THE ELECTRON ©

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January 2008 (revised February 2009)

INTRODUCTION

At one time, there was a raging controversy between those who believed that quantum physics was a marvelously accurate method for solving the many body problem, the physics of ensembles, and those who believed that it was the most fundamental form of physics. Einstein and Planck were among those who held that the fundamental basis of physics was the deterministsic description they worked so hard and long to extend. The quantum fundamentalists won the argument by default, and Main-Line physics withered.

Recognizing the immense utility of quantun physics, still the present author takes the side of Einstein and Planck. Note 1 of this web page has demonstrated the possibility of moving Main-Line physics past where it has wallowed for a hundred years. This and the next few Notes will resolve several of the remaining road blocks. Particularly, they will attempt to reduce the defeatism so prevalent in atomic and particle physics today.

Many textbooks say that atomic and particle physics are unlike ordinary experience, and cannot be understood like everyday physics. Some, flat out, state that it is impossible to describe atoms deterministically, because atoms have stable states and accelerating electrons radiate, preventing stable orbits. As this web page expands, it will be shown that all of atomic physics and probably all of particle physics are derivable from Maxwell's equations in potential form and Newton's laws. The principal reason for the present impasse is the lack of specific knowledge about the electron; not just its structure but details about its behavior. The present Note addresses that problem.

The proper analysis of particle structure begins with Maxwell's equations in terms of the fields **E** and **B**. These are *macroscopic* and do *not* apply directly to particle structure. However, from these equations, the potential form (Heaviside-Lorentz Units),

$$\nabla^2\phi - \frac{1}{c_0^2}\frac{\partial^2\phi}{\partial t^2} = -\rho \quad , \quad \nabla^2\mathbf{A} - \frac{1}{c_0^2}\frac{\partial^2\mathbf{A}}{\partial t^2} = -\frac{\mathbf{J}}{c_0} \quad , \quad \nabla\bullet\mathbf{A} = -\frac{1}{c_0}\frac{\partial\phi}{\partial t} \qquad (1)$$

are found. These are, in every way equivalent to the **E** and **B** form, and, as generally used, are also primarily *macroscopic*. By that is meant that the charge density ρ represents counts of *whole charged particles* (such as electrons) and the current density **J** represents the flow of whole charged particles. The failure of classical physics was in the blind use of these equations in the study of particle structure.

As discussed in Note 1, the scalar equation, when used to find the extended electron structure, is actually the *definition* of distributed charge density and ρ is not the source of the potential field. Also, the equation for ε_e derived in Note 1 is the definition of distributed electric energy density, and ε_e is not the source of the potential ϕ. The potential is found from a completely different analysis; but the complexity of that analysis and the space needed to describe it are out of place here and would obscure the present goal, which is to present the form of Maxwell's equations that apply to particle structure.

It just happens that the microscopic definition of ρ and the macroscopic equation for ϕ with ρ (count of whole particles) as the source of the scalar field are *equations of the same form*, although what each one is describing is quite different. It is the vector potential equation that must be handled in a different manner. This comes about because of the existence of two kinds of magnetic fields, energy bearing and energy-less. The energy bearing fields are macroscopic and calculated from Eqs.(1), because the whole charged particles circulate to produce the energy storing field, and provide the handle by which the stored energy can be recovered. In the microscopic case, *there are no circulating charged particles*, just the moving distributed charge; and it neither generates a stored magnetic field energy nor provides a handle for retrieving that energy.

From the preceding, it is possible to write the complete set of equations in the form:

MACROSCOPIC

$$\nabla^2\phi - \frac{1}{c_0^2}\frac{\partial^2\phi}{\partial t^2} = -\rho \quad , \quad \nabla^2\mathbf{A} - \frac{1}{c_0^2}\frac{\partial^2\mathbf{A}}{\partial t^2} = -\frac{\mathbf{J}}{c_0} \quad , \quad \nabla\bullet\mathbf{A} = -\frac{1}{c_0}\frac{\partial\phi}{\partial t} \qquad (1)$$

