RADIO RECEPTION

Initially in the radio receiver antenna there is a sequence over time, t, in picoseconds or less, of Coulomb forces,$eE(t) = (e)[(1/4\pi\varepsilon_0)(neA_0D_0\cos(2\pi ft/r^3)] = F_0\cos\omega t$ perpendicular to a line from the source, on free electrons of charge, e; (similarly for orbital electrons and on the orbital charge inside the lattice nuclei of the receiver antenna.)

These forces constitute a single oscillating force analogous to that of a forced mechanical oscillator, eg the pushing of a child on a swing, with characteristic parameters, the mass, m, the elasticity or stiffness, h, and the frictional resistance, j. There is the possibility of resonance if the forcing frequency, $\omega = 2\pi ft$ is timed to the natural frequency, ω_0 , of the oscillator eg the child is pushed forward always at the time of the swing's highest backward ascent.The mechanical force equation is

$$F_0 \cos(\omega t) - hx - jx' = mx''.$$

$-hx$ denotes a restoral force proportional to the displacement and $-jx'$ denotes a resistive eg frictional, force proportional to the velocity. Dividing by the mass, m, and rearranging terms.

$$.\ (F_0 / m) \times \cos(\omega t) = x'' + \gamma x' + \omega^2 x$$

where $\gamma=j/m$ and $h/m = \omega_0^2$ is the natural frequency squared of the mechanical oscillator being forced. We can think of, x, as the displacement at time, t, of oscillating electrons in a radio antenna from their average position and $q(t) =neAx(t)$ as the magnitude of charge displaced, and $dq(t)/dt$ is the current at time t, etc..

We show, following this analogy, that the field at the receiving antenna acting on, q, is

$$E(t,r) = (1 - \exp - ct / kr) \times [-(krf / c)^2] \times [(1/4\pi\varepsilon_0) \times nAD \cos(2\pi ft)]/[(r^3)]$$

where

$$\omega = 2\pi f, and, \omega_0 = 2\pi f_0$$

In words the oscillation of charge in the receiving antenna rises to two thirds of its steady state maximum after kr/c seconds where the steady state maximum is an oscillation at the same frequency as the source field. The maximum is proportional to the source field divided by the distance from the source and multiplied by the square of the frequency divided by the speed of light squared.

This transient increase and constant of proportionality is produced by the interplay of changing transverse and longitudinal dipoles inside the lattice nuclei of the receiving antenna in response to repeated forces from the oscillating source field. The effect is to produce an increase in the amplitude of the oscillation of charge until it is detectable as an oscillation of the free electrons in the receiving antenna.

That this is exactly equal to Maxwell's formula for the radiation received at a later time except for the exponential term in the numerator is support for the validity of the assumptions.

This implies that a stronger source sometimes can be received or detected sooner than a weaker source. In Maxwell's formulation the received radiation from a strong or weak source will arrive at the same time. We make the disclaimer that at small distances, r, the average transverse dipole effect of a stronger source could inhibit more strongly the transient increase of the received radiation than a weaker source. The net effect would be that the radiation from a stronger source becomes detectable no sooner than that from a weaker source. But at larger distances, r, this effect may be negligible given nearer sources of other such transverse dipoles. That is the expansion of transverse dipoles in the receiver is not made easier by having the distance to the original source made larger.

Lets now show how this result is obtained where we take into account charge polarization inside atomic nuclei as well as the motion of free electrons caused by the applied forcing oscillator. We have a displacement of charge, nex, in the antenna containing neAD electrons where neAx'(t) = I(t) is the current and the restoral force on - an electron, e, is

$$-ne^2x(t)/\varepsilon_0$$

from this displacement as derived below. The above mechanical solution suggests

$$x(t) = KF_0\cos(\omega t)$$

where K is to be determined.

We have a second force, *-jx'* to the resistive effect of more thermal collisions when the electron velocity, *x'*, increases due to more collisions and reduced time between collisions and that this is due in part to greater transverse dipoles, (r/c) times x'(t), so the resistive force is –(j) × (r/c) × (-KωF$_0$(sin(ωt)).

We have a third force proportional to x'' that is due to longitudinal dipoles that produce a field in the opposite direction to the applied field. These longitudinal dipoles $(r/c)^2$ times x'' yield, $-(K)(r/c)^2(\omega^2)F_0\cos(\omega t)$

Let's examine more closely first, the restoral force and then the forces due to transverse and longitudinal dipoles:

$$mx'' = -(ne^2/\varepsilon_0)\times x$$

describes the force of an electron displaced a distance, x, in a closed volume of electrons and positive particles from its equilibrium position where the net force on it is zero. This formula is derived from considering the force per unit charge produced by a region of unspecified net charge inside a sphere of radius, r, on the surface of the sphere which Gauss showed was the same for any shaped surface, eg a cube enclosing the sphere.

