inside these free electrons and atomic nuclei have been shown as a possible explanation of the magnetic forces between current carrying wires following the formulations of magnetism by Ampere and Weber in terms of infinitely small current elements or wire segments. More recent proposals of linkages between gravity and electrical forces are as follows:

Immanuel Velikovsky in Cosmos without Gravitation (1946) repeats - without attribution - Zollner's theory: "Gravitation is an electromagnetic phenomenon. There is no primary motion inherent in planets and satellites. Electric attraction, repulsion, and electromagnetic circumduction govern their movements.......Each atom is made up of positve and negative electricity and though neutral as a whole may form an electric dipole when subject to an electric force. Thus, in the theory presented here, this attraction is not due to "inherent gravitational" properties of mass but instead to the well known electrical properties of attraction. Two dipoles arrange themselves so that the attraction is stronger than their mutual repulsion....The cause of the Earth's magnetic field is in the magnetic field of the Sun, and the rotation of the charged Earth around its axis." Velikovsky refers to a large number of inadequately explained atmospheric phenomena. But one is left with the impression that he is simply not aware of some existing explanations. One interesting reference is to Laplace who "calculated that in order to keep the solar system together the gravitational pull must propagate with a velocity at least fifty million times greater than the velocity of light." (I would like to thank the Velikovsky society, and in particular Wal Thornhill and Gunnar Heinsohn for showing me Velikovsky's and Zollner's books on these matters.)

We will see later that the electric dipole theory of gravity avoids both this problem and the General Relativity solution to this problem.

V. A. Bailey In the May 14, 1960 issue of Nature writes
" It has been found possible to account for the known orders of magnitude of five different astronomical phenomena and the directions relating to three of them. By means of the single hypothesis that a star like the Sun of mass M grams carries a net negative charge, -Q, which is given by the formula: $Q=.03MG^{1/2}$. [For example the maximum energy found for a primary cosmic ray particle.]" Bailey acknowledges in subsequent issues of Nature in 1960, minor problems with the hypothesis but argues that it is generally valid for the Sun at least. Recent astronomy texts I have looked at perhaps are unaware of this relation but simply describe the phenomena in terms of the great electrical activity and of the strong varying magnetic field of the Sun.

Velikovsky's approach is more intuitive and scholarly than mathematical and experimental but.both Bailey and Velikovsky make a strong case that the gravitational and magnetic fields as presently formulated do not adequately account for certain features of cosmic ray activity and atmospheric phenomena that require enormous concentrations of charge and enormous differences in electric potential.

P.M.S. Blackett In the May 17, 1947 issue of Nature writes of the Magnetic Field of Massive Rotating Bodies: "It has been known for a long time, particularly from the work of Schuster, Sutherland and H.A. Wilson, though lately little regarded, that the magnetic moment P and the angular momentum U of the Earth and Sun [and then recently the star 78 Virginis] are nearly proportional, and that the constant of proportionality is nearly the square root of the gravitational constant, G divided by the speed of light ,c."

Blackett first noticed this while considering the influence of the magnetic field of stars on cosmic ray activity. The importance of cosmic rays and magnetic field disturbances on communications and radar surveillance during World War Two stimulated interest in these matters. But prior to this time and even now the regard of geologists and astronomers for this relationship was and is surprisingly indifferent and it does not appear even in their texts or recent general physics texts that I have seen. Blackett suggested a laboratory test using a bronze sphere of 1 meter diameter rotating at 100 r.p.s. which should give a field of about 10^{-8}Gauss, which modern devices like the SQUID for measuring weak magnetic fields could reveal and perhaps already has. T.Gold in a later issue (April 2, 1949) of Nature represents the opinions of Runcorn and Hoyle that the difficulty in entertaining the hypothesis was that there was "no physical quantity which might be related, by way of a new law, to the magnetism of large rotating bodies."[Perhaps the proposed radially and longitudinally oriented electrostatic dipole in the atomic nuclei is the unknown missing quantity.]

A related phenomenon might be the following(from the New Scientist (2/14/80 p485): "In one [of Henry Wallace's-US patent 3 626 605] kinemassic machines a pair of wheels of brass alloy, like giroscopes are rotated at a speed of 20,000/60 r.p.s. [and then at the same time] rotated about another axis [at some unspecified speed]... [the wheels appear to be propelled upward or become lighter]" I am told but I do not have the references that other evidence of gravitational anomalies of spinning objects has been obtained by DePalma, Kidd, Strachan, and Laithewaite. The Hyzer angle of frisbees and sinker pitches in baseball also may be related phenomena.

P.S. Wesson in Phys Rev D v23 p1730 (1981) derives a relation similar to the one of Wilson that Blackett describes, namely that the angular momentum of planets stars and galaxies divided by the square of their masses is approximately constant and equal to 10^{-17} meters squared per sec per kilogram. This suggests a common centripetal acceleration from zero, a common force, associated perhaps in analogy to other forces, with an agent, with a Prime Mover.

The basic idea here is that gravity may be due to radially oriented electrostatic dipoles inside the Earth's atomic nuclei; the negative pole, with some multiple of the electron's charge, is the inner pole and the outer pole has enough positive charge so that the total charge is that of a proton; the distance between oppositely charged poles is between 10^{-12} and 10^{-18} meters inside the Earth's atomic nuclei; the value of each dipole increases with the distance between it and all other dipoles so the force between any two dipoles is proportional to the distance between the dipoles squared taking into account their relative orientation; this means that the instantaneous dipole-dipole force which varies inversely as the fourth power between colinear dipoles reduces to an inverse square force; the different sizes of dipoles determined by different pairwise interactions and their different forces when summed together over all pairwise interactions yields a single force and implies a single unique dipole in each nucleus intermediate to the pairwise extremes given above and closer to the measured values of nuclear radii in different contexts, approximately 10^{-15} meters.

From this premise, it is possible to derive all of the substantiated predictions of General Relativity, most of which have to do with the explicit interaction of gravity with electrical and magnetic forces; it is possible to derive these predictions without recourse to Einstein’s assumption of a plastic deformable space-time or to Maxwell’s assumption about a mechanical aether or later versions of these Medium theories. We do so by assuming instead that there are properties of objects in motion which change as their motion changes; then the forces due to these objects also change. But these forces, as Newton assumed about gravity, can be assumed to act instantaneously at a distance.

The advantage of this approach is that non intuitive implications of the ‘Medium’ theories can be avoided. Of course force at a distance is non intuitive also though to a lesser degree. We are familiar with effects of magnets on nails and the relation between Newton’s falling apple and the orbital movement of the moon about the Earth. We are less familiar with things that have the density of iron and yet are invisible, a property ascribed to the medium which supposedly transmits electromagnetic radiation. That is, an invisible medium that is responsible for a delayed force is no more counterintuitive than the invisible contact or lack of contact between objects which exert forces on one another. But if the invisible medium besides being invisible has the density of iron then a greater degree of counterintuitiveness is introduced.

The standard answer to such criticisms of Maxwell’s aether and Einstein’s deformable space-time is that the mathematics makes correct predictions. And the reply to this is that we can make the same predictions with a lesser degree of counterintuitiveness. Maxwell’s invisible cams and ball bearings for propagating the electromagnetic field could be ignored so long as the mathematics describing the mechanism was retained- like the grin of the

Cheshire cat in Lewis Carroll's Alice in Wonderland also a figment of the 1860s imagination.

But one can't accept Maxwell's mathematics and ignore the degree of counterintuitiveness implied. The mathematics predicted the observed radiation but it also implied a mechanism for transmitting the effects for which there is no independent evidence. And worse, the medium of transmission is invisible but has the rigidity of iron. Such absurd implications were swept under the rug; not until Feynman's QED modification of Einstein's photon theory and a probabilistic theory of light and its interactions with matter was the problem at least partially resolved -by substituting probabilistic photons for waves at all frequencies. I say partially because probability is just another word for a lack of an adequate model or theory. Feynman’s probabilistic theory could consistently represent if not explain, the wave like interference effects of light and the way light appeared to bend around corners.

In Maxwell's wave theory, the fact that the source of a radiated force, a moving charge, was oscillating in a repetitive pattern helped; just like the regular pattern of planets orbiting the Sun and the solar system orbiting the center of the galaxy etc helped Einstein's GR theory of wrinkles in space and time that can only be perceived indirectly.

Awkward implications of the Young-Maxwell wave theory can be avoided without Feynman’s clever circumlocutions that permit some general description of the interaction of light with matter but prevent one from knowing the specific interactions of specific photons or their source with the receiver. How? One acknowledges that light is not a moving entity, but the result of many successive cumulative instantaneous forces at a distance on charged matter whose inertia delays the appearance of received radiation. Then the interaction of light with matter can be described in terms of what actually happens and not merely probabilistically.

Is such a theory of light consistent with measurements of the speed of light? Yes as we have discussed at length earlier. For example, in all but one case the observed values can be so interpreted; the exception is Roemer's crude measurement which is far enough from the other values to be regarded as a non coincidence. Roemer's measurement also involves inconsistencies when measurement of moons of Jupiter besides Io, eg Europa, are taken into account.

The counterintuitive implications of GR also can be avoided by finding an alternative to the assumption that the gravitational field is a function of the velocity and the acceleration of the source of the field. This alternative is the assumption of charge polarization inside atomic nuclei to explain the gravitational force. Support for this assumption is given below. This assumption as shown below implies 1) a greater degree of charge polarization on the side of the Earth facing the Sun and so a greater delay in the reception of radiation. 2) a torque between planets and the Sun. And so the apparent bending of light and frequency shifts of radar due to the Sun, of gamma rays due to the Earth, etc., and the precession of Mercury's perihelion are explained without the premise of a plastic space-time. Since one does not observe distortions in space time in ordinary experiences, it is counterintuitive to postulate such distortions and non Euclidian geometries in these less common experiences.

Getting back to the basics of the proposed alternative theory. The electrostatic dipoles proposed to explain gravity also exist in larger measure inside current carrying wires, transverse to and proportional to the driving force of the current, more specifically inside the atomic nuclei and free electrons of current carrying wires formerly characterized as their spin. These dipoles which also increase with the distance between interacting wires and decrease with the currents in other wires as explained below produce the magnetic field of a current carrying wire. (Experiments suggesting that electrons and atomic nuclei do not have electrostatic dipoles do so only after the effects of spin have been taken into account; but as we shall see the magnetic effects ascribed to the sum of spin and orbital motion can be ascribed to one electrostatic dipole transverse to the motion of the electron; note there are two orthogonal transverse direction components

These dipoles are superimposed on the dipoles associated with gravity to produce a net dipole. The net dipole has a non zero component along the plumb line or radius toward the center of the Earth unless an applied magnetic field acting on a nail, for example, is just strong enough but not too strong so that the net component in this direction is exactly zero. If the magnetic field is stronger, the nail has a negative dipole component in this direction and rises upward say to the magnet.

Electrostatic dipoles in the atomic nuclei of ferromagnetic materials can also explain the magnetic field of these materials; unlike materials composed of any of the other elements, the atoms in these materials are connected by their orbiting electrons moving in around adjacent nuclei in configurations that prevent to some extent the nuclear dipoles from changing direction so as to line up with the gravitational field of the Earth of which they are a part; that is they prefer to line up with the nuclear dipoles around them in the same domain or in the entire bulk material of which they are a part.

To make the nuclear dipoles in such magnetized materials line up completely with the gravitational field of the Earth it is necessary that the bulk material containing the nuclear dipoles also changes orientation - as in a compass needle. When the magnetic material is unmagnetized, the dipoles in each domain are similarly oriented but neighboring domains are differently and randomly oriented so that the net effect is zero. No single domain can move in bulk because the neighboring domains prevent them from doing so, the nuclear dipoles in these cases realign themselves to be aligned with the radial and longitudinal dipoles of the spinning Earth.

Now a magnetized piece of iron or steel held below a piece of paper with iron filings on it can cause the iron filings to line up in a certain way giving rise to Faraday's notion of invisible lines of force; a piece of copper, silicon or what have you, will not be able to produce the same effect on the iron filings; the reason for this is that the electrostatic dipoles in the nuclei of silicon and of these other materials change direction constantly so as to line up with the Earth's radius from these atoms toward the center of the Earth etc; The force of gravity can be shown to be nothing more than the collective force of an enormous number of such electrostatic dipoles.

The Argument: 1) We argue that the spin of electrons and nuclei can be better characterized in terms of charge polarization inside the electrons and nuclei;

2)That electrostatic shielding involving the relative displacement of free electrons and lattice ions in conductive materials producing a relatively large dipole does not shield against the effects of the much smaller relative displacements of charge inside the free electrons and lattice nuclei of such materials when they are carrying a current, ie their so called magnetic effects;

3) That the electrostatic dipoles causing the gravitational effects of satellites, planets, stars, galaxies, clusters, superclusters etc were produced by a primordial force whose initial effect was the forward motion of the atomic nuclei within a large collection of nuclei and charge polarization transverse to the forward motion and subsequently a torque on these collections of transverse electrostatic dipoles which moved together causing the galaxies etc to spin and spin off stars and stars to spin off planets and planets to spin off satellites etc.;

4)That the attraction of planets to the Sun requires a dipole inside nuclei tracking the Sun in addition to the one whose orientation is constantly changing so as to be directed toward the center of the planet. Similarly for the Sun's attraction to the center of the Galaxy, for the Galaxy's attraction to the center of the Universe or for some other center etc. until the Center of centers is reached.

5) That Cavendish's measurement of the horizontal gravitational force between lead balls is due to the attraction between the transverse component of radial oriented dipoles inside the atomic nuclei of the attracted balls; that to sustain the dipoles in the atomic nuclei of planets and stars, the transverse dipole component fields may sustain one another; that is the radial and longitudinal dipoles transverse to a force in the latitudinal direction produce fields at right angles to one another; hence the longitudinal dipole field can produce a radial dipole and the radial dipole field can produce a longitudinal dipole and thereby the radial and longitudinal fields can be selfsustaining (Note in Newton's theory the radial force of gravity comes first and the orbital motion of the Earth is due to this force and to a uniform velocity that was assumed always there or produced by a First Mover who then went away.

Here we are assuming that a primordial force was partitioned into ever smaller circular movements and forces and that the force causing the Earth to orbit the

Sun and spin is a part of this total primordial force. Gravity then comes second and results from the dipoles produced by this force on particles held in orbit by electrical forces; The resulting dipoles may be self sustaining or the primordial force, perhaps initiated a finite number of years ago with a big explosion remains, however far removed from the Earth, and acts to sustain the Hubble accelerative expansion and may act directly and constantly to sustain the electrostatic dipoles inside every atom after thermal collsions.)

6)That Einstein's explanation of the bending of starlight by the Sun etc can be otherwise explained in terms of a small relative delay in response to electromagnetic radiation due to the greater residual dipole in atomic nuclei on the side of the Earth facing the Sun; the red shift of radar reflections from planets could be attributed to the same delay. The precession of the perihelions of Mercury and the other planets could be explained in terms of the torque exerted on the planet’s dipoles by the Sun’s dipoles.

Reviewing the magnetic effects of current carrying wires: Electrostatic dipoles inside atomic nuclei and free electrons can produce the magnetic force observed between parallel (or however oriented) current carrying wire segments r meters apart where the currents are nevA and nev'A' say. The Amperian force per unit length between the two parallel current segments then is 10^{-7} times (nevA)(nev'A) divided by r^2. which could also be written as (9 times 10^9 divided by $((3)(10^9))^2$) times (r)(v/v')(nevA)(r)(v'/v)(nev'A') divided by r^4 which is the force per unit length between nA and nA' electrostatic dipoles; this force is larger the greater r is and the greater v is compared to v' etc..

That is the electrostatic dipoles are in part due to the emf causing the speed, v, of the electron and in part due to the lack of interference from other such dipoles in a parallel wire for example. When the current in one wire is much larger than the current in another wire, the interference effect on the smaller current is greater and so the increase in its dipoles is less than the increase in the dipoles in the wire carrying the larger current. The expansion of the dipoles inside the atomic nuclei and free electrons can be represented as K(S)res and k(s)reS where K(S) is the ratio of S over s+S or over s; k(s), similarly. The mechanism for the expansion of the dipole can be described in terms of the elliptization of an orbital system ie of an initially circularly orbiting particle made to move in a transverse ellipse perpendicular to an applied tangential electrostatic force at some point on the orbit.

The assumption that there is only one orbiting charge and that the the magnitude of the charge being polarized is that of a single electron or positron can be modified; the general assumption is that the proton consists of a negative charge of -ne and a positive charge of +(n+1)e where n is a positive integer so that the net charge is as observed.

It might be helpful to repeat some earlier arguments regarding the question why electrostatic shielding is not effective in shielding against magnetic fields; the answer is that a large number of similarly oriented small electrostatic dipoles inside the nuclei and free electrons of a piece of metal produce entirely different fields than an excess of free electrons on one side of the piece of metal and a deficiency on the other; that is the dipoles in parallel current carrying wires attract the dipoles in both the free electrons and atomic nuclei in the other wire and this force is stronger than the force of the dipoles on the electrons and atomic nuclei as point charges. This was shown mathematically as well as by the experiments cited previously. The mathematical argument in summary is that the dipoles are proportional to the distance r between the wires so that the inverse fourth power dipole force becomes an inverse square force. This force is greater and more effective than the dipole - point charge force between dipoles and electrons or positive ions which acts in opposite directions on the electrons and positive ions etc..