MICROSCOPIC

$$\rho = -\left(\nabla^2\phi - \frac{1}{c_0^2}\frac{\partial^2\phi}{\partial t^2}\right) \quad , \quad \varepsilon_e = \tfrac{1}{2}\left((\nabla\phi)^2 - \frac{1}{c_0^2}\left(\frac{\partial\phi}{\partial t}\right)^2\right)$$

$$\nabla^2\mathbf{A} - \frac{1}{c_0^2}\frac{\partial^2\mathbf{A}}{\partial t^2} = 0 \quad , \quad \nabla\bullet\mathbf{A} = -\frac{1}{c_0}\frac{\partial\phi}{\partial t} \qquad (2)$$

BULK ELECTRON STRUCTURE

In Note 1, the finite extended electron, at *rest*, was derived from Eq.(2) above. The *total* physical presence of an electron is illustrated graphically as the top curve of Figure 1 below. It represents a very simple electric potential field sliced across a diameter. The field is spherically symmetrical and dips to just short of -2000 heavyside – lorentz volts at the center, which is designated as ϕ_0.

The only other distinguishing feature of the bulk electron is its effective radius, $r_e = 3.522426 \times 10^{-14}$ cm, at the inflection sphere of the field.

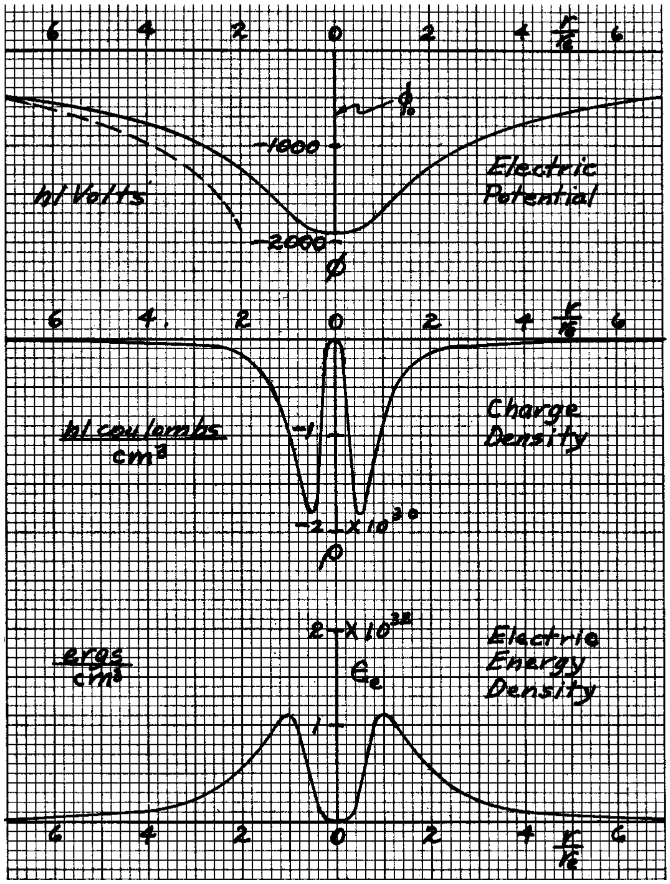

Figure 1. Extended electron structure ϕ and auxiliary implicit functions ρ and ε_e

An important feature of Dirac's electron theory is its prediction of the existence of the positron. The theory is vey complicated and the argument that the *negative* energy states imply a positve particle with positive self energy involves some wishful thinking. The extended particle derived here automatically gives the positron if ϕ_0 is positive.

It is important to understand that the potential ϕ shown in Figure 1 is the total electron (when extended out to $r \to \infty$). The charge density ρ and the energy density ε_e are not "part" of its structure tacked onto it. They are just descriptions of shapes of the functions $\frac{1}{2}(\nabla\phi)^2$ and $-\nabla^2\phi$, implicit in ϕ, that help to determine some of the electron's behavior. That is why their spherical maxima can occur at two different radii. The peak charge density is at $r_e / 2$ and is roughly -1.8×10^{30} hlcoulombs / cm^3. The peak electric energy density is at r_e and is roughly 1.1×10^{32} ergs / cm^3. Almost all (approx. 99%) of both the charge and energy are enclosed in a sphere of radius about $200\ r_e \cong 7\times10^{-12}$ cm .