Considering the force component vector at each point of the surface normal ie perpendicular, to the surface due to all of the net charge enclosed and integrating over the sphere, we get the net charge inside. So a displacement of charge by a distance x perpendicular to one face of the cube, times the density gives a net charge and this is the integral over the surface, so that you multiply the surface area of the sphere, $4\pi r^2$ times $nex/4\pi\varepsilon_0 r^2$ times, e, the charge of a displaced electron, which is the force per unit charge at each point on the sphere normal to the surface so that all that is left is, ε_0, in the denominator and ne^2x in the numerator.

Now let's examine the transverse dipoles. As in the case of a constant voltage in a dc current carrying wire, there is here in the case of an oscillating current, a transverse distortion of the orbits of negatively charged particles around a more positive core inside the lattice nuclei of the radio antenna or of the atomic antennas of the photoreceptors which produces transverse dipoles, perpendicular to the movement of the electrons and negatively charged particles inside the lattice nuclei. We showed that these dipoles per unit length were kr/c times the electron velocity in the direction of current and voltage, so in this ac case, $krx'(t)/c = p_{tran}$ is the transverse dipole.

The rate of change of these dipoles is a transverse oscillation of charge, a transverse oscillating "current" which produces a current of oscillating longitudinal dipoles per unit length $(kr/c)^2 \times x''(t) = p_{\lg}$

At successive times, t, transverse chains of these dipoles produce a transverse field at any point along the chain in the direction of the dipole and on either side of the dipole where the distance between dipoles is "a" where for example $1/a^3 = n = 8.47 \times (10^{28})$ for copper. (Note the field of each dipole, p, of length, s, p=es, along the axis of the dipole is $2p/4\pi\varepsilon_0 a^3$.(R.Feynman, **Lectures on Physics** vol 2, p6-3) ref 6. Adding up the forces from each dipole:

$$E_{tran} = [(p_{tran}/(4\pi\varepsilon_0)\times(2/a^3)]\times(2+2/8+2/27+\ldots) = (p_{tran}/\varepsilon_0)\times(.383)/a^3)$$

"If the next identical lines of dipoles were only the distance "a" away - the number .383 would be changed to 1/3. In other words, if the next lines were at the distance "a" they would contribute only -.050 to our sum.[that is all the other atoms in the wire can be ignored in determining the longitudinal force at any point in a single chain]" Feynman Lectures, vol 2, p11-10 , ref 6.

E_{tran} is the field produced by each chain of dipoles on every point eg on every free electron inside the conductor in addition to the field from the emitting antenna.

Now this field would be immediately cancelled by a redistribution of free electrons if it was not constantly changing. This oscillating current of varying transverse dipoles inside the atomic nuclei or rather the associated changing field creates dipoles transverse to itself, i.e., longitudinally. Just as in the case of direct currents the dipoles per unit length are proportional to the current or the average electron velocity, namely krv/c. In this case a transverse current of changing transverse polarizations of charge inside the atomic nuclei.

One question here is that the original longitudinal current was the movement of free electrons and still this provided a measure of the charge polarization of much smaller mass inside the atomic nuclei transverse to it. Does the derivative of this "current" also provide a measure of the rate of change of charge polarization inside the nuclei? We assume that it does. In both cases the "current" is produced by an implicit electric field in combination with the elasticity of charge, c, inside the nucleus, that produces the charge polarization.

The longitudinal dipoles in combination produce a field described by the same cosine function as the field from the emitter but with a negative cosine so the field is opposite to the field from the emitter.

$$E_{long} = (p_{long} / \varepsilon_0) \times (.33 / a^3) = (n / 3\varepsilon_0) \times (kr / c)^2 (x''(t))$$

Thus the forced oscillator equation to be solved could be written, with $(1/4\pi\varepsilon_0) \times neAD\cos(2\pi ft)/r^3$ set equal to E(t,r), acting on a point in the receiver antenna along with forces 1)proportional to the second derivative of this force times $(kr/c)^2$ meaning it is a cosine function in the opposite direction of E(t,r), and 2) a force also proportional to the current which is ninety degrees out of phase with E(t,r) meaning it is a "–sine" function of the same frequency, and 3) a force in the opposite direction of the displacement.