We discussed earlier the arguments regarding the uniqueness of dipoles inside nuclei involved in many pairwise interactions. Namely that each pairwise force between one wire segment carrying current i(1) and many other segments would imply different dipoles associated with the same segment; Now it is true that a dipole inside one wire segment cannot at the same time be the product r(1,2)s(1) and also r(1,3)s(1) where s(1) = i(1)/c and the distance between segments 1 and 2 denoted r(1,2) is not equal to r(1,3), the distance between segments 1 and 3. But the actual dipole involved here, r(1)s(1), where r(1) is yet to be determined is equivalent in its effects to the sum of dipole-dipole forces involving different dipoles for the same wire segment The mathematical procedure for determining r(1) etc and the unique dipole r(1)(s(1) etc is as follows: The force on the first of three current carrying wire segments due to the other two is $[ks(1)s(2)r(1,2)^2]/r(1,2)^4$ +[ks(1)s(3)r(1,3)^2]/$r(1.3)^4$ where k denotes a constant of proportionality and the other terms are as defined above.

We set this expression for the force equal to another expression, in terms of unknowns to be determined, for the same force,

Namely, $[ks(1)s(2)r(1)r(2)]/r(1,2)^4+[ks(1)s(3)r(1)r(3)]/r(1,3)^4$. Note this equivalence will only be valid if $r(1)r(2)=r(1,2)^2$ and $r(1)r(3)=r(1,3)^2$; that is if $r(1)=r(1,2)^2/r(2)$ and $r(2)=[r(1,3)^2/r(1,2)^2]r(3)$. The force on the second wire segment due to the first and third gives a similar equation which will hold under similar conditions. Now we have enough to solve $r(2)^2=[(r(1,3)^2/(r(1,2)^2)][r(2,3)^2]$ and $r(1)=[r(1,2)^2]/r(2)$. Proceeding in this way we obtain r(3) and thus unique dipoles for each segment. The procedure generalizes for many however oriented current segments even if the currents are of different magnitudes. The argument also applies to residual electrostatic dipoles that account for gravity.

Regarding the electrostatic force that produced the residual electrostatic dipoles in atoms that accounts for gravity: A primordial electrostatic force, perhaps as part of a big bang explosion, produced the motion of the superclusters, the galaxies, the present 200 km/sec orbiting of the Sun around our galaxy's center, the 29.9 km/sec Earth around the Sun the .465 km/sec spin of the Earth about its center. Note the throwing, batting or cueing of a ball is ultimately an electrostatic force between the outer electrons in the hand, bat or tip and the surface of the ball. (Note also that the spin of the Earth is not much greater than the speed of sound in the Earth’s atmosphere at room temperature, about a third of a kilometer per second or 1100 feet per second.)

Such forces may have produced the initial linear motion of atoms and the elliptization of circularly orbiting particles inside atomic nuclei and free electrons. This produced a separation of centers of positive charge and negative charge inside atomic nuclei etc.. Such dipoles produced in the big bang perhaps in galactic clumps of atoms interacting with the primordial linear force gave rise to a torque accounting for the spin of galaxies etc. and the spinning off of planets from the stars and satellites from the planets. It may be that the radially and longitudinally oriented dipoles once produced by a latitudinally directed force are capable by their mutual interactions of sustaining themselves as in the dipole chain model of ferroelectrics(see Feynman v2p5-5). It may also be that the force producing the Hubble accelerative expansion or other motion of galaxies, the orbit of the solar system and the orbit of planets about the Sun etc is an ever present force which is needed to sustain the dipoles inside atomic nuclei as well as the component motions of the galaxies, that is their swirling motion and perhaps their Hubble motion outward from the locus of the big bang.

Regarding the size of the electrostatic dipoles: According to Cavendish even as interpreted above, the gravitational constant for a small lead ball horizontally pulled toward a larger fixed lead ball was about 6.67 times 10^{-11}; and according to Eratosthenes (from the 7.2degree greater shadow of a vertical stick in the ground at the noon zenith of the the Sun on the summer solstice day at Alexandria compared to that at Syene(Aswan) 948km south, the curvature of the assumed spherical Earth) the Earth's radius was computed to be nearly today's value R=6,371km.; and according to Galileo and Newton, the Earth pulls objects down such that the downward acceleration is, whatever the object, GM/R^2=9.8 meters per sec per sec..(note the meter was not defined until 1791 as 1/10,000,000 of the distance between the equator and the geometric north pole along a line passing through Paris)

From these three observations, Cavendish inferred the density of the Earth to be nearly 5.5kg/cubic meter, the accepted value now based on improvements in Cavendish's method; Hence the force of the Earth whose mass then is 5.98 times10^{24} kg on a proton of mass 1.67 times 10^{-27}kg on the Earth's surface

$R=6.37(10^6)$ meters away from the Earth's mass concentrated at the center is .24 times 6.67 times
$10^{(-11+24-27-12)}= 1.6(10^{-26})$newtons.

Compare this to the gravitational force between two protons one meter apart which is $(6.67)(10^{-11})$ times $[(1.67)(10^{-27})]^2$ which if set equal to the force between electrostatic dipoles of unknown length s, $(9)(10^9)(es)^2$ implies $s=(.9)(10^{-18})$.

It is important to note that this value is consistent with that implied by Einstein's equation for the transformation of energy into mass and vice versa, $E=mc^2$. The energy supposedly latent in the mass, m, and which can be partially or wholly transformed into energy eg including the kinetic and potential energy of other particles etc., this energy may be viewed as the potential energy plus the kinetic energy of a particle,m*, orbiting another particle,m**, inside of the larger particle with mass,m.

That is, the energy of oppositely charged particles in an orbital system can be written independently of the masses of the orbiting particle and the central particle as $-(9)(10^{-9})(2)e^2/R(x)$.

Suppose the charge of one particle is -e and the charge of the other is +2e. The total charge of this orbital system is +e, the charge of a proton. If the signs are reversed, the charge of the orbital system is the charge of an electron.

The total mass of this system can be denoted, m(x). Suppose m(x) is the mass of a proton or of an electron. The deflection of such particles in an electric field or a magnetic field can be used to measure this mass of the particle. Thus the mass of the proton is about 1836 times that of the electron because it is deflected that much less by the same deflecting force. Etc..

The rest energy of such a particle then is $m(x)c^2 =-(9)(10^9)(2)e^2/R(x)$.Hence the rest mass of the proton,$m(x)=1.67(10^{-27})$kg =
$-(9)(10^9)(2)e^2/c^2R(x)$ which, if we ignore the minus sign, determines the value of $R(x)= (18(2.58)/9(1.67))(10^{9-38-16+27}=3.08(10^{-18})$ for x=proton.

It would seem then that the smaller mass electron is larger in volume than the greater mass proton!

The problem with this argument is that we have ignored the masses inside the orbital systems which also contribute to the energy of the orbital system $mc^2=E$. The implication of the argument is that the central mass of the electron and that of the proton are smaller than the
total mass measured and that we are measuring these masses and their binding energies as given by the orbital system formula above

If the initially assumed circular orbit inside electrons and protons is now assumed to be an elliptical orbit with the eccentricity needed to produce a 10^{-18} meter displacement between centers of opposite charge, we see that Einstein's equation $E = mc^2$ implies, or at least is consistent with, an electrostatic dipole theory of gravity.

We are assuming that the charge displaced is 'e' when in fact it might be some multiple of 'e' greater than one or less than one and it would be necessary to reassess "s". The mass of protons are known from their deflection when propelled by an electric field through a magnetic field in mass spectrometers; that is from the degree of charge polarization inside the nuclei due to the electric field propelling them and the strength of the magnetic field relative to the degree of charge polarization in the nuclei due to gravity and the gravitational strength of the Earth.

Now consider how many atoms there are in the Earth and how many protons plus neutrons in the average atom eg a total of 28 protons-neutrons if all silicon on average. (56 if all iron , 12 if all oxygen etc..) There are 6.02 times 10^{26} atoms of silicon in 28kg so if the mass of the Earth has (5.98 times 10^{24})/28 times 6.02 times 10^{26} atoms and each of these times has 28 (= 14protons plus 14 neutrons) yields 3.6 times 10^{51} dipoles. Hence the force between half these dipoles concentrated at a point R/2 meters from the surface and a single dipole at the Earth's surface is $(9)(10^{9})(3.6/2)(10^{51})$times $[(6.37/2)(10^{6})(1.6)(10^{-19})(.9)(10^{-18})]^{2}$ divided by $[(6.37/2)(10^{6})]^{4}$. This reduces to (3.32)(10^60-38-36-12) =$(3.32)(10^{-26})$ newtons compared to $(1.6)(10^{-26})$ newtons as calculated above in the usual way with the gravitational constant.

Note that this dipole length in each proton neutron is due to the 465m/sec spin of the earth,v, and the inhibiting effect of the forces due to all the other dipoles. Thus the dipole associated with n protons-neutrons is (v/c)(ns/(S+s))=(n)(10^(3-8))(s/(S+s))=(10^-18) which implies that s/S is only 10^-13 while n/10^51 is for n=1 up to n=10^38 is a much smaller number. This is attributable to the fact that more distant dipoles have a less inhibiting effect and most dipoles are at greater distances.

The exact process is a matter for further research. But the equivalence of the electrostatic dipole representation of the gravitational force and the Newtonian representation is unequivocal.

The electrostatic dipole interaction is analogous to the the effect of a large current carrying wire or wires on a parallel small current carrying wire where the average electron velocity is generally between 10^-4 and 10^-7 m/sec which implies a dipole length per proton-neutron of 10^-14 to 10^-17 meters given 29protons plus 34 neutrons=63 protons-neutrons in copper for example. The dipoles are transverse to the direction of the free electrons. The drift velocities are much smaller than the 10^6 meter thermal velocities but the duration of the forces, here 10^-14 sec., about are not long lasting enough to produce dipoles inside the free electrons and oscillating nuclei as are the electric field forces which are constantly reinstated in the same direction for many seconds and minutes etc., in a current carrying conductor.

Regarding the attraction of the planets to the Sun: Here the distance between objects from Mercury through Pluto is between .58 to 59 times ten to the eleventh power. That is the force between a dipole inside an Earth atomic nucleus and a dipole inside a Sun atomic nucleus would be such as to allow expansion of these dipoles proportional to this distance but the weight of such analytic dipoles would be smaller than the weight of neighboring dipoles in each case. There are about a million times more nuclei and dipoles in the Sun and this factor must also be considered. Also finally the expansion of the dipoles cannot exceed the limit set by the size of the atom on the Earth and by the size of the atoms on the Sun although it may be that dipoles can exist in the plasma gas of the Sun as well as in atomic nuclei etc..

The Sun is spinning counterclockwise as one might view it looking down on the roughly planar solar system. The force producing this motion would also produce a dipole with the center of negative charge on the side of each nucleus closest to the center of the Sun. The received wisdom is that the planets were formed from outer material of the Sun that was spun off and coalesced later into the form of the planets. This protoplanetary material on the surface of the Sun would have dipoles with the positive pole facing the Sun’s center and when it was spun off, the same orientation of this dipole would persist; although the spinning of the planet would produce another dipole that would have a positive pole on the outside of the planet; On the night side of a planet like the Earth, the dipole associated with the Earth’s spin would have the positive pole on the outside but the dipole associated with the Earth’s motion about the Sun would have its negative pole on the outside; the accumulation of negatively charged particles on the surface of the Earth and the similar potential gradient of the atmosphere; if this was the case then the outer pole of each of the Sun's dipoles is negative. Thus the outer positive pole of the Earth's atomic dipoles are attracted to the negative outer pole of the Sun's atomic dipoles.

At a greater distance from the planet, the dipoles associated with the spin of the planet and facing the Sun may be substantially weakened by oppositely directed such dipoles on the dark side of the planet. That is the dipoles in the Earth’s nuclei on the opposite side of the Earth from the Sun are repelled by the Sun. This demands that we add a solar dipole component in the planet's atomic nuclei of a size that is similar to the spin dipole component oriented along the planet's radii and that the solar component dipole in each atomic nucleus changes orientation as the planet changes its position with respect to the Sun, just as the spin component dipole changes orientation as the Earth's radius on which it is situated changes direction as the Earth spins.

Also the orbital component dipole may be larger than the spin component dipole because the orbital speed is about seventy times greater than the spin speed. The dipole in each atom is caused in part by this velocity but also by the distance between the dipole and other dipoles. Hence, the just neighboring dipoles exert a stronger influence than the more distant dipoles; the influence is such that the greater the distance between dipoles, the greater the size of the dipole associated with a given velocity. If there are many nearby dipoles, this has the effect of limiting the size of the dipole produced by the spin velocity and size of the dipole produced by the orbital velocity and so of their difference.

Still the component factor associated with the orbital velocity should be greater than the component factor associated with the spin velocity. This would imply a greater attraction between objects on a line toward the Sun than on a line toward the center of the Earth, if the lines contained as many atoms in both cases- which they don't.

Also these orbital component dipoles are rotated by the spinning motion of the Earth so that they are made to line up with the spin component dipoles and add to the spin component dipoles forming attractive dipoles along radii of the Earth and on radii facing the Sun along a line toward the Sun.

The need for such an added dipole is that it would help to explain why the Earth does not fall apart under the influence of the Sun's attraction of one side and its repulsion of the others oppositely oriented dipoles. That is the side of the Earth nearest the Sun is more attracted to the Sun but also because of the added dipole in the atomic nuclei, the atoms of the Earth nearest the Sun are more attracted to each other when compared to atoms on the dark side of the Earth. Both of these effects largely cancel so that the net gravitational force on the Sunny side of the Earth is the same as that on the dark side except for the observed tidal effects. Similar considerations apply for dipoles in the atomic nuclei of the the Earth, other planets and the Sun tracking the center of the galaxy.

Now the largest distance between atomic nuclear dipoles on the Earth implicitly determining the maximal size of the dipoles is about $10^{6.8}$ meters whereas the distances for planets to the Sun is $(5.79)(10^{10})$ for Mercury, $(1.49)(10^{11})$for Earth to $5.9(10^{12})$ meters for Pluto and for the Sun to the galactic center 10^4 parsecs = $(3)(10^{20})$ meters. Lets see what the atomic nuclear dipoles in the Sun and Earth must be to give the observed gravitational force between them and if they are small enough to be consistent with the known distances between atoms at various temperatures etc..

That is we must be able to write the total dipoles as keRs and KeRS where k and K are functions of the relative influence of the total dipoles on each other etc; the total dipoles here are proportional to the masses (note the planet masses are .22, 4.87, 5.97, .64, 1899.7, 568.8, 86.9, 103.0, and .013 times 10^{24}kg vs the Sun's$(2)(10^{30})$kg.); that is, to the number of protons plus neutrons, denoted, protons+neutrons, in each mass.

Since the Sun is .75H+.25He so that 1.75kg of Sun contains 6.02 times 10^{26} molecules each of which contains on average 1.75 protons+neutrons so 1kg of the gaseous Sun contains 6.02 times 10^{26} protons+neutrons in a volume that is larger of course than that of 1 kg of a solid planet; but 1kg of any planet or the Sun contains the same number of protons+neutrons. There are about $2(10^{30})$ kg in the Sun. Hence the Sun contains 6.02 times 10^{26} times M or 12 times 10^{56} and the Earth contains 6.02 times 10^{26} times m or 3.59 times 10^{51} unit dipoles in the Earth. The total dipoles are: $1.2(10^{57})$k(s)RS* and $3.59(10^{51})$K(S)Rs*.

Hence $GmM/R^2 = 9(10^9)mM[6.02)(10^{26})]^2$ times kK times s*S* times (N)(2.56) times 10^{-38} divided by R^2. If N=1, this implies kKs*S*=$(.0079)10^{(-61-11+38)} = 10^{-36}$ approximately. Now RkS* and RKs* are the magnitudes of the dipoles associated with the Sun and planet respectively where R is about 10^{10} to 10^{13} meters. But we also know that the Earth's dipoles cannot be much larger than atomic nuclei about
10^{-15} =RKs* that Ks*=10^{-26} which implies kS*=10^{-10} and also RkS*= $10^{(-10+11)}$ so the dipoles on the Sun are 10 meters in length.

This sounds impossible. Perhaps the charge of the dipole could be somehow larger so that instead of the Sun's dipoles being eS* etc., it could be e*S* where e* is the charge on say 1000 electrons or more and S* could be that much smaller. After all at the high temperatures ($T=5.77(10^3)$ to $1.5(10^7)$ degrees Kelvin of the Sun the average kinetic energy is $.5mv^2= (1.5)(1.38)(10^{-23})T$ Joules where $1.602(10^{-19})$ Joules =1eV and $9.1(10^{-31})$kg times v^2 gives the speed of an electron at this temperature; that is about (10^{-20})Joules /(10^{-30}) at the low 5770 degree value of T suggesting $v=10^5$ meters per second for this temperature; but below the Sun's surface then with much greater temperatures, v is far in excess of the 10^6 meter/sec velocity of the electron around the hydrogen or helium nuclei. This suggests that dipoles much larger than those proposed for atomic nuclei are possible within plasmas between groups of electrons and groups of ions, protons or helium nuclei separated by distances that can still be many orders of magnitude smaller than ten meters.