MASS

When the electron moves, it exibits a property called momentum. It resists being accelerated or decelerated, and this is attributed to its "mass". However, mass again is an unexplained property assigned to point particles, just as charge and energy are. It is thought to be related in some way to energy. Even when at rest the electron has a rest mass, m_0, that can be converted into energy in the form of photons. Modern writers say that mass and energy are "equivalent" on the basis of the famous equation of Einstein, et al,

$$m_0 = \frac{E_0}{c_0^2} \quad . \tag{3}$$

Here, the position is taken that they are identical, i.e. one physical phenomenon, with two names, expressed in different units. There is just one gradient squared distortion, $(\nabla\phi)^2/2$. It causes all the effects of electric energy and all the effects of mass, but the units identified with mass are c_0^2 larger than those identified with energy.

SPIN

During pair production, electron/positrons evolve with *spin*. Rotating energy and charge densities produce angular momentum and a magnetic moment. Determination of the spin angular momentum requires knowing the spin velocity field. Since moving charge density generates a magnetic field, the vector Eq.(2) provides part of that information. In the simplest case the electron is at rest and the circulation is not changing with time. Eq.(2) then reduces to,

$$\nabla^2\mathbf{A} = 0 \quad , \tag{4}$$

where, **A** represents only the unchanging magnetic field about one particular axis through the electron's center (see Figure 2). In spherical coordinates (r, θ, α),

$$\mathbf{A} = \hat{\alpha} A_\alpha \quad , \tag{5}$$

and Eq.(4) leads to,

$$\nabla^2 A_\alpha - \frac{A_\alpha}{r^2 \sin^2\theta} = 0 \quad . \tag{6}$$

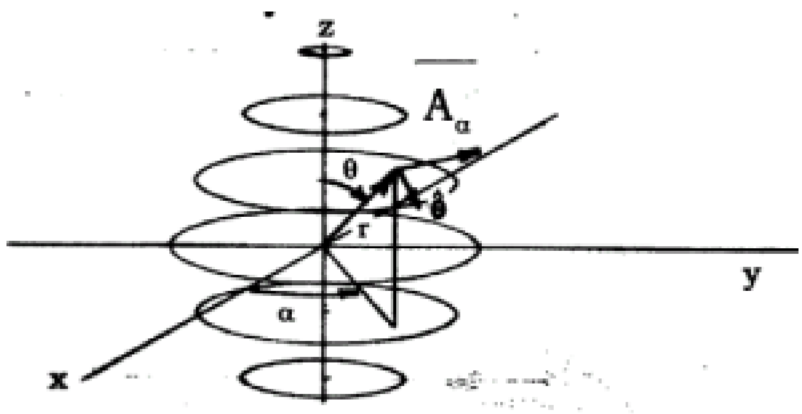

Figure 2. The spin field

Considering A_α as separable into r and θ dependent parts, let,

$$A_\alpha = \frac{\mathcal{R}(r)}{r^2}\mathcal{T}(\theta) \ , \tag{7}$$

and the separated equations become,

$$\frac{d^2\mathcal{R}}{dr^2} - \frac{2}{r}\frac{d\mathcal{R}}{dr} + \left[1 - \frac{\ell(\ell+1)}{2}\right]\frac{2\mathcal{R}}{r^2} = 0 \quad ,$$

and, (8)

$$\frac{d^2\mathcal{T}}{d\theta^2} + \frac{\cos\theta}{\sin\theta}\frac{d\mathcal{T}}{d\theta} + \left[\ell(\ell+1) - \frac{1}{\sin^2\theta}\right]\mathcal{T} = 0 \quad .$$

The simplest solution free of non physical attributes evolves from $\ell = 1$, with the result,

$$\mathcal{T} = \sin\theta \quad , \tag{9}$$

and,

$$\frac{d^2\mathcal{R}}{dr^2} - \frac{2}{r}\frac{d\mathcal{R}}{dr} = 0 \quad . \tag{10}$$

Eq.(10) is solved directly, with $\mathcal{R}$ expressed as,

$$\mathcal{R} = C_s + C_r r^3 \quad . \tag{11}$$

Eqs.(9) and (11) can now be combined with Eq.(7) to give the magnetic spin field. For obvious physical reasons, the solution has two regions, inner and outer, where A_α of each matches at some radius δr_e. Thus,

$$A_\alpha = \begin{cases} C_s \dfrac{r}{(\delta r_e)^3} \sin\theta & , \quad \text{inside } \delta r_e \\ C_s \dfrac{1}{r^2} \sin\theta & , \quad \text{outside } \delta r_e \end{cases} \quad . \tag{12}$$