$$eE(t,r) - (ne^2 / \varepsilon_0) \times x(t) - (kr / c) \times (ne^2 / \varepsilon_0) \times x'(t) - (ne^2 / 3\varepsilon_0) \times (kr / c)^2 \times x''(t) = mx''(t)$$

But multiplying

$$eE(t,r) - (ne^2 / \varepsilon_0) \times x(t) - (kr / c) \times (ne^2 / \varepsilon_0) \times x'(t) - (ne^2 / 3\varepsilon_0) \times (kr / c)^2 \times x''(t) = mx''(t)$$

by D/e and writing x=q/neA and ED=V we obtain

$$V(t,r) = [(ne^2 / 3\varepsilon_0) \times (kr / c)^2 + \mathrm{m}] \times q''(t) \times (D / ne^2 A) + [(kr / c) \times (ne^2 / \varepsilon_0)] \times q'(t) \times (D / ne^2 A)\,] + [(ne^2 / \varepsilon_0)] \times q(t) \times (D / ne^2 A)$$

or

$$V(t,r) = [(ne^2/3\varepsilon_0)\times(kr/c)^2]$$
$$\times q''(t)\times(D/ne^2A) + [(kr/c)\times(ne^2/\varepsilon_0)]\times q'(t)\times(D/ne^2A)]$$
$$+[ne^2/\varepsilon_0]\times q(t)\times(D/ne^2A)$$

(Note $(ne^2/\varepsilon_0)\times(r/c)^2$ which for typical values, like $r=10^4$ 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 $m=9\times10^{-31}$, that we can drop the "m" term or electron mass in the first V(t,r) equation here. Simplifying, we obtain

$$[(kr/c)^2\times(1/3\varepsilon_0)\times(D/A)]\times q''(t) + [(kr/c)\times(1/\varepsilon_0)\times(D/A)]\times q'(t)$$
$$+ [1/\varepsilon_0]\times(D/A)]\times q(t) = V(t,r)$$

This equation represents the voltage difference in a wire of cross section area, A, and length D at time, t, at a distance, r, from a powered emitting antenna. It is similar to the equation for an oscillatory amplifier circuit with the inductance, resistance, and capacitance parameters as indicated by the corresponding bracketed coefficients of q",q' and q.

$V = [L]q'' + [R]q' + [1/C]q$. The familiar amplifier circuit solution (see Feyman Lectures vol 1, pg23-6 and 24-6 (ref 6) and as summarized in Feynman Note below) is obtained by assuming that the charge displacement, q, is proportional to the forcing oscillator with a phase lag and considering the corresponding complex numbers, $\hat{q}$, and, $\hat{V}$.

$\hat{q} = (1-e^{Rt/L})\times\hat{V}/(L((i\omega)^2 + R(i\omega) + 1/C)$ but here
$\omega_0^2 = 1/LC = 3c^2/k^2r^2$ and
$\gamma = R/L$
$= 3c/kr$.

Also here the charge displacement, q, is determined after the transient delay time less by the source field than by the induced field which is the product of L and q'' or $(krf/c)^2$ time the source field at the distance, r, from the source.

Thus the charge displacement at time, t, and the oscillation of charge in the receiver is NOT given by the source oscillation divided by the sum of the inductive, resistive and capacitive coefficients that can be chosen at will.

Rather it is determined by the dominant force in the receiver, the inductive coefficient times the second derivative of the charge displacement where the inductive coefficient is $(krc/)^2$ and the charge displacement is assumed oscillating at the same frequency as the emitting antenna. This factor is derived from the assumption of induced longitudinal charge polarization and changing longitudinal charge polarization producing changing transverse charge polarization in turn producing increased longitudinal charge polarization etc.. The inductive force proportional to the second derivative is $(krf/c)^2$

times the source force and thus larger than the source force if the product of the separation distance and the frequency is larger than $3(10^8)$. For example a frequency of 30kHz and a separation distance, r, equal to 10km.. Thus for most radio and light signals the source force is less and the dominant field in the receiver is

$$E(t,r) = (1 - \exp - ct/kr) \times [-(krf/c)^2] \times [(1/4\pi\varepsilon_0) \times nAD\cos(2\pi ft)]/[(r^3)]$$

Note that the resonance characteristics and phase lag that followed from the standard amplifier circuit assumptions are not implied by our alternative assumptions. Of course by tuning the receiving antenna to the expected frequency by adding amplifying circuits, with inductors and capacitors and by lowering the resistance eg by cooling or increasing the crosssection ares etc, the signal could be made resonant with the receiver and detected more quickly than otherwise.