Similar reasoning could explain the dipole attraction between the solar system and the center of the galaxy. But what about the moon 3.84 times 10^8 meters away which suggests that if RKS* = (10^8)KS*=10^{-15} say, that (10^8)ks*=$10^{(-36+15)}$ suggesting that Rks*=10^{-13} meters. Could atomic nuclei on the moon be larger than those on Earth? Perhaps this is a problem or perhaps the tidal effects of the moon on the Earth and vice versa and perhaps the amount of charge polarized inside the Earth's atomic nuclei are larger than we first considered; that is, e*s instead of es where, e*, is greater than, e.

What is the relationship of gravity to the net spin of the planet, satellite, star, galaxy etc. and to the number of atoms contained in each? Clearly as in Newtonian gravity theory, the gravitational attractive force of a planet etc is proportional to the number of atoms. Is it then proportional to the angular momentum and if the angular velocity was increased and the mass was decreased so that the angular momentum remained the same would the attractive force remain the same?

Blackett suggests such a possibility and a correlation between magnetic field and gravitational field in the May 1947 issue of Nature regarding the planets, the Sun, and a few stars. An extension of this idea is that a primordial electrostatic force produced a linear momentum of galaxies or clusters of galaxies which was partitioned first into the angular momenta of the spinning galaxies and then into the spinning stars and then into the spinning planets and their satellites. That is, the strength of the magnetic field is a function of the total of the angular momentum components and the linear momentum component and the number of protons-neutrons in the mass considered.

The total force may also be evident in each of these objects down to the planetary satellites.If for example the total force produces charge polarization inside atomic nuclei and electrons initially in a high temperature plasma state, the effect of the assumed linear force on charge polarized nuclei and plasmas would be to cause a torque on individual nuclei but also on large clumps of electrons and nuclei. This mechanism could provide a rationale for the approximate covariation of gravity with angular momentum that Blackett, Wilson and others had observed and an explanation of why the relationship might not be more exact.

Thus any accelerated object, eg a bullet, a rocket, a plane, a car, a frisbee, a skidding or spinning billiard ball etc has electrostatic dipoles produced in its atomic nuclei transverse to and proportional to the accelerating force which even if mechanical is still ultimately electrostatic; The tendency of linearly propelled atomic nuclei to then rotate may add to the aerodynamic efficiency of spinning projectiles. The resulting dipole field may or may not be self sustaining against thermal disturbances as in the dipole chain model of ferroelectrics (Feynman v2p5-5, 11-10).

In the above mentioned ferroelectric model the dipoles are assumed to be composed of poles, concentrations of charge, that are fairly constant over time unlike our model of charge polarization inside atomic nuclei which changes rapidly with the position of the orbiting charged particle(s) inside the nuclei but which averaged over the orbital time period represents a displacement of centers of negative and positive charge in a specific direction. In both models the dipole-dipole interaction is the same but the interaction of one dipole with a single pole of the other is different in the two models.

In our model the action of one dipole on the single pole of another is to produce a transverse elliptical motion of the single pole, rather than as in the ferroelectric model to produce a motion of the pole only in the direction of the dipole field and thereby to sustain a dipole field.

It is conceivable that the longitudinal and radial dipoles initially created by the primordial force acting in the latitudinal direction causing the planet to spin could also sustain the dipoles then produced; that is the longitudinal dipole field would act to produce radial dipoles after thermal collisions etc and vice versa. Perhaps this occurs more readily in spherical spinning objects.

But it is also conceivable that the force producing the accelerative motions of the galaxies and so in some small component part, the spin of the Earth is constantly creating the dipoles anew; that the First Mover or the Force producing the accelerative Hubble expansion of the galaxies (if this is indeed the implication of red shifts proportional to faintness of the therefore more distant images) is always however far away "with us” also in the sense of sustaining the electrostatic dipoles of the gravitational force in our atoms.

To keep things simple, suppose the primordial force acted only on a clump of atoms that became the spinning Earth when dipoles produced in the atomic nuclei transverse to the initial linear force responded then to the linear primordial force by also spinning. The spinning might continue in the absence of friction by inertia. But what prevents the dipoles from disappearing due to thermal collisions of atomic nuclei with the inner shell of electrons, if there is no force to produce them? Now working backwards suppose the linear primordial force is associated with the movement of the solar system in the galaxy; then further backward with the movement of the galaxy in a cluster etc. and that the primordial force remains.

The existence of this primordial force then is the cause of the movement of galaxies is the cause of the movement of stars is the cause of the sustained dipoles in the atomic nuclei of the planets of stars that have planets which dipoles otherwise would be reduced to zero after a few seconds of thermal collisions.

When the moon was spun off the Earth and when we launch a satellite by rocket, the satellite is accelerated to a velocity that exceeds the velocity that would bring it back to Earth but at all times during this transitional state and once it is in orbit around the Earth it is also being acted upon by the force which causes the spinning of the Earth and the Earth's orbital and galactic motions and so it responds like everything else to this force when the force that launched it is removed; that is the nuclear dipoles in its atoms are sustained, even when they have superimposed on them during the time of launching other dipoles, and its motion with the Earth around the Sun etc is sustained as well as its motion toward the Earth constantly just enough to keep it in orbit.

Returning to the Blackett and Wilson conjecture, the reason for the relation between gravity, magnetism and angular momentum may be due to the component of the ever present force that is manifest in the linear and angular velocity components of the motion of the astronomical body. The more atomic nuclei there are in the body and the greater its velocity components the greater the gravitational and magnetic fields of the body. Hence a spinning motion given to a ball by a momentary force may produce initially additional charge polarization in its atomic nuclei in radial oriented directions but without repetition of this force perhaps through the self sustaining interaction of radial and longitudinal dipole fields the added charge polarization in the atomic nuclei quickly becomes zero due to thermal collisions.

In the case of the planets, measurements of their magnetic fields is complicated by the fact that different parts and layers of the Sun and gaseous planets rotate at different velocities and for the planets near the Sun, the Sun's magnetic field has an influence on the measurements. The fact that the gaseous planet Jupiter has a magnetic field ten times stronger many miles above its equator suggesting a field at the surfact 20,000 times that of the Earth even though it is only several hundred times larger in mass and spinning only 30 times faster and the fact that the direction of the field is opposite to its surface rotation is perhaps understandable in terms of different directions of rotation in different regions and is consistent with the Blackett and Wilson theory;

Also the similarity of Neptune to Jupiter except that Neptune is about one twentieth of the mass of Jupiter and the similar ratio of their magnetic fields to the ratio of their masses can be so understood.

With repetition of the force causing linear motion or spin, the dipoles can be sustained. This would imply that an airplane traveling from Europe to the US for example is kept up not only by Bernoulli's principle but also by a small antigravitational repelling force between the atomic nuclear dipoles in the airplane and those of the Earth below that should increase with the Bernoulli effect with the speed of the plane. By the same token, a plane traveling from the US to Europe would be heavier the faster it traveled which even though offset by the greater lift due to greater speed would not be offset as much as when the plane traveling in the opposite direction also had speed related lift but was lighter. It would be interesting to know if planes generally used more fuel per unit speed and per unit wind speed and distance when traveling from Europe to America or America to Asia than when traveling in the opposite direction.

Regarding the gravitational red shifts and bending of electromagnetic radiation. Before considering the esoteric experiments, consider the commonplace observation of improvement in the reception of radio frequencies at night from reception during the day. This is attributed to greater radio activity ie interference during the day but it could also be attributed in part to a decrease in the distance between colliding free electrons and lattice ions, nuclei and their surrounding electron shells in the receiver antennas when the antenna is on the Sunny side of the Earth.

That is, as we hypothesized above, the side of the Earth nearest the Sun is more attracted to the Sun but also because of the added Sun tracking dipole in the atomic nuclei, in the same direction as the dipole associated with the planet’s spin, both having their positive pole toward the Sun, the atoms of the

Earth nearest the Sun are more attracted to each other than to atoms on the dark side of the Earth. On the dark side, the Sun tracking and Earth center tracking dipoles are in opposite directions.

When a star is observed against the background of stars at say midnight its position seems to be about 3/3600 degrees ahead of its position when its position is determined at the time of year it is visible during an eclipse near the Sun at noon; that is the greater residual nuclear dipole seems to make possible a difference in the delay of reception; a longer delay as the Earth turns more before light from the particular star becomes visible. And this effect is greater, the less the angle between the radial orientation of the dipoles. That is the proposed theory explains the bending of light, by gravity without requiring a distortion in the three dimensional Cartesian coordinate system, according to Einstein's ingenious formula, representing physical space far beyond ordinary observations.

What about gravitational lensing; quasars viewed on different sides of large distant star or galaxy. The red shift of the quasars is about the same with an error that translates into thousands of meters per second. Can we simply say, to please the General Relativity departments and the Black Hole subdepartments, that this is evidence of a single quasar whose light is bent by a large mass as it passes by the large mass on the way to Earth?

A better case could be made if there was clear evidence, but there isn't, that stars or quasars as near each other as those in claimed instances of gravitational lensing but without a closer stellar object blocking their view from the Earth had more dissimilar red shifts. The difficulty if not impossibility of making a conclusive case of this sort reduces the claim to idle speculation.

A similar explanation applies to the red shift in radar reflections from Venus and Mercury when they are on the opposite side of the Sun; that is the gravitational effect of the Sun is not to change the time scale of light wave disturbances in the aether near the Sun so as to increase the time between successive peaks and valleys of a sine oscillation but to influence the radar receiving antennas on the Earth so that they do not respond as quickly to changes in oscillating forces on the free electrons in their antennas resulting in a lower frequency for the received oscillation of charge in the radar antenna.

Similarly for other red shift experiments like Brault's on the gravitational red shift of solar lines (Bull Amer Phys Soc. 8,28 1963). The red shift of gamma rays as a function of their height, 22.5 meters above the Earth's surface and the gravitational field of the Earth may have a similar explanation. That is the shift should be greater the greater the distance between the source and the receiver at least during the day; if the experiment is performed at night the results should be a lesser delay.

But the cause of the delay is not the gravitational field of the Earth but the effect of the Sun's gravitational field on the Earth's gravitational field. Recent variations in the gravitational constant when electrostatic means are used to create stability in balance measurements also may be explained more clearly in terms of these effects than in terms of General Relativity

Regarding Special Relativity which in 1905 helped to explain the Michelson Morely Experiment and Kaufmann's mass increase experiment and later was used to explain the slower decay time of faster moving muons, the mass defect of the Cockroft Walton and modern accelerator experiments, relativistic Doppler shifts and the Hafele Keating experiment.

We have shown that by attributing light's delay to effects inside the atomic nuclei of the receiver we avoid the need for an aether and its different effects on the first light ray moving with the Earth and the light ray moving perpendicular to the first. We have also showed how charge polarization inside a beta electron causes a decrease in the rate of increasing magnetic responsiveness of the fast moving beta electron which is srongly interpreted as an increase in inertial mass. We have suggested how the same principle could be at work in the case of the the Cockroft Walton experiment, the faster moving muons and the magnetic clock in the Hafele Keating experiment. And so when unstable particles like pions, muons, kaons etc are made to move at .98c etc the muons for example decay five times faster than they do when they are at rest. The force which produces the increase in speed also can act on the orbiting particle or particles within the larger particle so as to increase the ever widening elliptical orbits that are the norm for these unstable particles.

Special Relativity implied that momentum and velocity change in a relatively moving frame as $mv = mv/(1-v^2/c^2)^{1/2}$ so that mass could be viewed as $m/(1-v^2/c^2)^{1/2}$ and Kaufmann's experiment could be approximately described by this formula.

It is no surprise then that the same rate of elliptization would occur in these electron-like particles and that spatial contraction and time dilation would be described by the same Voigt Lorentz transform:of 1877:

$$x' = x - vt/ (1-v^2/c^2)^{1/2}, \; y' = y, \; z' = z \text{ and } t' = (t - vx/c^2)/(1-v^2/c^2)^{1/2}$$

It should be noted that such an explanation provides a physical cause regarding the machinery of the process while the Special Relativity explanation avoids doing so. For example, the Lorentz space time distortions inside a fast moving muon as observed from an 'observer' in a muon at rest on the Earth are the same as those one might observe from the fast moving muon regarding the Earth. That is each muon would 'observe' the other as decaying more slowly and later than itself and the muon falling to rest on the Earth would be a little surprised to see that, according to Earth clocks, the muon that had been at rest during this time on the Earth had decayed earlier. In a sense what the falling muon observes is irrelevant to what the muon and other observers at rest on the Earth observe. It is the prediction of these observers that is relevant.

The same might be said about the observers on the beta electron whose mass seemed to increase to cause it to intersect the emulsion at the point where it did; or about the observers in the clocks losing a few nanoseconds on an eastward moving airplane. How surprised they must have been when they saw evidence that their mass had increased not the other way around or that their clocks had slowed down not the other way around when they came to rest again with the Earth and looked around.

Perhaps we can dismiss the surprises the other observers might have felt as counterintuitive but mathematically consistent implications of the Lorentz transform and the rules of its application according to Einstein. But wouldn't it be nice if we had an explanation of these things which was 1)not merely descriptive and 2)not counterintuitive, which explained the machinery of mass increase, the slowing down or speeding up of magnetic clocks, the decay rate of the muon at different speeds, etc. which, Feynman acknowledges, the Einsteinian theory does not.

Feynman addresses this problem in his Lectures on Physics v1p16.3 is "We do not know why the muon disintegrates or what the machinery is but we...can still predict that when it is moving at 9/10 of the speed of light the apparent length of time that it lasts is $(2.2)(10^{-6})/(1-9^2/10^2)^{1/2}$.... When we discussed the fact that moving muons live longer we used as an example their straight line motion in the atmosphere. But we can also make muons in a laboratory and cause them to go in a curve with a magnet and even under this accelerated motion they last exactly as much longer as they do when they are moving in a straight line....one could compare a muon which is left standing with one that had gone around a complete circle, and it would surely be found that the one that went around the circle lasted longer....but it is really unnecessary because everything fits together all right... This may not satisfy those who insist that every single fact be demonstrated directly but...we confidently predict.....[that is we have a predictive equation and rules on how to apply the equation which work]"

It is perhaps worth noting that there have been only one sided confirmations of Einstein's first premise of Special Relativity. That is, space time distortion in rapidly moving particles has been observed from the point of view of the lab but not of the lab from the viewpoint of the particle.

The possibility exists in the Hafele Keating experiment that the changes in the clock in one plane when it comes to rest with respect to a second moving plane instead of the Earth, that space time distortion of the first plane's clock will be observed by an observer in the second plane to have slowed down and the observer in the first plane will similarly observe the clock in the second plane

The bottom line is that a deeper understanding of nuclear transformations is required than present theory including Einstein's relativity permits. It is required if the problems of fusion, radioactive waste and leakage from more and more reactors are to be solved. The students of Fermi, Bohr, Eddington, Einstein, Compton,Oppenheimer, Szilard etc, experts on chain reactions and neutrons who built the atomic bomb and designed the nuclear reactors have not been able to solve these problems with ideas based on Relativity and QED.

New theoretical considerations are needed; for example the model proposed here involving charge polarization inside electrons, atomic nuclei and other elementary particles.

APPENDIX

Excerpt 1

COMMUNICATIONS TO THE ROYAL SOCIETY

A Letter to Dr. Edmund Halley, Astronom. Reg.& c. giving an account of a new-discovered Motion of the Fixed Stars.

(Philosophical Transactions, No. 406. vol. XXXV., 1727-28, p.687.)

Sir,

You having been pleased to express your satisfaction with what I had an opportunity sometime ago of telling you in conversation, concerning some observations that were making by our late worthy and ingenious friend, the honourable Samuel Molneux, esq. and which have since been continued and repeated by myself, in order to determine the parallax of the fixed stars; Ishall now beg leave to lay before you a more particular account of them.

Before I proceed to give you the history of the observations themselves, it may be proper to let you know that they were at first begun in hopes of verifying and confirming those that Dr. Hooke formerly communicated to the public, which seemed to be attended with circumstances that promised greater exactness in them, than could be expected in any other that had been made and published on the same account. And as his attempt was what principally gave rise to this, so his method in making the observations was in some measure that which Mr. Molyneux followed: for he made choice of the same star, and his instrument was constructed upon almost the same principles. But if it had not greatly exceeded the doctor's in exactness, we might yet have remained in great uncertainty as to the parallax of the fixed stars; as you will perceive upon the comparision of the two experiments.

This indeed was chiefly owing to our curious member, Mr. George Graham, to whom the lovers of astronomy are also not a little indebted for several other exact and well-contrived instruments. The necessity of such will scarce be disputed by those that have had any experience in making astronomical observations; and the inconsistency which is to be met with among different authors in their attempts to determine small angles, particularly the annual parallax of the fixed stars, may be a sufficient proof of it to others. Their disagreement indeed in this article is not now so much to be wondered at, since I doubt not but it will appear very probable, that the instruments commonly made use of by them, were liable to greater errors than many times that parallax will amount to.