The spin is steady-state, and *it is assumed that the vector potential and the spin velocity have the same form*, so that,

$$V_\alpha = \begin{cases} K_s \dfrac{r}{(\delta r_e)^3} \sin\theta & , \quad \text{inside } \delta r_e \\ K_s \dfrac{1}{r^2} \sin\theta & , \quad \text{outside } \delta r_e \end{cases} \quad . \tag{13}$$

Now, in light of Eq.(3), the spin diadic is,

$$S = \frac{\sigma}{2}(\mathbf{ij} - \mathbf{ji}) \quad , \tag{14}$$

where,

$$\sigma = \kappa \int_0^\infty \int_0^\pi \int_0^{2\pi} \frac{\varepsilon_e}{c_0^2} V_\alpha (r \sin\theta) \, dvol \quad , \tag{15}$$

ε_e is the energy density of Eq.(2)(&Eq.10,Note1), and κ is an as yet unspecified scaling factor. With the proper substitutions,

$$\sigma = \kappa K_s \frac{q^2}{12\pi c_0^2 r_e^2} \left[\frac{1}{\delta^3} \int_0^\delta \varepsilon^{-4/x} dx + \int_\delta^\infty \frac{\varepsilon^{-4/x}}{x^3} dx \right] \quad . \tag{16}$$

The result is insensitive to values of $\delta < 0.06$, which only affect terms that are down by 10^{-13}. Final integration yields,

$$\sigma = \kappa K_s \frac{q^2}{192\pi c_0^2\, r_e^2}\left[1 - \left(1 + \frac{4}{\delta}\right)\varepsilon^{-4/\delta} + \frac{64}{\delta^3} T\left(\frac{\delta}{4}\right)\right] \quad , \qquad (17)$$

where δ establishes the break point of maximum V_α, and T(x) is the Truncation integral (see Appendix). Conventionally, spin is taken as the vector of S, which is S_v or,

$$\sigma = \mathbf{k}\sigma \quad . \qquad (18)$$

Following along the same lines, the spin magnetic moment is expressed as a vector,

$$\mu_s = \frac{\kappa}{2c_0}\int_0^\infty\int_0^\pi\int_0^{2\pi} \mathbf{r} \times \rho\mathbf{V}\ \mathrm{dvol} \quad ; \qquad (19)$$

but, because the charge density circulates always perpendicular to the radius vector $\mathbf{r}$ (see Figure 2), the only components that do not cancel in the integration over all θ and α are the z components. Again, this is better described by writing a spin magnetic dipole moment diadic,

$$\mathrm{M} = \frac{\mu_s}{2}(\mathbf{ij} - \mathbf{ji}) \quad , \qquad (20)$$

where,

$$\mu_s = \frac{\kappa}{2c_0}\int_0^\infty\int_0^\pi\int_0^{2\pi} \rho V_\alpha (r \sin\theta)\ \mathrm{dvol} \quad , \qquad (21)$$

and ρ is the charge density from Note 1. With the proper substitutions and integrations,

$$\mu_s = \kappa K_s \frac{q}{6c_0 r_e}\left[1 - \left(1 + \frac{2}{\delta}\right)\varepsilon^{-2/\delta} + \frac{8}{\delta^3} T\left(\frac{\delta}{2}\right)\right] \quad , \qquad (22)$$

and the usual vector magnetic moment is the vector of M, which is M_v or,

$$\mu = \mathbf{k}\mu_s \quad . \qquad (23)$$

Taking the ratio μ_s/σ with the help of Eq.(3) above and $e = 8\pi\phi_0 r_e$ and $E_0 = 2\pi\phi_0^2 r_e$ from Note 1,

$$\frac{\mu_s}{\sigma} = \pm\frac{e}{m_0 c_0}\frac{\left[1-\left(1+\frac{2}{\delta}\right)\varepsilon^{-2/\delta}+\frac{8}{\delta^3}T\left(\frac{\delta}{2}\right)\right]}{\left[1-\left(1+\frac{4}{\delta}\right)\varepsilon^{-4/\delta}+\frac{64}{\delta^3}T\left(\frac{\delta}{4}\right)\right]} \quad , \tag{24}$$