This is all quite analogous to Maxwell's model of a changing electric field creating a magnetic field and the changing magnetic field creating an electric field. But instead of changes happening through ethereal vortices or wheels and ball bearings or some mathematical equivalent, i.e., the curl and divergence of vector fields, ie of magnetic and electric fields, in the intervening space between source and receiver, it happens in movements of actual, charged particles inside atomic nuclei in the receiver and source.(If you haven't used the concepts of divergence and curl lately or ever, a good review can be found at the web site at reference 7.)

Note that for large r, rv/c, is near .1 Angstrom even when the average or root mean square velocity of charge in the receiver is very small and so the delay before this occurs and the electron oscillation amplitude is large enough to be detectable, may not be so great. That is, the delay may be much smaller than r/c. kr/c is the delay where k is much less than 1, before the oscillation of charge inside the nuclei increases and produces the oscillation of charge inside the antenna.

We have now definitions of Inductance, and Resistance, in terms of charge polarization inside atomic nuclei.

Are these definitions compatible with the standard definitions?

Since R=1.7×10^{-8}D/A is the resistance of a copper wire of length D meters and cross section area, A square meters, as in this example, it follows from the equation,

$$q''(t) \times [D/A] + (kr/c) \times (1/\varepsilon_0) \times q'(t) \times [D/A]] - (1/\varepsilon_0) \times q(t) \times [D/A]$$

that $(kr/c) \times (1/3\varepsilon_0) = 1.7 \times 10^{-8}$ which it is for the right value of ,r.

In this context we have k=1. With $c = 3 \times 10^8$ and

$4\pi\varepsilon_0 = 1/(9 \times 10^9)$ so $\varepsilon_0 = 1/(12.56 \times 9 \times 10^9) = .88 \times 10^{-11}$

then $r = 3 \times 2.64 \times 1.7 \times 10^{8-11-8} = 10 \times 10^{-11}$ This implies that the distance between interacting filaments of current is a little more than the interatomic spacing. Such spacing is consistent with the fact that the dipole force formula is applicable only when the dipole length is much smaller than the distance between the dipole and another dipole or point charge on which the first dipole is exerting a force.

Since $L = (4\pi\times 10^{-7})\times(8\pi l)$ for a wire of length, l, this should equal our $((kr/c^2)\times$ $(1/3\varepsilon_0)\times(D/A)]$ where $D = l$ and $A = \pi r^2$ and we see that $(1/c^2)\times(1/3\varepsilon_0) = (1/3)\times(1/9)\times 10^{-16}\times 4\pi\times 9\times 10^9/3 = (1/3)\times 4\pi\times(1/3)\times 10^{-7}$ and that $r^2/\pi r^2$ times this is (4/9) times 10^{-7} and times l, gives us the standard, experimentally determined value, $L = 4\pi\times$ (10^{-7}) $\times$ $(l)/(8\pi)$ for a wire of length, l.

Thus electrostatic dipoles inside atomic nuclei used to explain the magnetic force between current carrying wires also explain the mechanism of resistivity and the mechanism of self inductance.

. Such an explanation of light transmission requires that the cumulative increase of the received radiation above a threshold of observation depends on constant exposure of the receiver to the source. That is, radiation we observe from stars cannot have originated years or centuries ago as implied by the extrapolation of terrestrial light speed measurements to such distances; indeed it could not have originated more than 12 hours or 12 times 3600 = 43,200 seconds earlier at most when a heavenly object rises and then falls below the horizon of any observer tracking its trajectory across the sky.

One of the side benefits of this explanation of light transmission is that the Lorentz Transformation, $(1-v^2/c^2)^{-12}$, times mass, length or duration, where v is the relative velocity of source and observer, which Einstein used to explain infinite `mass increase because it so well explained the lack of ether drift in the Michelson Morely experiment is unnecessary. That is, if light is not the motion of something but rather the additive effect of repeated instantaneous forces at a distance, then there is no need for space contraction or time dilation etc..

Red Doppler shifts etc. of spectra from a source moving away from a receiver would be expected because of the ratio of the speed of the moving source to the rate of increase of the transient as successive oscillations of charge are produced in the receiver and have nothing to do with time slowing down. Slower muon decay in very fast moving muons can be ascribed to the interference of forces causing the high speed of the muons and the inner forces leading to the decay and not to time slowing down in the muon.