The success then of this experiment evidently depending very much on the accurateness of the instrument, that was principally to be taken care of: in what manner this was done is not my present purpose to tell you; but if, from the result of the observations which I now send you, it shall be judged necessary to communicate to the curious the manner of making them, I may hereafter perhaps give them a particular description not only of Mr. Molyneux's instrument, but also of my own, which hath since been erected for the same purpose and upon the like principles, though it is somewhat different in its construction, for a reason you will meet with presently.

Mr. Molyneux's apparatus was completed and fitted for observing about the end of November 1725, and on the third day of December following, the bright star in the head of Draco (marked gamma by Bayer) was for the first time observed as it passed near the zenith, and its situation carefully taken with the instrument. The like observations were made on the 5th, 11th, and 12th days of the same month, and there appearing no material difference in the place of the star, a farther repetition of them at this season seemed needless, it being a part of the year wherin no sensible alteration of parallax in this star could soon be expected. It was chiefly therefore curiosity that tempted me (being then at Kew, where the instrument was fixed) to prepare for observing the star on December 17th, when having adjusted the instrument as usual, I perceived that it passed a little more southerly this day than when it was observed before. Not suspecting any other cause of this appearance, we first concluded that it was owing to the uncertainty of the observations, and that either this or the foregoing were not so exact as we had before supposed; for which reason we purposed to repeat the observation again, in order to determine from whence this difference proceeded; and upon doing it on December 20th, I found that the star passed still more southerly than in the former observations.

This sensible alteration the more surprised us, in that it was the contrary way from an annual parallax of the star but being low pretty well satisfied that it could not be entirely owing to the want of exactness in the observations, and having no notion of any thing else that could cause such an apparent motion as this in the star, we began to think that some change in the materials &c. of the instrument itself might have occassioned it. Under these apprehensions we remained some time, but being at length fully convinced, by several trials, of the great exactness of the instrument, and finding by the gradual increase of the star's distance from the pole, that there must be some regular cause that produced it; we took care to examine nicely, at the time of each observation, how much it was: and about the beginning of March 1726, the star was found to be 20" more southerly than at the time of the first observation. It now indeed seemed to have arrived at its utmost limit southward, because in several trials made about this time, no sensible difference was observed in its situation. By the middle of April it appeared to be returning back again towards the north; and about the beginning of June, it passed at the same distance from the zenith as it had done in December, when it was first observed.

From the quick alteration of the star's declination about this time, (it increasing a second in three days,) it was concluded that it would now proceed northward, as it before had gone southward of its present situation; and it happened as was conjectured: for the star continued to move northward till September following, when it again became stationary, being then near 20" more northerly than in June, and no less than 39" more northerly than it was in March. From September the star returned towards the south, till it arrived in December to the same situation it was in at that time twelve months, allowing for the difference of declination on account of the precession of the equinox.

This was a sufficient proof that the instrument had not been the cause of this apparent motion of the star, and to find one adequate to such an effect seemed a difficulty. A nutation of the Earth's axis was one of the first things that offerd itself upon this occasion, but it was soon found to be insufficient; for though it might have accounted for the change of declination in gamma Draconis, yet it would not at the some time agree with the phaenomena in other stars; particularly in a small one almost opposite in right ascension to gamma Draconis, at about the same distance from the north pole of the equator: for though this star seemed to move the same way as a nutation of the Earth's axis would have made it, yet, it changing its declination but about half as much as gamma Draconis in the same time, (as appeared upon comparing the observations of both made upon the same days, at different seasons of the year,) this plainly proved that the apparent motion of the stars was not occasioned by a real nutation, since, if that had been the cause, the alteration in both stars would have been near equal.

The great regularity of the observations left no room to doubt but that there was some regular cause that produced this unexpected motion, which did not depend on the uncertainty or variety of the seasons of the year. Upon comparing the observations with each other, it was discovered that in both the forementioned stars, the apparent difference of declination from the maxima was always nearly proportional to the versed sine of the Sun's distance from the equinoctial points. This was an inducement to think that the cause, whatever it was, had some relation to the Sun's situation with respect to those points. But not being able to frame any hypotheses at that time sufficient to solve all the phaenomena, and being very desirous to search a little farther into this matter; I began to think of erecting an instrument for myself at Wansted, that, having it always at hand, I might with the more ease and certainty inquire into the laws of this new motion. The consideration likewise of being able by another instrument to confirm the truth of the observations hitherto made with Mr. Molyneux's was no small inducement to me; but the chief of all was, the opportunity I should thereby have of trying in what manner other stars were affected by the same cause, whatever it was. For Mr. Molyneux's instrument, being originally designed for observing gamma Draconis, (in order, as I said before, to try whether it had any sensible parallax,) was so contrived as to be capable of but little alteration in its direction, not above seven or eight minutes of a degree: and there being few stars within half that distance from the zenith of Kew bright enough to be well observed, he could not, with his instrument, thoroughly examine how this cause affected stars differently situated with respect to the equinoctial and solstitial points of the ecliptic.

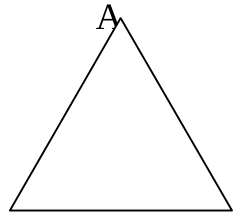
These considerations determined me; and by the contrivance and direction of the same ingenious person, Mr. Graham, my instrument was fixed up August 19, 1727. As I had no convenient place where I could make use of so long a telescope as Mr. Molyneux's, I contented myself with one of but little more than half the length of his, (viz. about 12 1/2 feet, his being 24 1/4,) judging from the experience which I had alread had, that this radius would be long enough to adjust the instrument to a sufficient degree of exactness; and I have had no reason since to change my opinion; for from all the trials I have yet made, I am very well satisfied, that when it is carefully rectified, its situation may be securely depended upon to half a second. As the place where my instrument was to be hung in some measure determined its radius, so did it also the length of the arch, or limb, on which the divisions were made to adjust it: for the arch could not conveniently be extended further than to reach to about 6 1/4 on each side of my zenith. This indeed was suffficient, since it gave me an opportunity of making choice of several stars, very different both in magnitude and situation; there being more than two hundred inserted in the British catalogue that may be observed with it. I needed not to have extended the limb so far, but that I was willing to take in Capella, the only star of the first magnitude that comes so near my zenith.

My instrument being fixed, I immediately began to observe such stars as I judged most proper to give me light into the cause of the motion already mentioned. There was variety enough of small ones; and not less than twelve that I could observe through all the seasons of the year; they being bright enough to be seen in the day-time, when nearest the Sun. I had not been long observing, before I perceived that the notion we had before entertained of the stars being farthest north and south, when the Sun was about the equinoxes, was only true of those that were near the solstitial colure; and after I had continued my observation a few months, I discovered what I then apprehended to be a general law, observed by all the stars, viz. that each of them became stationary, or was farthest north or south, when they passed over my zenith at six of the clock either in the morning or evening. I perceived likewise, that whatever situation the stars were in with respect to the cardinal points on the ecliptic, the apparent motion of every one tended the same way, when they passed my instrument about the same hour of the day or night; for they all moved southward, while they passed in the day, and northward in the night; so that each was farthest north when it came about six of the clock in the evening and farthest south when it came about six in the morning.

Though I have since discovered that the maxima in most of these stars do not happen exactly when they come to my instrument at those hours, yet not being able at that time to prove the contrary, and supposing that they did, I endeavoured to find out what proportion the greatest alterations of declination in different stars bore to each other; it being very evident that they did not all change their declination equally. I have before taken notice that it appeared from Mr. Molyneux's observations, that gamma Draconis altered its declination about twice as much as the forementioned small star almost opposite to it; but examining the matter more particularly, I found that the greatest alteration of declination in these stars was as the sine of the latitude of each respectively. This made me suspect that there might be the like proportion between the maxima of other stars; but finding that the observations of some of them would not perfectly correspond with such an hypothesis, and not knowing whether the small difference I met with might not be owing to the uncertainty and error of the observations, I deferred the farther examination into the truth of this hypothesis, till I should be furnished with a series of observations made in all parts of the year; which might enable me not only to determine what errors the observations are liable to, or how far they may safely be depended upon; but also to judge whether there had been any sensible change in the parts of the instrument itself.

When the year was completed, I began to examine and compare my observations, and having pretty well satisfied myself as to the general laws of the phaenomena, I then endeavoured to find out the cause of them. I was already convinced that the apparent motion of the stars was not owing to a nutation of the Earth's axis. The next thing that offered itself was an alteration in the direction of the plumb-line, with which the instrument was constantly rectified; but this upon trial proved insufficient. Then I considered what refraction might do; but here also nothing satisfactory occurred. At last I conjectured that all the phaenomena hitherto mentioned proceeded from the progressive motion of light and and the Earth's annual motion in its orbit. For I perceived that, if light was propagated in time, the apparent place of a fixed object would not be the same when the eye is at rest, as when it is moving in any other direction than that of the line passing through the eye and object; and that when the eye is moving in different directions, the apparent place of the object would be different.[e.g. light from a star high above the horizontal orbital plane of the Earth's orbit about the Sun; If the response time of the rods and cones in the retina corresponding to the locus of the impinging light in the field of view is 3 nanoseconds and the Earth moves .0002 meters in this time in opposite directions at different times of year(six months apart) then the apparent place of the light source will be different.But we see this can be due to response time or to a speed of propagation.]

I considered this matter in the following manner.I imagined CA to be a ray of light,falling perpendicularly upon the line BD; then if the eye is at rest at A, the object must appear in the direction AC,where light be propagated in time or an instant.But if the eye is moving from B towards A, and light is propagated in time, with a velocity that is to the velocity of the eye, as CA to BA; then light moving from C to A, whilst the eye moves from B to A, that particle of it by which the object will be discerned when the eye in its motion comes to A, is at C when the eye is at B. Joining the points B,C, I supposed the line CB to be a tube (inclined to the line BD in the angle DBC) of such a diameter as to admit of but one particle of light; then it was easy to conceive that the particle of light at C (by which the object must be seen when the eye, as it move along, arrives at A) would pass through the tube BC, if it is inclined to BD in the angle DBC, and accompanies the eye in its motion from B to A; and that it could not come to the eye, placed behind such a tube, if it had any other inclination to the line BD. If instead of supposing CB so small a tube, we imagine it to be the axis of a larger; then, for the same reason, the particle of light at C could not pass through that axis, unless it is inclined to BD, in the angle CBD. In like manner, if the eye moved the contrary way, from D towards A, with the same velocity; then the tube must be inclined in the angle BDC



Although therefore the true or real place of an object is perpendicular to the line in
which the eye is moving, yet the visible place will not be so, since that, no doubt, must be in the direction of the tube; but the difference between the true and apparent place will be (caeteris paribus) greater or less, according to the different proportion between the veloctity of light and that of the eye. So that if we could suppose that light was propagated in an instant, then there would be no difference between the real and visible place of an object, although the eye were in motion for in that case, AC being infinite with respect to AB, the angle ACB (the difference between the true and visible place) vanishes. But if light be propagated in time, (which I presume will readily be allowed by most of the philosophers of this age,) then it is evident from the foregoing considerations, that there will be always a difference between the real and visible place of an object, unless the eye is moving either directly towards or from the object. And in all cases the sine of the difference between the real and visible place of the object will be to the sine of the visible inclination of the object to the line in which the eye is moving, as the velocity of the eye to the velocity of light.

If light moved but 1000 times faster than the eye, and an object (supposed to be at an infinite distance) was really placed perpendicularly over the plane in which the eye is moving, it follows from what hath been already said, that the apparent place of such an object will be always inclined to that plane, in an angle of 89degree 56' 1/2; so that it will constantly appear 3' 1/2 from its true place, and seem so much less inclined to the plane, that way towards which the eye tends. That is, if AC is to AB or AD as 1000 to 1, the angle ABC will be 89 degree 56' 1/2, and ACB = 3' 1/2, and BCD = 2 ACB =7'. So that, according to this supposition, the visible or apparent place of the object will be altered 7', if the direction of the eye's motion is at one time contrary to what it is at another.

If the Earth revolve round the Sun annually, and the velocity of light were to the velocity of the Earth's motion in its orbit (which I will at present suppose to be a circle) as 1000 to 1; then it is easy to conceive that a star, really placed in the pole of the ecliptic would to an eye carried along with the Earth, seem to change its place continually, and (neglecting the small difference of on the account of the Earth's diurnal revolution on its axis) would seem to describe a circle round that pole every way distant therefrom 3' 1/2. So that its longitude would be varied though all the points of the ecliptic every year; But its latitude would always remain the same. Its right ascension would also change, and its declination, according to the different situation of the Sun in respect to the equinoctial points; and its apparent distance from the north pole of the equator would be 7' less at the autumnal than at the vernal equinox.

The greatest alteration of the place of a star in the pole of the ecliptic (or which in effect amounts to the same, the proportion between the velocity of light and the Earth's motion in its orbit) being known, it will not be difficult to find what would be the difference upon this account between the true and apparent place of any other star at any time; and in the contrary the difference between the true and apparent place being given, the proportion between the velocity of light and the Earth's motion in its orbit may be found.

As I only observed the apparent difference of declination of the star I shall not now take any farther notice in what manner such a cause as I have here supposed would occasion an alteration in their apparent places in other respects; but, supposing the Earth to move equally in a circle, it may be gathered, from what hath been already said, that a star which is neither in the pole nor plane of the ecliptic will seem to describe about its true place a figure insensibly different from an ellipse, whose transverse axis is at right angles to the circle of longitude passing through the star's true place, and equal to the diameter of the little circle described by a star (as was before supposed) in the pole of the ecliptic; and whose conjugate axis(minor) is to its transverse(major) axis, as the sine of the star's latitude to the radius. And allowing that a star by its apparent motion does exactly describe such an ellipse, it will be found that if A be the angle of position, (or the angle at the star made by two great circles drawn from it through the poles of the ecliptic and equator,) and B be another angle, whose tangent is to the tangent of A as radius to the sine of the latitude of the star; then B will be equal to the difference of longitude between the Sun and the star, when the true and apparent declination of the star are the same. And if the Sun's longitude in the ecliptic be reckoned from that point wherein it is when this happens, then the difference between the true and apparent declination of the star (on account of the cause I am now considering) will be always as the sine of the Sun's longitude from thence. It will likewise be found, that the greatest difference of declination that can be between the true and apparent place of the star, will be to the semi-transverse axis of the ellipse, (or to the semi-diameter of the little circle described by a star in the pole of the ecliptic,) as the sine of A to the sine of B.

If the star hath north latitude, the time when its true and apparent declination are the same is before the Sun comes in conjunction with or opposition to it, if its longitude be in the first or last quadrant (viz. in the ascending semicircle) of the ecliptic: and after them, if in the descending semicircle; and it will appear nearest of the north pole of the equator at the time of that maximum (or when the greatest difference between the true and apparent declination happens) which precedes the Sun's conjunction with the star.

These particulars being sufficient for my present purpose, I shall not detain you with the recital of any more, or with any farther explication of these. It may be time enough to enlarge more upon this head, when I give a description of the instruments, &c. if that be judged necessary to be done; and when I shall find what I now alvance to be allowed of (as I flatter myself it will) as something more than a bare hypothesis. I have purposely omitted some matters of no great moment, and considered the Earth as moving in a circle, and not an ellipse, to avoid too perplexed a calculus, which after all the trouble of it, would not sensibly differ from that which I make use of, especially in those consequences which I shall at present draw from the foregoing hypothesis.

This being premised, I shall now proceed to determine from the observations what the real proportion is between the velocity of light and the velocity of the Earth's annual motion in its orbit; upon supposition that the phaenomena before mentioned do depend upon the causes I have here assigned. But I must first let you know, that in all the observations hereafter mentioned, I have made an allowance for the change of the star's declination on account of the precession of the equinox, upon supposition that the alteration from this cause is proportional to the time, and regular through all the parts of the year. I have deduced the real annual alteration of declination of each star from the observations themselves; and I the rather choose to depend upon them in this article, because all which I have yet made concur to prove that the stars near the equinoctial colure change their declination at this time 1" 1/2 or 2" in a year more than they would do if the precession was only 50", as is now generally supposed. I have likewise met with some small varieties in the declination of other stars in different years, which do not seem to proceed from the some cause, particularly in those that are near the solstitial colure, which on the contrary have altered their declination less than they ought, if the precession was 50". But whether these small alterations proceed from a regular cause, or are occasioned by any change in the materials, &c. of my instrument, I am not yet able fully to determine. However, I thought it might not be amiss just to mention to you how I have endeavoured to allow for them, though the result would have been nearly the same if I had not considered them at all. What that is, I will shew, first, from the observations of gamma Draconis, which was found to be 39" more southerly in the beginning of March than in September.