where the sign is + for the positron and – for the electron. It is a well established fact that the theoretical value of μ_s/σ given by Dirac's equation is $e/m_0 c_0$, and that the measured ratio is slightly larger. The latter is the result of the necessity of making the measurement on an ensemble of particles, and is of no special interest at this point. The actual, or intrinsic μ_s/σ ratio of individual electron/positrons is given by Eq.(24); and for any δ is slightly smaller than $e/m_0 c_0$. Since the effects of the brackets in Eq.(24) and the ensemble measurements are opposite, the exact value of δ cannot yet be determined; but indications are that $\delta < 0.06$, and the maximum $\mathbf{V}_\alpha$ occurs at a radius less than $2\times10^{-15}\,\mathrm{cm}$. Assuming that $\delta < 0.06$, then,

$$\sigma = \kappa K_s \frac{q^2}{192\pi c_0^2 r_e^2}$$

and (25)

$$\mu_s = \kappa K_s \frac{q}{6 c_0 r_e}$$

differ from the intrinsic values by less than 10^{-13} parts. In the remainder of this work Eqs.(17), (22), and (25) will all be referred to as intrinsic, unless otherwise specified.

The constants κ and K_s are not determined, up to here, in this derivation. However, because A_α and V_α are, by a number of indications, related by,

$$A_\alpha = c_0 V_\alpha \quad , \tag{26}$$

the values of κ and K_s are obtained in the following way. Using the *experimental* value for the electron's magnetic moment μ_s,

$$\mu_s = \mu_B = 3.287553 \times 10^{-20} \quad \text{ergs/hlG} \quad , \tag{27}$$

directly in Eq.(26), yields,

$$\kappa K_s = 1.2233489 \times 10^{-13} \quad . \tag{28}$$

Substituting this κK_s in Eq.(25) produces a value for the spin angular momentum,

$$\sigma = \tfrac{1}{2}\hbar = 5.272863 \times 10^{-28} \quad \text{erg-sec} . \tag{29}$$

L. O. Heflinger has pointed out that, since the outer field is equivalent to a magnetic dipole, combining Eqs. (12), (13) and (26), K_s can be eliminated and $\kappa = 24\pi c_0^2 \, r_e/q$, or, $\kappa = 1.4018713 \times 10^{18}$. If this value is used for κ, then $K_s = 8.72654177 \times 10^{-32}$. From Eq.(13), the maximum V_α at $\delta = 0.06$ $(\theta = \pi/2)$ is found to be $V_{\alpha\,max} = 1.9537 \times 10^{-2}$ cm / sec.

THE MOVING ELECTRON

The physical effects produced by the gradient squared distortion ε_e are numerous. To see exactly what happens when an electron/positron (e/p) is brought up to some velocity $\mathbf{u}$, first consider the particle at rest. Based on the development in Note 1, the contour surfaces of constant ϕ are shown to be spheres, as represented in Figure 3a. The corresponding surfaces of constant ϕ for a moving e/p are the oblate spheroids appearing in Figure 3b. So much emphasis has been placed on the Lorentz "contraction" and the electric field $\mathbf{E}$, in present day texts, that it

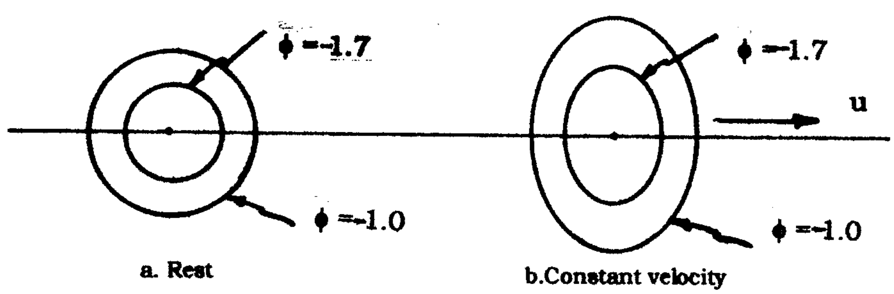

Figure 3. Lateral expansion of the moving electron/positron, (e/p).

is almost always overlooked that the potential ϕ does **not** contract longitudinally to the motion but expands *laterally*. This is why the $(\nabla\phi)^2/2$ distortion of the moving particle, integrated over all space, increases. Note that for each different constant velocity $\mathbf{u}$, a specific lateral extension and shape is required. Thus, a specific amount of distortion energy is associated with each velocity.