Also, as shown in detail later, there is no need to have the force of Gravity, say between the Sun and the Earth, depend on curved space, ie the rate of change of the force, proportional to the mass and inversely to the distance squared, to avoid the supposed light speed delay problems of Gravity. This was Laplace's concern around 1800, that the Earth orbiting at .5km/second, for example would be dragged backward when pulled in the direction the Sun was when the force was "emitted" and so spiral into the Sun unless the speed of Gravity was much larger than the speed of light. If the force of Gravity is instantaneous and continuous unlike the repeated oscillating relatively weak instantaneous forces causing increases in oscillations of light or microwave frequencies etc., from comparable distances over times that are still much less than the r/c seconds usually ascribed, there is no need to worry.

The bending of starlight by the Sun associated with the curved space effect is the same as predicted by the difference in the electrical influence of the Sun on radiation reception on the Earth when the Sun is facing the Earth compared to its effect when the Sun is on the other side of the Earth. Other supposed validations of the curved space hypothesis, eg the precession of Mercury and other planets have explanations in terms of torques produced by the net electrostatic dipoles associated with the planets and the Sun. etc..

FEYNMAN NOTE. Here is an expanded version of Feynman's solution of the equation for a forced oscillator with damping:
$m(d^2x/dt^2) + c(dx/dt) + kx = F$

The solution to this equation is obtained by writing the unknown, x, as the real part, x_r, of a complex number, $\hat{x}$ =(x_r,x_i) and the known driving force F as the real part of a complex number $\hat{F} = (F_r, F_i)$ = $F_0 \cos \omega t + iF_0 \sin \omega t$ $= \hat{F}\, e^{-i\omega t}$. We thus are led to assume that $\hat{x}$=(x_r,x_i) = $x_0 \cos(\omega t + \theta) + ix_0 \sin(\omega t + \theta) = \hat{x}\, e^{i\omega t + \theta}$. In words we are led to assume that the unknown solution of the displacement of charge at time, t, due to the driving force and the resonance properties of the oscillator, is an oscillation at the same frequency as the driving oscillator with a possible delay of phase,

The advantage of this complex representation is that the derivative of an exponential function is the function itself. Thus, d/dt [$\hat{x}\, e^{i\omega t + \theta}$] = $e^{i\theta} d/dt$ [$\hat{x}\, e^{i\omega t}$]=$i\omega\ \hat{x}\ e^{i\omega + \theta}$
Substituting the complex numbers in our forced oscillator equation above. $(F_0/m) \times \cos(\omega t) = x'' + \gamma x' + \omega_0^2 x$ and writing their derivatives as indicated we obtain.

$$[i\omega)^2 \hat{x} + \gamma(i\omega)\hat{x} + \omega_0^2 \hat{x}]e^{i\omega t + \theta} = (\hat{F}/m)e^{i\omega t}$$

Dividing both sides by $e^{i\omega t}$ and dividing the left side by the coefficient of $\hat{x}$ we see that $\hat{x}$= $\hat{F}$ divided by $m \times ((-\omega^2 + \omega_0^2) + i\gamma\omega)$ times $e^{i\theta}$ is the solution.
$= F_0 \cos \omega t + iF_0 \sin \omega t$. Note
$(1/\rho)e^{-i\theta}$ =$((1/\rho)\cos(-\theta) + i(1/\rho)\sin(-\theta))$ =$(1/\rho)\cos(\theta) - i(1/\rho)\sin(\theta))$.
We can write $\hat{x}$ as $(1/\rho)e^{-i\theta} \times \hat{F}$ where $1/\rho^2 = [m((-\omega^2 + \omega_0^2) + i\gamma\omega)]$
$\times [m((-\omega^2 + \omega_0^2) - i\gamma\omega))]]$ =
$((1/\rho)\cos(-\theta) + i(1/\rho)\sin(-\theta)) \times ((1/\rho)\cos(-\theta) - i(1/\rho)\sin(-\theta))$
=$((1/\rho^2)(\sin^2\theta + \cos^2\theta))/ = [m^2((-\omega^2 + \omega_0^2)^2 + \gamma^2\omega^2)]$ so

Thus the real solution is $x_0 = F_0 \cos(\omega t + \theta)/m\sqrt{(\omega_0^2 - \omega^2)^2 + \gamma^2\omega^2}$
This representation too, shows us that
$[(1/\rho)\sin(-\theta]/[(1/\rho)\cos(-\theta)] = -m\gamma\omega/m(\omega_0^2 - \omega^2) = \tan\theta$
It is minus because tan(-θ)= - tan(θ). A negative value of θ results for all ω, and this corresponds to the displacement x lagging the force F. The moreso the greater the resistance over the inductance, $\gamma = R/L$, and the closer to resonance the forcing oscillator is to the receiving circuit..
(see ref 6) Feynman **Lectures on Physics**, v1, 23-4, 23.12.