From what hath been premised, it will appear that the greatest alteration of the apparent declination of gamma Draconis, on account of the successive propagation of light, would be to the diameter of the little circle which a star (as was before remarked) would seem to describe about the pole of the ecliptic, as 39" to 40", 4. The half of this is the angle ACB, (as represented in the figure below.) This therefore being 20", 2, AC will be to AB, that is, the velocity of light to the eye(which in this case may be supposed the same as the velocity of the Earth's annual motion in its orbit) as 10210 to 1, from whence it would follow, that light moves or is propagated as far as from the Sun to the Earth in 8'12".

It is well known that Mr. Roemer, who first attempted to account for an apparent inequality in the times of the eclipses of Jupiter, by the hypothesis of the progressive motion of light, supposed that it spent about 11 minutes of time in its passage from the Sun to us: but it hath since been concluded by others, from the like eclipses, that it is propagated as far in about 7 minutes. The velocity of light therefore deduced from the foregoing hypothesis, is as it were a mean betwixt what had at different times been determined from the eclipses of Jupter's satellites.

These different methods of finding the velocity of light thus agreeing in the result, we may reasonably conclude, not only that these phaenomena are owing to the causes to which they have been ascribed; but also, that light is propagated (in the same medium) with the same velocity after it hath been reflected as before: for this will be the consequence, if we allow that the light of the Sun is propagated with the same velocity, before it is reflected, as the light of the fixed stars. And I imagine this will scarce be questioned, if it can be made appear that the velocity of light of all the fixed stars is equal, and that their light moves or is propagated through equal spaces in equal times, at all distances from them: both which points (as I apprehend) are sufficiently proved from the apparent alteration of the declination of stars of different lustre; for that is not sensibly different in such stars as seem near together, though they appear of very different magnitudes. And whatever their situations are, (if I proceed according to the foregoing hypothesis,) I find the same velocity of light from my observations of small stars of the fifth or sixth, as from those of the second and third magnitude, which in all probability are placed at very different distances from us. The small star, for example, before spoken of, that is almost opposite to gamma draconis, (being the 35th Camelopard Hevelii in Mr. Flamsteed's Catalogue,) was 19" more northerly about the beginning of March than in

September. Whence I conclude, according to my hypothesis, that the diameter of the little circle described by a star in the pole of the ecliptic would be 40", 2.

The last star of the Great Bear's tail of the second magnitude (marked eta by Bayer) was 36" more southerly about the middle of January than in July. Hence the maximum or greatest alteration of declination of a star in the pole of the ecliptic would be 40", 4, exactly the same as was before found from the observations of gamma Draconis.

The star of the fifth magnitude in the head of Perseus, marked tau by Bayer, was 25" more northerly about the end of December than in the 29th of July following: hence the maximum would be 41". This star is not bright enough to be seen as it passes over my zenith about the end of June, when it should be, accornding to the hypothesis, farthest south. But because I can more certainly depend upon the greatest alteration of declination of those stars, which I have frequently observed about the times when they become stationary, with respect to the motion I am now considering; I will set down a few more instances of such, from which you may be able to judge how near it may be possible from these observations to determine with what velocity light is propagated.

Alpha Persei Bayeri was 23" more northerly at the beginning of January than in July; hence the maximum would be 40", 2. Alpha Cassiopea was 34" more northerly about the end of December than in June; bence the maximum would be 40", 8. Beta Draconis was 39" more northerly in the beginning of September than in March; hence the maximum would be 40", 2. Capella was about 16" more southerly in August than in February; hence the maximum would be about 40". But this star being farther from my zenith than those I have before made use of, I cannot so well depend upon my observations of it, as of the others; because I meet with some small alterations of its declination that do not seem to proceed from the cause I am now considering.

I have compared the observations of several other stars, and they all conspire to prove that the maximum is about 40" or 41". I will therefore suppose that it is 40" 1/2, or (which amounts to the same) that light moves or is propagated as far as from the Sun to us in 8'13". The near agreement which I met with among my observations induces me to think, that the maximum (as I have here fixed it) cannot differ so much as a second from the truth, and therefore it is probable that the time which light spends in passing from the Sun to us may be determined by these observations within 5" or 10"; which of such a degree of exactness as we can never hope to attain from the eclipses of Jupiter's satellites.

Having thus found the maximum, or what the greatest alteration of declination would be in a star placed in the pole of the ecliptic, I will now deduce from it (according to the foregoing hypothesis) the alteration of declination in one or two stars, at such times as they were actually observed, in order to see how the hypothesis will correspond with the phaenomena through all the parts of the year.

It would be too tedious to set down the whole series of my observations; I will therefore make choice only of such as are most proper for my present purpose, and will begin with those of gamma Draconis.

This star appeared farthest north about September 7th, 1727, as it ought to have done according to my hypothesis. The following table shows how much more southerly the star was found to be by observation in several parts of the year, and likewise how much more southerly it ought to be according to the hypothesis.

	The difference of declination by observation "	The difference of declination by hypothesiis "		The difference of declination by observation "	The difference of declination by hypothesiis "
1727 Oct 20	4.25	4.25	1728 April 6	36	36.5
Nov17	11.5	12	May 6	28.5	29.5
Dec 6	17.5	18.5	June 5	18.5	20
Dec 28	25	26	June15	17.5	17
1728 Jan 24	34	34	July 3	11.5	11
Feb	38	37		4	4

10			Aug 2		
Mar 7	39	39	Sept 6	0	0
Mar24	37	38			

	The difference of declination by observation	The difference of declination by hypothesiis		The difference of declination by observation	The difference of declination by hypothesiis
	“	“		“	“
1727 Sept14	29.5	28.5	1728 April16	18.5	18
Sept24	24.5	25.5	May 5	24.5	23.5
Oct 16	19.5	19.5	June 5	32	31.5
Nov11	11.5	10.5	June25	35	34.5
Dec 14	4	3	July17	36	36
1728 Feb17	2	3	Aug 2	35	35.5
Mar21	11.5	10.5	Sept20	26.5	26.5

Hence it appears that the hypothesis corresponds with the observations of this star through all parts of the year; for the small differences between them seem to arise from the uncertainty of the observations, which is occasioned (as I imagine) chiefly by the tremulous or undulating motion of the air, and of the vapours in it; which causes the stars sometimes to dance to and fro, so much that it is difficult to judge when they are exactly on the middle of the wire that is fixed in the common focus of the glasses of the telescope.

I must confess to you, that the agreement of the observations with each other, as well as with the hypothesis, is much greater than I expected to find before I had compared them; and it may possibly be thought to be to great by those who have been used to astronomical observations, and know how difficult it is to make such as are in all respects exact. But if it would be any satisfaction to such persons, (till I have an opportunity of describing my instrument and the manner of using it,) I could assure them, that in above seventy observations which I made of this star in a year, there is but one (and that is noted as very dubious on account of clouds) which differs from the foregoing hypothesis more than 2", and this does not differ 3".

This therefore being the fact, I cannot but think it very probable that the phaenomena proceed from the cause I have assigned, since the foregoing observations make it sufficiently evident, that the effect of the real cause, whatever it is, varies in this star, in the same proportion that it ought according to the hypothesis.

But lest gamma Draconis may be thought not so proper to shew the proportion in which the apparent alteration of declination is increased or diminished, as those stars which lie near the equinoctial colure; I will give you also the comparison between the hypothesis and the observations of eta Ursae major, that which was farthest south about the 17th day of January 1728, agreeable in the hypothesis. The following table shews how much more northerly it was found by observation in several parts of the year, and also what the difference should have been according to the hypothesis.

I find upon examination that the hypothesis agrees altogether as exactly with the observations of this star as the former; for in about fifth that were made of it in a year, I do not meet with a difference of so much as 2", except in one which is marked as doubtful on account of the undulation of the air, &c. and this does not differ 3" from the hypothesis.

The agreement between the hypothesis and the observations of this star is the more to be regarded, since it proves that the alteration of declination, on account of the precession of the equinox, is (as I before supposed) regular through all parts of the year: so far at least as not to occasion a difference great enough to be discovered with this instrument. It likewise proves the other part of my former supposition, viz. that the annual alteration of declination in stars near the equinoctial colure, is at this time greater than a precession of 50" would occasion: for this star was 20" more southerly in September 1728, that is, about 2" more than it would have been if the precession was but 50". But I may hereafter, perhaps, be better able to determine this point, from my observations of those stars that lie near the equinoctial colure, at about the same distance from the north pole of the equator, and nearly opposite in right ascension.

I think it needless to give you the comparison between the hypothesis and the observations of any more stars; since the agreement in the foregoing is a kind if demonstration, (whether it be allowed that I have discovered the real cause of the phaenomena or not,) that the hypothesis gives at least the true law of the variation of declination in different stars, with respect to their different situations and aspects with the Sun. And if this is the case, it must be granted that the parallax of the fixed stars is much smaller than hath been hitherto supposed by those who have pretended to deduce it from their observations. I believe that I may venture to say, that in other of the two stars last mentioned it does not amount to 2". I am of opinion, that if it were 1" I should have perceived it, in the great number of observations that I made, especially of alpha Draconis; which agreeing with the hypothesis (without allowing any thing for parallax) nearly as well when the Sun was in conjunction with, as in opposition to, this star, it seems very probable that the parallax of it is not so great as one single second; and consequently that it is above 400,000 times farther from us than the Sun.

There appearing therefore after all no sensible parallax in the fixed stars, the Anti-Copernicans have still room on that account to object against the motion of the Earth; and they may have (if they please) a much greater objection against the hypothesis by which I have endeavoured to solve the forementioned phaenomena, by denying the progressive motion of light, as well as that of the Earth.

But as I do not apprehend that either of these postulates will be denied me by the generality of the astronomers and philosophers of the present age; so I shall not doubt of obtaining their assent to the consequences which I have deduced from them, if they are such as have the approbation of so great a judge of them as yourself. I am,

Sir, your most obedient
humble servant,

J. BRADLEY

Exerpt 2

A DEMONSTRATION CONCERNING THE MOTION OF LIGHT, COMMUNICATED FROM PARIS, IN THE JOURNAL des SCAVANS, AND HERE MADE ENGLISH(Phil Trans vol 12,no 136, June 25, 1677 p893).

Philosophers have been labouring for many years to decide by some experience, whether the action of light be conveyed in an instance to distant places, or whether it requireth time. M.Romer of the R.Academy of the

Sciences hath devised a way, taken from the Observations of the first Satellite of Jupiter, by which he demonstrates, that for the distance of about 3000 leagues, such as is very near the bigness of the Diameter of the Earth, Light needs not one second of time.

Let (in Fig.II.) A be the Sun, B Jupiter, C the first Satellite of Jupiter, which enters into the shadow of Jupiter, to come out of it at D; and let E.FGHKL be the Earth placed at divers distances from Jupiter.

Now, suppose the Earth, being in L towards the second Quadrature of Jupiter, Hath seen the first Satellite at the time of its emersion or issuing out of the shadow in D; and that about 42 1/2 hours after, (viz after one revolution of this Satellite,) the Earth being in K, do see it returned in D; it is manifest, that if the Light require time to traverse the interval LK, the Satellite will be seen returned later in D; than it would have been if the Earth had remained in L, so that the revolution of this Satellite being thus observed by the Emersions, will be retarded by so much time, as the Light shall have taken in passing from L to K, and that, on the contrary, in the other Quadrature FG, where the Earth by approaching goes to meet the Light, the revolutions of the Immersions will appear to be shortened by so much, as those of the Emersions had appeared to be lengthened. And because in 42 1/2 hours, which this Satellite very near takes to made one revolution, the distance between the Earth and Jupiter in both the Quadratures varies at least 210 Diameters of the Earth, it follows, that if for the account of every Diameter of the Earth there wer required a second of time, the Light would take 3 1/2 minutes for each of the intervals GF, KL; which would cause near half a quarter of an hour between two revolutions of the first Satellite, one observed in FG, and the other in KL, whereas there is not observed any sensible difference.

Yet doth it not follow hence, that Light demands no time. For, After M.Romer had examined the thing more nearly, he found, that what was not sensible in two revolutions, became very considerable in many being taken together, and that, for example, forty revolutions observed on the side F, might be sensibly shorter, than forty others observed in any place of the Zodiack where Jupiter may be met with; and that in proportion of twenty two for the whole interval of H E, which is the double of the interval that is from hence to the Sun.

The necessity of this new Equation of the retardment of Light, is established by all the observations that have been made in the R.Academy, and it hath been lately confirmed, for the space of eight years, and it hath been lately confirmed be the Emersion of the first Satellite observed at Paris the 9th of November last at 5 a Clock, 35' 45". at Night, 10 minutes later than it was to be expected, by deducing it from those that had been observed in the Month of August, when the Earth was much nearer to Jupiter; Which M.Romer had predicted to the said Academy from the beginning of September.

But to remove all doubt, that this inequality is caused by the retardment of the Light, he demonstrates, that it cannot come from any excentricity, or any other cause of those that are commonly alledged to explicate the irregularitiesof the Moon and the other Planets; though he be well aware, that the first Satellite of Jupiter was excentrick, and that, besides, his revolutions were advanced or retarded according as Jupiter did approach to or recede from the Sun, as also that the revolutions of the primum mobile were unequal; yet saith he, these three last causes of inequality do not hinder the first from being manifest.

fig 11

Exerpt 3
II. Monsieur Caffini his New and Exact Tables for the Eclipses of the First Satellite of Jupiter, reduced to the Julian stile, and Meridian of London.
by Edmund Halley (Phil Trans v18,no.214,Nov.-Dec. 1694)

Among the Books the Royal Academy of Sciences at Paris has lately gratified the World withal, there is one which has for Title, Recueuil d'Observations faites en plusieurs Voiages pour parfectionner, l'astronomie & la Geographie, Avec divers traitez Astronomiques. In which those Scavans have set a very commendable Example in ascertaining by undoubted observations the true Geographical site of all the Principal Ports of France, which it were to be wished other Nations would imitate. By this Survey they have demonstrated the Encroachments their Geographers, and particularly Sanson, had made on the Sea to enlarge their Kingdom, and have retrenched more of their Usurpations on the West, South, and North, than all their Acquists on the East amount to twice told.

The Method they have used to determine the Longitudes of their Places, is by the Observation of the Eclipses of the First Satellite of Jupiter, which they find almost instantaneous, and with good Telescopes discernable almost to the very Opposition of Jupiter to the Sun: And it may be said, that this Account of the Longitudes observed, has put it past doubt that this is the very best way, could portable Telescopes suffice for the Work. And could these Satellites be observed at Sea, a Ship at Sea might be enabled to find the Meridian she was in, by help of the Tables Monsieur Cassini has given us in this Volume, discovering with very great exactness the said Eclipses, beyond what we can yet hope to do by the Moon, tho'they seem to afford us the only means Practicable for the Seaman. However before Saylors can make use of the Art of finding the Longitude, it will be requisite that the Coast of the whole Ocean be first laid down truly, for which work this Method by the Satellites is most apposite: And it may be hoped that either the true Geometrick Theory of the Moon may be discovered, by the time the Charts are compleated; or else that some Invention of shorter Telescopes manageable on Ship-board, may suffice to shew the Eclipses of the Satellites at Sea, at least those of the Third Satellite, which fall at a good distance from the Body of Jupiter, being near three times as far from him as the first.

The last but most considerable Treatise of this Collection gives the aforesaid Tables for computing the Motions of Jupiter's Satellites, but more especially those, for speedy finding the Eclipses of the first or innermost. Wherein Monsieur Cassini has employed his Skill to make easie and obvious to all Capacities the Calculation of them, which is otherwise operose to the Skilful, and not to be undertaken by the less knowing, who yet perhaps woud be willing to find the Longitude of the Places they live in.

These Tables have for Principles, That the innermost Satellite revolves to the Sun in 1d 18h 28' 36" so precisely, that in 100 Years the difference is not sensible; That in the time of the Revolution of Jupiter to his Aphelion, which he supposes in 4332d 14h 52' 48", this Satellite makes exactly 2448 Months or Revolutions to the Sun: and dividing the Orbit of Jupiter into 2448 parts, he has in a large Table of Equation shewn what is the inequality of the Motion of Jupiter in each revolution reduced to Time assuming Thirdly, the greatest Equation of Jupiter 5degrees 30'. whence the hourly Motion of the Satellite from Jupiter being 8degree 26'1/4, it follows, that the greatest inequality (Jupiter passing the Signs of Cancer and Capricorn,) amounts to 39'8" of time, to be added in Cancer, subtracted in Capricorn. Lastly, As to the Epocha or beginning of this series of Revolutions, he has determined the Aphelion of Jupiter about 1 1/2 Degree forwarder than Astronomia Carolina, and above 2 Degrees more than the Rudolphine Tables, viz precisely in 9degree of Libra, in the beginning of this Century, which perhaps he finds the proper Motion of Jupiter about the Sun at this time to require; and the number of Revolutions since Jupiter was last in Perihelio, is here titled Num. I.