It is possible to form a very useful mental picture of the interaction of say, two electrons, while ignoring certain details. An electron will be acted upon to bring it from rest up to some velocity $\mathbf{u}$. However, there are no sticks or stones to move it, there is only the electric field, and specifically, only the field in the form of another particle. So, as illustrated in Figure 4, the sequence starts with one energized electron,

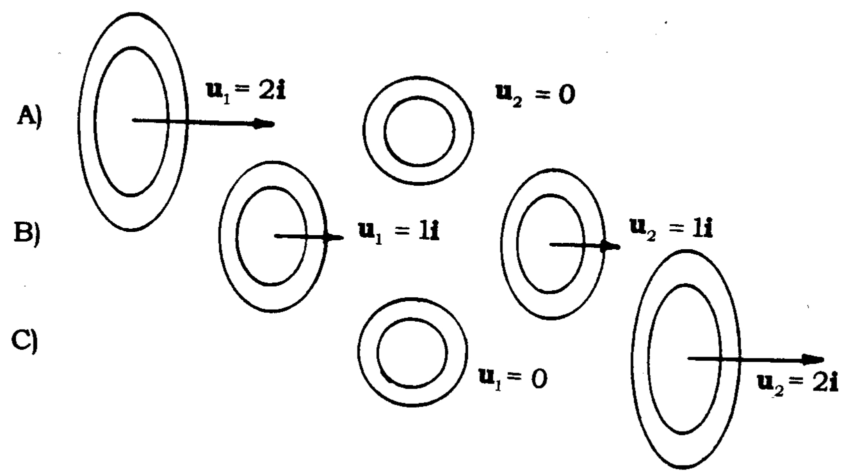

Figure 4. Energy exchange between two electrons.

moving in the x direction at velocity $\mathbf{u}_1 = \mathbf{i}2$, approaching another electron which is at rest. It must be emphasized that the contours shown are not edges or surfaces in any real sense; they are equipotential surfaces of the field. There are an infinite number of these imaginary surfaces increasing in size from the electron center to the far reaches of space. Clearly, certain liberties are taken in the simplified picture of Figure 4. Nevertheless, electron number one is originally carrying excess deformation energy (over its rest value) and number two is at rest. Later, the excess in 1 has caused 2 to move away, at the same time resulting in a transfer of distortion from 1 to 2. Number 1 cannot run slower unless distortion is removed from its field and the latter is allowed to change shape to exactly match the reduced velocity. Number 2 cannot take on the transferred distortion unless it moves and changes shape to exactly match the condition of its moving at its new velocity. As the process of transfer continues, the first electron finally gives up all of the excess distortion and comes to rest. Number 2, meanwhile, has taken on all of the original distortion and is now moving at the velocity originally exhibited by 1. The shape of 2 is now also exactly the same as the original shape of 1. In this example, radiation has been neglected.

Delving further into the operation of an e/p, it's energy can be written as,

$$E = \gamma E_0 = \frac{E_0}{\sqrt{1 - \frac{u^2}{c_0^2}}} \quad ; \qquad (30)$$

and this can be expanded in series to give,

$$E = E_0\left(1 + \frac{1}{2}\frac{u^2}{c_0^2} + \ \ldots\ldots\ldots\ldots\right) \quad . \qquad (31)$$

For small velocities, all higher order terms of the series are negligible; and, making use of Eq.(3), the excess energy of the particle due to its constant velocity is,

$$E_k \cong \frac{1}{2}\frac{E_0}{c_0^2}u^2 = \frac{1}{2}m_0 u^2 \quad . \qquad (32)$$

This is called the kinetic energy of the moving particle. At higher velocities, the exact form is found by subtracting E_0 from E of Eq.(30), so that,

$$E_k = E - E_0 = E_0(\gamma - 1) \quad . \qquad (33)$$

This brings the discussion to the following point. The electron is a small negative spherical or oblate spheroidal field. There is no rock in the middle, there are no objects in the field. It has two kinds of deformation that are significant in determining its charge and energy. When it is forced to move, it changes shape in a very precise way, increasing its distortion content. The excess distortion, called its kinetic energy, is determined by its shape and velocity. Eq.(30) represents the *total* energy of the moving electron/positron. Contrary to conventional belief, the electron's magnetic field carries no energy.