A second Inequality is that which depends on the distance of the Sun from Jupiter, which he says Monsieur Romer did most ingeniously explain by the Hypothesis of the Motion of Light; to which yet Cassini by his manner of calculus seems not to assent, though it be hard to imagine how the Earth's Position in respect of Jupiter should any way affect the Motion of the Satellites. This Inequality he makes to amount to two Degrees in the Satellite’s Motion, or 14'10" of Time, wherein he supposes the Eclipses to happen so much sooner when Jupiter Opposes the Sun, than when he is in Conjunction with him. The distribution of this Inequality he makes wholly to depend on the Angle at the Sun between the Earth and Jupiter, without any regard to the Eccentricity of Jupiter, (who is sometimes 1/2 a Semi-diameter of the Earth's orb farther from the Sun than at other times) which would occasion a much greater difference than the Inequality of Jupiter and the Earth's Motion, both of which are accounted for in these Tables with great Skill and Address. But what is most strange, he affirms that the same Inequality of two Degrees in the Motion, is likewise found in the other Satellites, requiring a much greater time, as above two Hours in the fourth Satellite: which if it appeared by Observation, would overthrow Monsieur Romer's Hypothesis entirely. Yet I doubt not herein to make it demonstratively plain, that the Hypothesis of the progressive Motion of Light is found in all the other Satellites of Jupiter to be necessary, and that it is the same in all; there being nothing near so great an Annual Inequality as

Monsieur Cassini supposes in their Motions, by his Table, pag.9 and his Praecepta Calculi. The Method however used to compute this is very Curious; for having found that whilst the Sun revolves to Jupiter there pass 398d 21h 13’. wherein are made 225 3/8 Revolutions of the Satellite to Jupiter, the number of Revolutions since Jupiter was last in Opposition to the Sun, is what he calls Num.II. in which the Inequality of the Earth's Motion is allowed for in the Months, and that of Jupiter's Orb by a Table of Equation of Num. II. amounting in all to 3 1/2 Revolutions of the Satellite to Jupiter. This in the Tables following I have thought set to leave out, shewing how to find it by help of the former Equation of Num.I. The Numbers are in effect the same with Monsuieur Cassini's, only reduced to our Stile and Meridian, and the form of them abridged, and it is hoped amended.

This last Table of the equation of Natural Days might have been spared, as being published in several other places, but it was thought proper to have all the Elements of this Calculus together, that there might be no occasion of any other book to perform it.

The Use of the Tables

To any given year, Month, and Day, to find the next Eclipse of the first Satellite of Jupiter.

I. In the Table of Epoche (pag.240) find the Year of our Lord, and set down the Day, Hours, Minutes, and Seconds, with the Num.I. and Num.II thereto annext; and (in pag.241 and the following) seek the Month, and day of the Month, with the Hours and Minutes, and Num.I. and II. affixt, and add them together: and the respective Suns shall shew the mean time of the middle of the Eclipse sought, with Num.I. and Num.II. required. But it must be observed, that in January and February in the Leap Year one Day is to be added to the Day thus found.

II. If Num.I. be found less than 1224 with Num.II; or if greater than 2448, Substracting 2448 therefrom, with the residue, enter the Table, pag.245 and you will have the first Equation to be added to the mean Time before found. But if Num.I. be less than 2448, but greater than 1224, Substract it from 2448, and entering the same Table with the remainder, you shall have the first Equation to be substracted from the mean Time. Then Divide the Minutes of the said first Equation by II, or rather 3 4/3 and the Quote shall be the Equation of Num.II. (answering to the Eccentrick motion of Jupiter) to be added thereto when the first Equation Substracts, and e contra substracted when that adds.

III. If Num.II. thus aequated exceed 225,4, Substract 225,4 therefrom and if the remainder or Num.II be less than 113, with the said remainder or Number; or if greater than 113, with the complement thereof to 225,4 seek in Table pag.246. the second Equation, which being added to the Time before found, gives the true Time of the middle of the Eclipse.

IV. With Num.I. in Tab. pag.247, seek the half Continuance of the Total Eclipse, which is to be added for the Emersion when the equated Num.II. is less than 113, or if more than 225,4, it be less than 338. But if it exceed 113 or 338, then the Semimora to be substracted for the Immersion.

V. Lastly, with the Sun's true Place take out the equation of Natural Days (in Tab. pag. 248) which added or substracted according to the Title, gives the time of the Immersion or Emersion sought.

Now how few Figures serve for this Computation, will best appear by an Example or two.

Anno 1677. September 17th. 8h9'40" at Greenwich, Mr.Flamsteed observed the first Satellite to begin to Emerge; that is 8h9'20". at London.

					Num.I.	Num.II.
1677.	0d	3h	I4'	36"	2028	102,5
Sept.	17	4	4	12	147	145,5
Sept.	17	7	18	48	2175	248,0
Equat.I. --			26	11	2448	2,3 +
	17	6	52	37	273	250,3
Equat.2. +			1	39		225,4
Semimora +		1	7	0		24,9
Equal T	17	8	1	16		
Equation +			9	25		
Appar.T	17	8	10	41		
Obser.		8	9	20		
Error		-	1	21		

Again, Anne 1683. November 30th 16th 48' 40". under the Meridian of London, the Immersion of this Satelite was observed by E. Halley.

					Num.I.	Num.II.
1683	0d	5h	21'	24"	818	213,6

Nov	. 30	12	5	24	189	188,2
Nov.	30	17	26	48	1007	401,8
Equat.I. +			19	52		1,8 -
Equat.2. +			6	0	II)20(1,8 -	400,0
						225,4
Nov.	30	17	52	40		
Semimora -		1	6	36		174,6
						50,8
Tempeq.	.30	16	46	4		
Equat.T.+			6	3		in
Nov.	30	16	52	7		Temp. appar.
Obser.		16	48	40		
Error		-	3	27		

A third Example shall be the emersion Observed at Paris by Monsieur Cassini Anno 1693. January 14th 10h 40'28". that is, at London at 10h 30' 48".

					Nom.I.	Num.II.
1693.	0d	5h	11'	48"	434	23,9
Jan.	14	3	48	48	8	8,2
Equat.I. +			36	8	442	32,1
Equat.2. +			2	13		3,2 -
Semimora		1	4	57		
					II)36,(3,2-	28,9
Temp.eq	. 14	10	43	54		
Equat. -			13	15		in
Januarii	14	10	30	39		Temp. app
Obser.		10	30	48		
Error		+	0	9		

After this manner I Have compared these Tables with many good and certain Observations, and scarce ever find them err above three or four Minutes of Time; Which Proceeds, as may well be conjectured, from some small Eccentricity in its Motion, and from the Oval Figure of Jupiter's Body, whose quick diurnal Rotation has by its Vis Centrifuga dilated his Equinoctial, and made his meridians much Elliptical, so as to be discernable by the Telescope. Mr.Newton has shewn that his Polar Diameter is to that of his Equinoctial as 40 to 41 nearly. But we may hope future Observations may shew how to divide those compounded causes of error, and correct them; which Errors are exceeding small in comparison of the short time that the Satellites have been discovered and argue the Skill an Diligence of the deservedly Famous Author of these Tables.

I had almost forgot the Construction of the Table, pag 247 shewing the half continuance of these Eclipses: In this the Semidiameter of the shadow of Jupiter is made by Cassini just 10 Degrees, and that of the Satellite 30'; and the Satellites Ascending Node being supposed in 15 degrees of Aquarius, at the end of this Century, (that is 55degrees20' before the Peribelion of Jupiter) it will thence follow, that Num.I.being 816 or 2102, Jupiter passes the Nodes of the Satellites Orb, and consequently these Eclipsese are Central, and of the greatest Duration. But Num.I. being 215 or 1481, the satellite passes the shadow with the greatest Obliquity, viz 20° 55' from the Center, whence the Semimora be comes of all the shortest. This Table is not however so nicely computed, but that it may admit of Correction in the seconds, if a small part of a minute were considerable in this affair.

The Tables of the other Three Satellites not being so perfect or exact as those of the first, having greater inequalities, are here given in another form, requiring the assistance of the Tables of Jupiter's proper motion. The Periods of their Revolutions to Jupiter's shade are as follows:

Period. Secondi.	3d	13h	17'	54"	3'''	sive 2 1/23 Rev.primi.
Period. Tertii.	7	3	59	39	22	sive 4 3/21 Rev.primi.
Period. Quarti.	16	18	5	6	50	sive 9 7/15 Rev.primi

Whence the Table of the Equation of the first Satellite, pag.245, or Monsieur Cassini's larger Table, may by an easie Reduction serve the other three; the Equation of the Second being 2 1/123, or twice the Minutes with half so many Seconds as there are Minutes in the Equation of the first, and the greatest Equation thereof 1h 18' 35". The Equation of the Third is 4 1/20 times greater than that of the First, and when greatest amounteth to 2h 38' 29". And the Equation of the fourth being 9 7/15 times that of the First, is had by Substracting 1/2 and 1/30 from ten times the Equation of the First, whence the greatest becomes 6h 10' 28". So that Num.I. and Num.II. as here collected for the First, may indifferently serve all the rest.

As to the Second Equation of the other Satellites, Monsieur Cassini has, by his praecepta Calculi (as is before mentioned) supposed the Minutes thereof to be increased in the same proportion; as instead of 14'10" in the first, to be 28'27". in the Second, 57'22". in the third, and no less than 2h 14'7". in the Fourth; whereas if this second Inequality did proceed from the successive propagation of Light, this Equation ought to be the same in all of them, which Monsieur Cassini says was wanting to be shewn, to perfect Monsieur Romer's Demonstration; Wherefore he has rejected it as ill founded. But there is good cause to believe that his motive thereto, is what he has thought not proper to discover. and the following Observations do sufficiently supply the Defect complained of in the
making out of that Hypothesis.

Anno 1676. Octob. 2. Stil 6h10'37" app. but 5h59'37". aeq. time, Monsier Cassini at Paris observed the Emersion of the Third Satellite from Jupiter's shadow. And again, Novemb.14 following, 6h20'55".app. Time, but 6h5d5" aeq. T. he observed the like Emersion of the same Satellite. The observed Interval of Time between these Emersions was 43d0h6'18" which is 8'22" more than 6 mean Revolutions of this Satellite, of which 4'27" arises from the difference of the first Aequations and the greater continuance of the latter Eclipse; so that the other 4 Minutes is all that is left to answer for the difference of the second Aequations; and NumII in that time increasing from 48 to 72, gives 4'.36" for the difference of the second Aequations of the First Satellite, So that here the second Aequation of the Third is found rather less than that of the First, but the difference is so small, that it may rather be attributed to the uncertainty of Observation. Whereas according to Monsieur Cassini's Method of Calculating instead of four Minutes it ought to be 18'38" and the Interval of these two Emersions 43d0h21' exceeding the Time observed by a whole quarter of an hour; which that Curious Observer could not be deceived in.

The like appears yet more evidently in the Fourth Satellite. By the Observation of Mr. Flamsteed at Greenwich, Anno 1682: Sept 24 degrees 17h 45' T app. but 17h 32' 1/2 T.aeq. the fourth Satellite was seen newly come out of the shadow, so that about 17h30' T aeq. the first beginning of Emersion was conjectured; and after five Revolutions, viz Decemb. 17d 11h 16' or llh 18'. T. aeq. he again observed the first appearance of the satellite beginning to emerge, that is, after and interval of 83d17h48'; whereas this Satellite makes five mean Revolutions in 83d18h25' 1/2 . Here we have 37' 1/2 to be accoounted for by the several Inequalities. Of this 21' is due to the first Aequations, which is reduced to 19' by the greater continuance of the latter Eclipse, Jupiter then approaching to his descending Node: So that there remains only 18' 1/2 for the difference of the Second Aequations,whilst the Earth approached Jupiter by more than the Radius of its own Orb; and the difference of the second Aequations of the First Satellite being according to Cassini 8’ 30”, the said difference in the Fourth ought to be 1h 20’ 1/2 instead of 18 1/2; whence the Interval of these two emersions would be according to his precepts, but 83d 16h 46’ instead of 83d 17h 48’ observed. And whereas 18’ 1/2 may seem too great a difference; it must be noted, first that Monsieur Romer had stated the whole second Aequation 22’ 00”, (vide Phil Trans Num 136) which Monsieur Casssini has diminished to 14’10”; so that instead of 8’ 1/2; Monsieur Romer allows above 13’; and secondly, that in the first of these Observations, being about half an hour before Sunrise the brightness of the morning might well hinder the feeling of this smallest and slowest satellite, till such time as a good part thereof was emerged.

But I have exeeded the Bounds of my intended discourse, and shall only Advertise, that these Tables are not Printed with the usual Care of the Imprimerie Royale a Paris, that the Tabula Revolutionum primi Satellitis Jovis in Annis 100 pag 13 &seq. is faulty in these Years 16,39,55,98,99 as is also the Epocha for the Year 1700 pag 99 where pro NumI 1853 lege 1873, and pro NumII 1004 lege 110,4: And that the Number of Revolutions of the Second Satellite in 100 Years pag. 60,61 of the Third, pag. 76,77; and of the fourth, pag. 90,91 are by a gross mistake of the calculator all false and erroneous, and must be amended by whosoever would use them . Which yet ought not in the least to be attributed to the Excellent Author but rather to the negligence of those employed by him. The Reader hereof is desired to amend these following Errata which were discovered when it was too late.

ERRATA pag238 lin24[p70 li4] pro 5degrees 30’leg 5 degrees 31’ 40” lin 25[li5] pro 8degrees 28’ 1/2 .

Excerpt 4

ON AN EXPERIMENT RELATIVE TO THE SPEED OF PROPAGATION OF LIGHT by M. H.Fizeau (Comptes rendus tome 29, p90, 1849)

I have succeeded in rendering sensible the speed of propagation of light by a method which seems to me to furnish a new way of studying with precision this important phenomena. This method is based on the following principles:

While a disc turns in its plane around the center of the disc with a great rapidity, one can consider the time employed by a point on the circumference for going through a very little angular space , for example 1/1000 of the circumference.

When the speed of rotation is very great, the time is generally very short; for ten and one hundred turns per second, it is only 1/10000 and 1/100000 of a second. If the disc is divided at its circumference in the manner of a toothed wheel [cogwheel, gearwheel], in equal intervals alternatively empty and full we will have for the duration of passage of each interval through the same point in space, the same very little fractions.

In considering the effects produced when a ray of light traverses the divisions of none such disc in movement we arrive at this result, that if the ray after its passage is reflected by means of a mirror and sent back to the disc, in the manner that it meets again in the same point of space the speed of propagation of light will be able to occur in such a way that the ray will traverse or will be intercepted depending on the speed of the disc and the distance at which will be placed the reflection.

Elsewhere, a system of two telescopes directed the one toward the other so that the image of the ojective of each of these is formed at the focus of the other, possesses some properties which permit the realisation of these conditions in a simple manner. It suffices to place a mirror at the focus of one and of modifying the ocular system of the other by interposing between the focus and the ocular[eyepiece] a transparent galss inclined on the axis by 45 degrees and being able to receive laterally the light of a lamp or of the Sun that it reflects to the focus. With this disposition, the light which traverses the focus in the supposed very little extension of the image which represents the objective of the second telescope is projected toward this latter is reflected at its focus and returns backwards crossing the same space in order to pass again through the focus of the first telescope, where it can be observed by means of the eyepiece through the glass.

This setup succeeds very well even in separating the telescopes by considerable distances; with the telescopes of 6 centimeter apertures the distance can be 8 kilometers without the light being too feeble. We see than a luminous point resembling a star and formed by the light which has departed form this point and has traversed a space of 16 kilometers from this point, then is returned to pass exactly by the same point before reaching the eye.

It is over this same point that it is necessary to make pass the teeth of a turning disc in order to produce the indicated effects; the experiment succeeds very well and one observes that according as the speed of rotation is more or less great, the luminous point shines with brilliance or is eclipsed entirely. In the circumstances where the experiment was performed, the first eclipse was produced approaching 12.6 turns per second. At twice the speed, the point shone again; at triple the speed it produced a second eclipse at quadruple the speed the point shone again, etc.

The first telescope was placed in the belvedere of a house situated in Suresnes, the second on the top of Montmartre, at a distance approximately 8633 meters.

The disc carrying seven hundred and twenty teeth was raised on clockwork moved by weights and constructed by M. Froment; a counter permitted measurement of the speed of rotation. The light was supplied by a lamp set up in a manner to offer a very vivid source of light. [Cornu's modification of Fizeau's original apparatus was subsequently placed in the Nice Observatory where it may still be]

The first attempts furnished a value of the speed of light little different from that which is acknowledged by astronomers. The average deduced from twenty eight observations which have been possible to do up to the present times gives for this value 70948 leagues of 25 to a degree.

I will have the honor of submitting to the judgement of the Academy a detailed Memoire when all the circumstances of the experiment will have been able to be studied in a more complete manner.
[In lieu of this account which I have been unable to find as of yet, the following account of Fizeau's experiment by Foucault- whose modification of Fizeau's method was used and improved upon by others culminating in those of Michelson- is given below]

On the Speed of Light in Air and Water 1853 Doctoral Thesis also Ann. de Ch et de Phys XLI.(from p194 historic preliminaries in the collected papers of Foucault)

The apparatus conceived by Fizeau presents for consideration two distinct parts: one system of two telescopes one facing the other at a very great distance and destined to unite the course of luminious rays and to reflect them exactly back to their point of departure; then a turning disc partitioned over its circumference in the manner of a toothed wheel with equal segments alternatively solid and empty, and susceptible of taking by the action of a motor variable speeds chosen at will.