MOMENTUM

What is needed here is a brief statement about the physical nature of inertia and momentum. In connection with Figure 4, the interaction of two electrons was described. Before the #1 electron had approached close enough to #2 to have a significant effect on it, their condition could be described as follows. Number 2, being at rest, was a solution of the field equations, and assuming the boundary conditions did not change, it would sit permanently at the same location forever. Number 1, being in motion at constant velocity, was also a solution of the field equations, and assuming the boundary conditions did not change, it would continue along a straight line at constant velocity forever. These are not mathematical statements, but physical. In both cases, the boundary conditions are $\phi \cong 0$ far out. Only when #1 electron approached close enough to #2 to lower the potential between them from 0 would both see the boundary conditions change and then adjust their representative solutions of the field equations. This is the physical meaning of inertia. Only when the boundary conditions change will a solution of the field equations be modified.

Momentum, $\mathbf{p} = m\mathbf{u}$, can be understood physically by realizing that it is a combination of the effect of inertia and the fact that it takes time to bring about the changes in velocity of a particle such as the electron. First the boundary conditions must change, usually by bringing another field into the outermost regions of the electron's field. As the electron moves away from or towards the changing region, the excess deformation energy must be carried throughout the electron's field at the speed of light. Only when the shifted deformation moves in a very prescribed manner and causes the shape of the electron potential ϕ to maintain the proper configuration to match the overall instantaneous velocity and motion of the electron field can the electron-external field combination remain as a valid solution of the field equations. Thus, time is involved. *It is this time delay that begets the concept of momentum.* Numerical examples reviewing momentum and energy calculations are common. The equations most often used for this are given here in Table 1.

TABLE 1

ENERGY AND MOMENTUM FORMULAS

$E = E_0 + E_k$	$E^2 = (pc_0)^2 + E_0^2$	$\gamma = 1 + \frac{E_k}{E_o}$
$p = mu = \frac{E}{c_0}\sqrt{1 - \frac{1}{\gamma^2}}$	$u = c_0\sqrt{1 - \frac{1}{\gamma^2}}$	$u = \frac{pc_0^2}{E}$
	$p = \frac{E_k}{c_0}\sqrt{1 + 2\frac{E_0}{E_k}}$	

ELECTRON RADIATION

Propagating energy in the form of radiation is normally detected at long distance from a changing configuration of charges. It is regarded as originating with those charges, but shaking free in a non-reversible process. It propagates until intercepted. Some of the most puzzling phenomena in conventional physics originate at the interface of the emitting charge and the freely propagating radiation. That is the inevitable result of the lack of knowledge about the charge's internal structure. The present section deals with the mechanism by which extended charges (e.g. electrons) create radiation.

The *standard* approach to this problem is to first solve Maxwell's equations for the field radiated from a point charge moving in explicit ways. If the question is then asked, "When can an electron radiate?", the conventional response is, "When it accelerates."; and this response may be true for *point* charges, if ever such existed, but it is wrong for real, extended electrons. Certainly the most conspicuous case is that of atoms in their ground state, where electrons orbiting and accelerating towards the nucleus do not radiate. So strong is the belief that the point charge solution of Maxwell's equations determine the presence or absence of radiation, that the concept of atomic orbits has been relinquished. Although no one has solved Maxwell's equations for the *extended* electron's radiation characteristics, the various examples discussed above can be used to obtain a simple rule of thumb that applies in all cases.

Figure 4 tells the whole story. The fields shown are primarily the bound energies of the particles. The interaction energies are asymmetric and not shown. In Figure 4A), the excess energy carried by the driving particle must find its way into the driven particle's field and this is never done exactly, so some of the distortion breaks free as radiation. In Figure 4B), the asymmetric interaction energies keep the process going in the forward direction, and radiation also occurs as the driven particle is pumped up. What is clear is that ***radiation only occurs when one or more particles*** **<u>change</u>** **<u>shape</u>**. Unless a particle's shape changes no electric energy becomes unbound.

RADIATION EXAMPLES

Accelerating charged particles can generate radiation. A simple rule of thumb about when and where e/p radiation will be generated was stated earlier. The following will illustrate its application in certain specific cases.

<u>Atomic Ground State Orbits</u>: The simplest non-radiating accelerating electron example is that of the ground state atomic orbit. Figure 5 portrays the hydrogen atom in its ground state condition. The proton (e^+) and the electron (e^-) are circling about their common center of energy as a rigid body. The total field equation solution is this steady state, rigid body type rotation. Since the electron's speed is not changing, there is no distortion change whatsoever; and the same applies to the proton. Therefore, such a system cannot radiate, regardless of what Maxwell's equations of the far field say. The non-radiating atom, with its extended particles, is part of the boundary condition for that solution that is not included in the conventional solution of Maxwell's equations for accelerating <u>point</u> charges.