The two telescopes A and B are directed the one toward the other in a manner such that the image of the objective of each is formed at the focus of the other, the light proceeding laterally from one very vivid source is directed on the axis of a system through a glass without silvering inclined at 45 degrees to the axis and placed between the ocular and the focus of the telescope A. All which falls of the light on the objective of A after having traversed in its focus the place of the very little image of the objective of the other telescope B is directed toward this telescope B in obedience to the law of conjugate foci. Similarly here, the rays come together to converge at the focus of the second telescope B in an image that represents in terms of very little dimensions the objective of the first; then this image falling on a normal mirror the bundle or pencil of light rays that it has formed is reflected on itself across succesively the two objectives whatever be their distance and proceeds in converging to come again exactly to the focus of A its point of departure.   One observes easily their return: By putting the eye to the ocular one notices a very little image a luminous point like a star.

The time that the light employs to cross two times the apparatus in all its length depends evidently on the distance apart of the two telescopes and when one renders this distance sufficiently great it becomes sensible and measurable to employ some turning disc.

The position to give to the disc is defined by the condition of parallelism of its axis of rotation with the optical axis common to the two telescopes and by the necessity of making[the optical axis] to pass through the teeth that it carries on its circumference through the point to the meeting of the rays which cross at the focus of A before and after their excursion in the apparatus

These conditions being satisfied the disc in turning has the effect of posing and raising the same obstacle of passage of the rays proceeding in inverse senses the one going the others coming. As the speed of the light is not infinite as the distance to travel through is very great, the precise instant of departure and return of one and the same ray does not coincide exactly; they are sensibly posterior the one to the other and it is possible to give to the disc a speed such that any ray which passes freely between two teeth be intercepted on its return by a tooth which will have had the time to come to make to it an obstacle. It is equally possible to give to the disc such another speed which will permit any ray admitted between two teeth to come again through another segment. But as the changes of speed take place in a continuous manner the phenomena also vary little by little and pass gradually through their different phases. At the moment where the disc begins to move the observer notices at the focus of the ocular the luminous point shining at the point of convergence of the reflected rays which come back to the point of convergence; then in taking a movement more and more rapid the disc determines a progressive weakening and even complete extinction of the returning rays. Through always increasing speeds this first eclipse is succeeded by a second brilliance then a second eclipse and on and on as many times as the power of the mechanical means permits.

The observation consists of producing, sustaining and measuring by means of a counter intrinsic to the machine the speed of rotation corresponding to an eclipse of which one notes the number of the order. The distance between the two telescopes being known gives half of this total intervening space jumped across by the light during the time that the disc employs to run through an angular space measured by the first eclipse by the arc sustained by a single tooth and measured by the succeeding eclipses by the same arc multiplied by the term of the natural series of odd numbers corresponding to the number of the order of the observed eclipse.

Fizeau had placed the telescope with the ocular [eyepiece] in the belvedere of a house situated in Suresne and the lens of reflexion on the heighths of Montemartre at a distance approximately of 8633 meters. The disc carrying seven hundred and twenty teeth[e.g.if one meter radius,4.4mm wide teeth and gaps] was mounted on clockwork moved by weights; a counter permitted estimation of the speed of rotation. The light was provided by an aether lamp of which the flame fed by oxygen was thrown out over a fragment of lime in a way to excite a vivid incandescense.

The first tentative attempts up to the present by this method have furnished a value of the speed of light little different from that which is allowed by astronomers. The average deduced from twenty eight observations gives for this value 70,948 leagues of 25 to a degree.

[Translating leagues into kilometers we have r=17.266km. so that if light left from the beginning of a gap and ignoring the process of reflection traveled this distance before returning to the start of the next 4mm gap where the tooth width was also 4mm and the speed of the wheel was such that it took 55.66microseconds for a point to move 4mm along the radius at this distance from the centert approximately then the speed of light was c= (3.102)10^8 near the 2.9973(10^8) value for the accepted measurement today of light speed in a vacuum]

Excerpt 5 from Experimental Determination of the Velocity of Light by A.A. Michelson, Master U.S.N.   U.S.Nautical Almanac 1879

In November 1877 a modification of Foucault's arrangement suggested itself by which this result,[an increase in the deflection observed by Foucault] could be accomplished
... At the expense of $10 a revolving mirror was made which could execute 128 turns per second... Accordingly the same lens(39foot focus) was eployed, being placed together with the other pieces of apparatus, along the north sea-wall of the Academy grounds, the distanct being about 2000 feet....The image of the slit...toward Sunset became clear and steady. It was thus demonstrated that with this distance and a deflection of 100 millimeters this measurement could be made within the ten-thousandth part.

In order to obtain this deflection it was sufficient to make the mirror revolve 250 times per second and to use a radius (distance of slit to revolving mirror) of about 30 feet. In order to use this large radius it was necessary that the mirror should be large and optically true; also, that the lens should be large and of great focal length. Accordingly the mirror was made 1.25" in diameter, and a new lens 8" in diameter, with a focal length of 150feet was procured.

In January,1879 an observation was taken using the old lens, the mirror making 128 turns per second. The deflection was about 43 millimeters. The micrometer eyepiece used was substantilly the same as Foulcault's except that part of the inclined plate of glass was silvered, thus securing a much greater quantity of light. The deflection having reached 43 millimeters, the inclined plate of glass could be dispensed with, the ight going past the observer's head throught the slit and returning 43 millimeters to the left of the slit, where it could be easily observed.

Thus the micrometer eyepiece is much simpified and many possible sources of error are removed.... The first observation with the new lens was made Jan 30 1879. The deflection was 70 millimeters. The image was sufficiently briht to be observed without the slightest effort. The first observation with the new micrometer eyepiece was made April 2, the deflection being 115 millimeters.

Theory of the New Method

Let S, fig. 1, be a slit, through which light passes, falling on R, a mirror free to rotate about an axis ar right angles to the plane of the papaer; L, a lens of great focal length, upon which the light falls which is reflected from R. Let M be a plane mirror whose surface is perpendicular to the line RM, passing through the centers of R,L, and M, respectively. If L be so placed that an image of S is formed on the surface of M then, this image acting as the object, its image will be formed at S, and will conincide, point for point, with S.

If, now R be turned about the axis so long as the light falls upon the lens, and image of the slit will still be formed on the surface of the mirror, though on a different part, and as long as the returning light falls on the lens an image of this image will be formed at S, notwithstanding the change of position of the first image at M. This result, namely, the production of a stationary image of an image in motion, is absolutely necessary in theis method of experiment. It was first accomplished by Foucault, and in a manner differing apparently but little from the foregoing.

In his experiments L, fig 2, served simply to form the image of S at M and M the returning mirror was spherical, the center coinciding with the axis of R. The lens L was placed as near as possible to R. The light forming the return I age lasts, in this case, while the firt image is sweeping over the face of the mirror, M. Hence, the greater the distane RM, the larger must be the mirror in order that the same amount of light may be preserved, and its dimensions would soon become inordinate. The difficulty was partly met by Foucault, by using five concave reflectors instead of one, but enen then the greatest distance he found it practicable to use was only 20 meters.

Returning fo Fig.1, suppose that R is in the principal focus of the lens L; then, if the plane mirror M have the same diameter as the lens, the first or moving image,will remain upon M as long as the axis of the pencil of light remains on the lens- and this will be the case no matter what the distance may be!

When the rotation of the mirror R becmes sufficiently rapid, then the flashes of light which produce the second or stationary image become blended, so that the image appears to be continuous. But now it no longer coincides with the slit, but is deflected in the direction of rotation, and through twice the angular distance described by the mirror, during the time required for light to travel twice the distance between the mirrors. This displacement is measured by the tangent of the arc it subtends. To make this as large as possible, the distance between the mirrors, the radius, and the speed of rotation should be made as great as possible.

The second condition conflicts with the first, for the radius is the difference between the focal length for parallel rays, and that for rays at the distance of the fixed mirror. The greater the distance, therefore, the smaller will be the radius.

There are two ways of solving the difficulty: first, by using a lens of great focal length; and secondly, by placing the revolving mirror within the principal focus of the lens. Both means were employed. The focal length of the lens was 150 feet, and the mirror was placed about 15 feet within the principal focus. A limit is soon reached, however, for the quantity of light received diminishes very rapidly as the revolving mirror approaches the lens.

The site selected for the experiments was a clear, almost level, stretch along the north sea-wall of the Naval Academy. A frame building was erected at the western end of the line.

The building was 45 feet long and 14 feet wide, and raised so that the line along which the light traveled was about 11 feet above the ground. A heliostat[a mirror tracking the Sun and reflecting the Sunlight in a fixed direction] at [one corner] toward a mirror which reflected the Sun's rays through the slit at S to the revolving mirror(fig 4) thence through a hole in a shutter, through a lens and to a distant mirror....

[The observer sits with an eyepiece in front of him on a frame that can be slid back and forth] ... In measuring the deflection the eye piece, a single achromatic lens,is moved till the silk fiber cross hair[at the focus of the eyepiece 2 inches away and nearly in the same plane as the face of the slit] bisects the slit and the reading of the scale and divided head gives the position.(fig 8) Then the eyepiece is moved till the cross hair bisects the detected image of the slit; the reading of scale and head are again taken and the difference in readings gives the deflection. ...

Method Followed in Experiment

... The method followed in experiment was as follows: The fire was started half an hour before and by the time everything was ready the gauge would show 40 or 50 pounds of steam.[hot air from this device went through a tube to fan blades attached to a vertical rod on which was fixed a mirror; the hot air made the vertical rod and mirror spin] The mirror was adjusted by signals. The heliostat was placed and adjusted. The revolving mirror was inclined forward and backward, till the light was seen reflected back from the distant mirror. This light was easily seen through the coat of silver on the mirror.

The distance between the front face of the revolving mirror and the crosshair of the eye piece was then measured by stretching from the one to the other steel tape, making the drop of the catenary about an inch as then the error caused by the stretch of the tape and that due to the curve just counterbalance each other.

The position of the slit, if not determined before, was then found as before described. The electric fork was started, the temperature noted, and sound beats between it and the standard fork counted for 60 seconds[the details of this method and the details of the fan and boiler a apparatus have been omitted]. This was repeated two or three times before every set of observations.

The eyepiece of the micrometer was then set approximately and the revolving mirror started If the image did not appear, the mirror was inclined forward or backward till it came in sight.

The cord connected with the valve was pulled right or left till the images of the revolving mirror represented by the two bright round spots to the left of the cross hair, came to rest(fig13). Then the screw was turned till the crosshair bisected the deflected image of the lit. This was repeated till ten observations were taken, when the mirror was stopped, temperature noted, and beats counted. This was called a set of observations Usually five such sets were taken morning and evening."

Ferromagnetism, Diamagnetism and Paramagnetism:

We will try to show that ferromagnets are similar to ferroelectrics but on a smaller scale. That is ferroelectrics involve charge polarization on a molecular level while ferromagnets involve charge polarization on a subnuclear and subelectronic scale. The standard explanation of paramagnetism due to atoms with odd electrons and a net spin is modified only to the extent that the spin of atomic electrons is attributed to charge polarization inside the electrons. The standard explantion of diamagnetism is modified only to the extent that the induction of opposite atomic and molecular currents is attributed to a sequence of static inductive effects occurring over very short time periods as described previously in the sections dealing with induction and radiation. The main implication of this revision of standard theory is that there are previously disregarded interactions between magnetic materials and sources of electrostatic fields.

We will also show how this theory can explain otherwise unexplained phenomena such as the Graneau effect inolving retrograde rail gun motions.

The force between an Amperian current element and a magnetic dipole perpendicular to the current element is equivalent to the force between a current carrying coil and a current element which Ampere showed was nil.

Does this mean there is no force between an Amperian current element and a permanent magnet. Although a current carrying circle produces a field equivalent to a magnetic dipole there are perhaps other things that can produce such a field.

We can associate with the Amperian current element an electrostatic dipole transverse to the current with components in each of two directions perpendicular to each other and to the current. For example if we have a circle of current carrying wire in a horizontal plane at the base of a cone and a small horizontal current carrying wire segment or current element at the apex of the cone we can analyse the force between a current element of the circle and the current carrying wire segment at the apex in terms of these electrostatic dipoles.

Suppose the distance between the elements is denoted r, then we can define a horizontal electrostatic dipole $rI^2/(3^{1/2})ic$ associated with current element in the circle and another vertically oriented electrostatic dipole $ri^2/(3^{1/2})Ic$ associated with the lone apex current element. c denotes the speed of light. The rationale

for this definition is given below. We then project the horizontal dipole onto the line r through an angle denoted, α, between r and the radius of the circle denoted, b, and project the vertical dipole at the apex also onto r through the angle 90-α. The product then with k=(3)(9)(10^9) gives us $k(rI^2/(3^{1/2})ic)\sin\alpha$ times $(ri^2/(3^{1/2})Ic)\cos\alpha$ divided by r^4. which reduces to the familiar inverse r^2 Amperian force between current elements of length, ds where ds= bdθ. (that is
F=(2)(9)(10^9)/((rc)^2)(ids sinacosB)(i'ds'sina')(1/2)(Ids cosa)(i'ds'cosa'))
is the current element formula in general while
G=(3)(9)(10^9)/r^4)(-(pdscosa cosB)(p'ds'cosa') + 2(p ds sina)(p'ds'sina')) is the electrostatic dipole formula in general)
When we integrate around the circle we can ignore the horizontal dipole at the apex and the vertical dipoles of the circle elements because interactions with opposite current directions in the circle cancel.

So we see here how an electrostatic dipole can be associated with a current element and how this can be done consistent with Ampere's mathematically and experimentally proven claim that the force of a circle of current on a current element is nil.

. We can also show that it is plausible to associate an electrostatic dipole with a unit element of a magnetic material. That is that the magnetic dipole can be viewed as an electrostatic dipole or as a large number of such dipoles with small distances between the poles of each dipole. An inverse distance square force is obtained if we can represent the electrostatic dipole transverse to the current element as having a magnitude ri^2/cNI^* and the magnetic dipole can be represented as an electrostatic dipole $(r)(NI^{*2})/ci$ where the magnetic dipole M=mL is such that $KMM/r^2 = [(k)(r)(NI^*)^2/cNI^*]^2$ divided by r^4 and where for mks units K is 4 π times 10^{-7} and k= 9 times 10^9 . The product of these two types of electrostatic dipoles thus reduces to an inverse distance squared ponderomotive force.

And representing the magnetic dipole as an electrostatic dipole in this way requires experimental proof of the interaction of a magnet with an electrostatic dipole. We have previously shown the reaction of an electrostatic dipole and a current element that tends to support the claimed interaction and formula. Also such an equation and the variation of the force with the relative orientation of the current element and the magnetic dipole can be verified with experiments involving rail guns as discussed below.

What is the rationale for the representation of the current element and the magnetic dipole as electrostatic dipoles defined in this way. We have already noted several other phenomena that suggest that the electric dipole associated with a current element i, interacting with another say parallel current element, I, r meters away is ri^2/cI so that the attraction between them is kri^2/cI times rI^2/ci divided by r^4, where k=9 times10^9 and c is the speed of light. If the elements were antiparallel the force between the elements would be a repelling force of the same magnitude.

That is the first dipole not only attracts or repels the second but acts transversely to inhibit the effect of the longitudinal emf force producing the second transverse dipole. This inhibiting force is inversely proportional to r and to the ratio of the second current to the first. That is the extent of the dipole is proportional to r and to the ratio of the first current to the second. Similarly for the second dipole. In summary, the same force that produces an attraction between two parallel current elements also tries to create longitudinal dipoles and so interferes with the emf force producing the currents and the transverse dipoles.

Now if we substitute for the first parallel current element in the above formula a cylindrical magnet perpendicular to the the second current element this magnet will attract the other current element but it will also depending on how close it is inhibit the transverse charge polarization in that current element.

This is the well documented phenomena of magnetoresistance. That is the strength of the current as measured by its magnetic effects is reduced by the proximity of a magnet in addditon to the one used in measuring the strength of the current some of which is passed through an ammeter.

We can associate with this magnet, N current elements perpendicular to the magnet eg the magnet is in the horizontal plane and the magnetic field lines through the magnet are say on a horizontal x axis and the current elements are on a vertical axis or on a horizontal axis perpendicular to the x axis. The value of N is such that these N elements of strength I* should produce N electrostatic rI*/c dipoles that in total have the same ponderomotive effect as the magnet. Of course there are limits on how many unit current elements and dipoles can exist in a given volume of current carrying wire and similarly for how many dipoles can exist in a given volume of a magnetic material.

Before we knew that electrostatic dipoles transverse to a current produced the magnetic effect of a current carrying wire, the circuit elements associated with a magnet are part of a closed circular circuit and distributed along the circle in a plane perpendicular to the axis through the poles of the magnet. If we were to partition such a circle into say 360 arc segments and associate a certain number of electrostatic dipoles with each segment perpendicular to the segment we would arrive at a similar total dipole proportional to the current running through the circular circuit. That is if we considered the interaction of each such dipole projected on a line toward a point say on a line axial to the circle and did this for each segment and added up these effects they would be comparable to that of a total dipole NrI*/c.

For example consider a magnet of length 2h and pole strength in webers, m, and so of a magnetic moment M=2hm. Note the force in newtons between a pole m and another pole r meters away,m', is $\pm kmm'/r^2 = f$ where $k= 1/4\pi\mu_0$ where $\mu_0= (4\pi)(10^{-7})$ so $k= [1/(158)][10^7]$.

Typically the pole m is within an order of magnitude of $10^{-4.5}$ webers and the force at one meter then is $1/[(158)(10^{-7})]$ times 10^{-9} or 6.33 times 10^4 times 10^{-9} newtons or 10^{-5} newtons.

The field or force (due to a magnet of pole strength, m, and of length 2h) per unit pole at a distance d2h can be shown to be
$f/m= H = m/4\pi\mu_0 r^2 =(1/\mu_0)(M/2\pi d^3)$ newton/webers.

Consider two poles +m and -m of a magnet a distance 2h apart along a horizontal x axis and at a much greater distance d from the center of the magnet is a unit test pole so that the force and the force per unit test pole can be represented in terms of the magnetic field intensity vector H.

$$H=f/1= \quad (1)(m)/[(1)(4\pi\mu_0)(d-h)^2] + (1)(-m)/[(1)(4\pi\mu_0 (d+h)^2]$$

$$= [m/ 4\pi\mu_0][(d^2 +2dh +h^2) - (d^2 - 2dh +h^2)]/[(d^2 - h^2)^2]$$

$$= 4hdm/[(4\pi\mu_0)(d^2-h^2)^2]$$

Since dh, we can remove the h^2 term in the denominator and we obtain $H=(1/\mu_0)(M/2\pi d^3)$ as stated above. For example h=1cm. and d=10cm then H= (10^7 divided by 12.57) times (2cm times $10^{-4.5}$webers divided by (6.28 times 10^{-3}))= $(2.5)(10^{1.5})$ newtons/weber or amp-turns/meter as shown in the next paragraph. We should also mention that the flux density vector $B= \mu_0 H$ where the units of B are webers/meter^2 and the units of μ_0 , the permeability of a vacuum or air is henrys/meter.

Given a circular current carrying coil with one loop of cross section area $\pi a^2=A$ experiment shows we can associate with this coil the above magnetic moment $M=AI\mu_0$ as if a magnet of this moment was lying along the axis of the circle. (If the current (of positive charge) is moving in a clockwise direction around the perimeter of a clock on the wall the north pole of the associated magnet points into the wall.) A current of 10 amp in wire circle of 10cm radius would have a magnetic moment of M=2 times 12.57 times 10^{-7} = 2.5 times 10^{-6} weber meters which might correspond to a magnet of pole strength 2.5 times 10^{-5} and length 2h=10cm..

The lack of observed reduction in the strength of a magnet caused by a current carrying element or coil interacting with the magnet may be adequately taken into account by the greater relative strength of the permanent magnet's equivalent current. Thus I/NI* might be very small so that the reduction of the magnet's dipole, the moreso the smaller r and the greater I/NI*, this reduction is much less than the reduction of the current element's dipole the more so the smaller r and the greater NI*/I.

How are these dipoles created in permanent ferromagnetic magnets? We have suggested that an emf driving current through a wire of copper which by the way is diamagnetic or through aluminum which by the way is paramagnetic, produce large changes in the charge polarization inside the atomic nuclei and free electrons of these conductors so as to produce the observed transverse magnetic fields. What are the causes of diamagnetism, paramagnetism and ferromagnetism in the absence of such applied electric fields.

The standard explanation of ferromagnetism is based on a characteristic of orbital shells of lattice ions in ferromagnetic atoms. According to Feynman [4, p36.15]: "We must conclude that ferromagnetism has to do with some non magnetic interaction between the spinning electrons in neighboring atoms." According to Kittel [5, p467], band theory provides the most likely approach to an explanation: "It is often convenient to speak of the magnetization of ferromagnetics as arising from the .54 hole in the 3d up spin band." Roughly speaking, this means that about every other atom in a ferroelectric has an unfilled inner electron shell with a missing up-spin electron that were it present would cancel the effect of a down-spin electron in the same shell. All the other up-spin and down-spin electrons are paired off. Somehow these up spin electrons come to be oriented in the same direction in a domain of magnetic material.

A similar but much weaker effect occurs in many other elements and molecules with an odd number of electrons in inner shells or in total. This is called paramagnetism. Some compounds with an even number of electrons are also paramagnetic [5, p 437]. The spins of neighboring atoms in paramagnetics do not tend to line up in the same direction except at very low temperatures. At higher temperatures paramagnets do line up somewhat with an applied magnetic field but not nearly as much as ferromagnets.

There is clearly something special about the arrangement or dynamics of orbital electrons in ferromagnets. We hypothesize that the odd electron in the inner shell acts in a way analagous to the intermediate chain atom in the chain model of ferroelectric molecules [4, p11.11] and that the spin of electrons is due to charge polarization inside the electrons. In ferroelectrics parallel chains of atoms with similarly oriented dipoles have oppositely oriented weaker chains of dipoles between them. The function of these weaker intermediate chains is to get the stronger chains started by electrostatic induction. This then may be the non magnetic interaction that Feynman could not explain. The forces between dipoles in the same chain or rather the force between the chain and a member of the chain is strong enough to sustain the common orientation of the dipole chains against thermal disturbances at temperatures below a certain temperature called the Curie temperature.

It might be then that the nuclei of the ferromagnetic atoms contain parallel chains of similarly oriented stronger dipoles inside atomic nuclei where the intermediate chains are formed by the electrostatic dipole inside the odd electron in the inner shell which in its orbital motion spends a sufficient length of time in the required intermediate position.

The force that might keep such dipoles oriented in a specific way in a specific domain could be due to the force of chains of such dipoles acting on individual nuclei so that thermal collisions that might temporarily reorient a dipole would be overcome by the force of such chains on a temporarily unaligned member. The rationale is the same on a slightly larger scale as the rationale for ferroelectric crystals eg KDP, Rochelle salt , Barium Titanate, etc., which exhibit an electric dipole moment in the absence of an applied field[2,3].

Note that the difference between ferroelectrics and ferromagnets is one of scale essentially. That is the electrostatic dipoles in ferroelectrics are molecular while those in ferromagnets are inside atomic nuclei and inside electrons.

Note that the relative strength of effects in arc spectra of atoms in magnetic fields attributed to electron and nuclear spin are based on the assumption that the nucleus being heavier spins more slowly than the electron so that if this were true the magnetic reaction of the nucleus’s spin associated with hyperfine structure in spectra is about one thousandth of the magnetic reaction attributed to electron spin due to this rationale. However it can be argued that magnetic effects of the electron and the nucleus are due to the displacement over time of the average center of charge of an orbital charged particle of very small mass inside the electron and inside the nucleus and that the mass of this smaller particle is about the same in each case. However local electrostatic forces on the nuclei may for other reasons require a stronger magnetic field to reorient the nuclear dipole than to reorient an electron dipole.

Just as ferromagnets can be thought of as analogues of ferroelectrics, antiferromagnetics with an even numbers of electrons in atoms can be thought of as analogues of antiferroelectrics where adjacent columns or rows are oppositely oriented so that in general there is no net effect of these dipoles. That is there are dipoles inside the atomic nuclei and no dipole in an odd electron between the atomic nuclei so that these nuclear dipoles arrange themselves to be oppositely oriented. One might expect an antiferromagnetic to respond like a dielectric when placed between the poles of a strong electromagnet The surface rows and columns of atomic nuclei may feel the force of the applied field trying to reorient these dipoles. But that may be prevented by the local electrostatic forces within atoms and molecules. So the only choice in accordance with the principle of expending the least energy is to move in bulk away from the applied field.

Antiferromagnetics like chromium which appear to have no net magnetization but when subjected to neutron scattering, theyshow a pattern like the one described above.

The standard explanation of diamagnetics is that due to the changing flux as the magnetic field is being applied to the diamagnetic object, the atomic orbits are made to revolve in the reverse direction of those in the source of the magnetic field and that somehow these directions are sustained at least for a short time despite thermal collisions and there is a repelling force between such atoms and those in the magnet producing the applied field. But then this should also happen in paramagnets and ferromagnets but the paramagnetic and ferromagnetic influences are that much stronger than the diamagnetic influences. This appears to be so but the process of induction may be as described previously in the section on radiation and inductance.

The Graneau Effect

The above theory gives some insight into the Graneau effect. The fact that the force between magnetic elements at least when these elements are in current carrying wires is equivalent to the force between electrostatic dipoles offers a way of explaining the retrograde rail gun motion that has been described by Graneau..

“A pair of current rails (half inch diameter copper pipes) are bridged by a quarter inch diameter metal rod. Two adjacent ends of the rails are connected to a 12 V car battery via a suitable switch. This forms a primitive railgun. Copper, aluminum and stainless steel rods will roll away from the battery as the switch is closed. This is normal railgun action. If however the rod consists of carbon steel it will roll toward the battery. This is retrograde railgun action.”

The current passing through a rod of nonmagnetic material makes transverse dipoles inside free electrons and inside atomic nuclei. Note that the symmetric charge distribution of orbital electrons around atomic nuclei implies a zero net force on the centrally located nucleus. That is, like the free electron, the nucleus is free to react to the sustained electric field driving the current.

However in magnetic material, domains of the material are subject to local forces as described above and these forces have a greater effect on the dipoles in the nuclei and specific inner shell electrons than the forces due to the sustained electric field, ie charge on the electrodes, driving the current. The dipoles in each domain are similarly oriented and the orientations are different and randomly distributed between domains.

In some domains then the electrostatic dipoles in the nuclei say may be oriented in approximately opposite directions as the dipoles in the free electrons and may be made to be more exactly opposite by the static inductive effect of the electrostatic dipoles in the free electrons. That is the free electrons act like the inner shell electrons. A small number excess of domains like these may be enough to cause the other domains to line up eventually in the same way.

Because the dipoles inside the nuclei are stronger than those in the free electrons, the rod of magnetic material instead of being repelled by the current carrying rail sections is attracted to these current carrying rail sections and moves toward the battery and away from the rail sections that are not carrying current.

The Hall Effect

The Hall Effect refers to a small voltage difference produced in a current carrying conductor transverse to the current when the conductor is placed in a magnetic field where the field lines are perpendicular both to the current and the transverse voltage difference produced.

More specifically, consider the voltage V driving a current through a thin rectangular strip of conductive material eg a piece of copper 2" by 1" by .05". The voltage V produces a current V/R where R, is the resistance or Ohmic resistance. The Ohmic resistance, R,is equal to the resistivity of the material times the length, 2", divided by the cross section area, .05" by 1", of the piece of conductive material
through which the current is moving.

It is possible to measure a slight voltage difference between opposite sides of the material in a direction perpendicular to the direction of the current when a magnetic field is applied where the lines of the magnetic field are perpendicular to the current. For example a current carrying wire parallel to and with current running in the same direction as that in the test strip. This will produce field lines perpendicular to a line drawn between the wire and the strip and perpendicular to the current in the strip.

Actually the magnetic fields needed to produce an observable Hall effect are much larger than those produced by say 10 or 100 Amps running through a single wire or rod. An electromagnet capable of producing a field of

And as one would expect from Ampere's experiments etc. the 2" by .05" edge of the strip is attracted to or repelled by the wire. Lets assume that the magnetic force is caused by electrostatic dipoles themselves produced in the free electrons and atomic nuclei in the wire by the voltage difference driving the current in the wire.

We have shown that such dipoles produce a force equivalent to the magnetic force if the dipoles are proportional to the distance between the wire and the middle of the strip, to the magnitude of the current in the wire and to the magnitude of the current in the wire relative to the current in the strip.

Similarly for the electrostatic dipoles in the free electrons and atomic nuclei of the strip. The dipoles are on lines perpendicular to the current. Lets assume in this case that the positive poles of the dipoles in the wire are closer to the strip and so the free electrons in the strip as point charges are attracted to the dipoles inside the free electrons of the current carrying wire producing the magnetic field. The dipoles inside the free electrons in the strip are are also attracted to the electrostatic dipoles inside those in the wire.

If the strip is not free to move, then only the relatively light, free electrons in the strip will move and they will move toward the side of the strip nearest the wire.

In semiconductors and certain conductors there are few free electrons and so the current is produced by loosely bound electrons that hop from one atom to the next leaving behind positive ions in succession so that it appears positive holes are moving in the opposite direction of these electrons and the free electrons.

The positive ions and the negative ions produced in this way also form electrostatic dipoles which are rotated by the transverse dipole field of the wire which is the source of the magnetic field here so as to attract the wire. But the wire and strip are prevented from moving .

So the transverse field produced by these dipoles acts on the comparatively small number of free electrons in the wire which move so as to cancel the transverse dipole field. That is there is a concentration of free electrons on the edge of the strip furthest from the wire and a lack of free electrons on the side closest to the wire. Note this is just the opposite of what happens in copper and other common conductors where the free electrons move to the side of the strip nearest the wire.

This is consistent with the band model predictions but it explains more specifically what is happening and suggests how different applied voltages and magnetic fields when combined with initial local electrostatic interactions may produce discrete changes in the Hall effect.

Originally it was shown by Hall and others that only the voltage that develops across a conductor is directly proportional to the current, to the magnetic field, and to the nature of the particular conducting material itself. Also that the voltage is inversely proportional to the thickness of the material in the direction of the magnetic field and varies with temperature depending on the material.

Light Pressure,Compton Effect & the Photoelectric Effect

In the wave theory of light, the pressure due to radiation falling on a material body is explained as electromagnetic momentum delivered to the body by the incident waves.

(The energy produced by a source of radiation around it in a volume of space, dxdydz, is written as $u=(1/2)(\varepsilon E^2 + \mu H^2)$ where E is in Volts/meter or Newtons per Coulomb and H is in Ampere turns per meter, attributable whatever the actual source to n circles of wire per meter carrying a current of I Amperes.. This energy travels at a speed $v=c/(\varepsilon_m\mu_m)^{1/2}$ where ε_m and μ_m are the dielectric constant and the magnetic permeability of the medium relative to a vacuum so in free space, $\varepsilon = \varepsilon_0$ and $\mu = \mu_0$ and v=c.. The Poynting vector ,Π = E X H in Joules per square meter per second is the energy traveling through a surface perpendicular to the direction of the vector Π and so $g = (1/c^2)$ (E X H) in kilograms per sec per square meter is the pressure on that surface. Since E and H are at right angles to each other always,

$g=(1/c^2)EH =(1/c^2)E^2/(\varepsilon_0 /\mu_0)^{1/2} = E^2/c$. Thus in free space, em waves carry momentum equal to the energy that they carry divided by the speed of light. It is as if energy W had a mass W/c^2 and were moving at a speed c.)

In the photon theory of light, the pressure due to radiation falling on a material body is explained by saying that the energy W, has a mass of W/c^2 and that the energy can be written as hf so that the momentum $p=hf/c^2$ times c or $p= h/\lambda$. The greater the frequency and the greater the number of photons, the greater is the pressure.

In the proposed theory, the pressure due to the light source on the receiver is attributed to instantaneous forces between the oscillations of charge in the source and the induced oscillations of charge in the receiver.

Consider first the simpler case of radio frequencies in a powered vertical source antenna acting on a passive parallel vertical receiving antenna. The resulting antiparallel oscillations of charge in the two antennas produce a varying but always attractive force between the two antennas.

But associated with the varying longitudinal electric fields in each antenna are transverse electrostatic dipole fields where the dipoles are proportional to the longitudinal fields and to the distance between the source antenna and the receiver antenna. That is, these inverse fourth power electrostatic dipole fields are equivalent to inverse square magnetic fields.

These varying transverse electrostatic dipoles are anti-collinear, oriented along the same line in opposite directions and so repel each other. The force of repulsion is greater the greater the velocity of the free electrons and the greater the force and duration of the force acting on the lattice nuclei between thermal collisions.

Since the force between collinear dipoles is twice as strong as the force between parallel dipoles as shown in the section on Ampere’s Formula and Transverse Electrostatic Dipoles, the net force on the antennas is one of repulsion.

Let’s consider now higher frequencies which are produced by the excitation of bound electrons in atoms and molecules and by accelerations or decelerations of electrons and ions in man made and non man made accelerators eg in extraterrestrial plasmas etc.

As electrons move from a ground state to a metastable state and fall back to the ground state their radiation is not cancelled and electrostatic dipoles are produced in the electrons transverse to their velocity. In a vertically polarized laser source many such oscillations are in phase and their transverse dipoles are in phase

The greater the frequency of oscillation of the electrons moving between bound states etc., the greater the velocity, and so just as in the case of free electrons moving in radio antennas at much lower frequencies, dipoles transverse to the movement are produced inside the electrons proportional to their velocity.

The energy supposedly in the moving photon before it produces an oscillation in the receiver material and the recoil as just described is in reality in the receiver material but of a magnitude which has not yet reached the magnitude required to produce an observable recoil or transition of the bound electron to a wider metastable orbit.

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