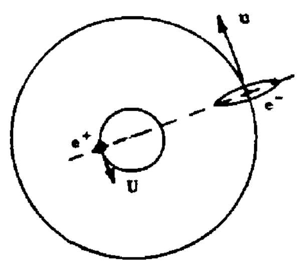

Figure 5.
Hydrogen atom ground state.

<u>Linear Accelerators</u>: Uniform acceleration of an electron in a straight line has significance in two senses. One, because a basic class of particle accelerating machines uses that format; and the other because the investigators into the conventional approach to radiation reaction have used that example as a work horse. Here a close look will be taken at the shape of a positron's field during acceleration. Assuming that the positron appears in the external electrostatic field with no velocity and

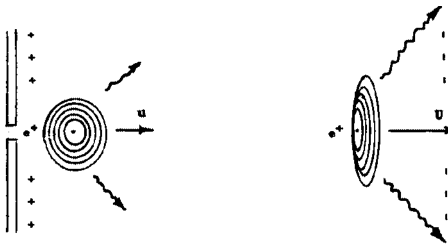

Figure 6.
The positron under linear acceleration.

spherical in shape (there are questions here, but they will not affect the following), it starts to move into the lower potential region. It does not do this as a rigid body, but begins to deform from the outside first, as delineated in Figure 6. As the particle accelerates, it not only takes on the interaction distortion by extending laterally, but its equipotential contours also bunch asymmetrically as a result of the accelerating motion. Thus, there are two bound components of the momentum, a velocity related and an acceleration related part. If, as shown in Figure 6, the positron passes out of the external field and is no longer accelerated; just as it leaves, a brief readjustment of the shape back to the symmetrical constant velocity form takes place, and the acceleration part of the bound field is radiated away. The total radiation during the whole process consists of the continuous free radiation during the acceleration process plus the final disposal of the bound asymmetrical acceleration momentum.

<u>Braking Radiation</u>: Whether a speeding positron is slowed by passing into a field, such as that portrayed in Figure 7, or by passing the surface

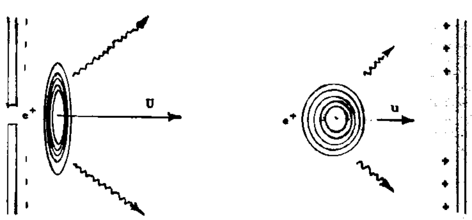

Figure 7.
Positron under linear deceleration.

atoms of a lattice structure as it enters the lattice, for example, the deceleration it experiences is caused by its slowing in some form of electrostatic gradient. Here again there are two forms of the bound deformation, the laterally expanded symmetrical *velocity* component and the *asymmetrical acceleration* component. As the equipotential ϕ contours bunch up, the kinetic energy of the braking positron is converted partly into the interaction energy between the positron and the external field and partly into free radiation. The description of collision energy transfer and radiation has been nicely summarized by Jackson and by Panofsky and Phillips, for example.[1]

Driven Electrons Moving in a Wire: The application of an alternating potential difference between the ends of a piece of wire causes the electrons, in addition to their random snaking motions, to drift in unison, to and fro, along the wire, alternately accelerating and decelerating. Figure 8 shows only the driven component of the motion and its effect on a single electron. At T_1, its velocity is a maximum with

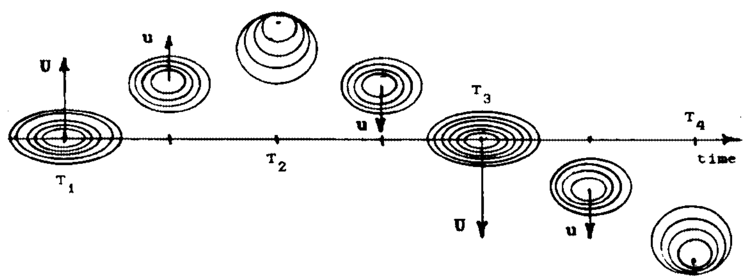

Figure 8. A single oscillating electron.

no acceleration. Subsequently, it decelerates and radiates until at T_2 its "center" is at rest and it is radiating at maximum rate, since outer regions of its field are unable to come back or reverse direction. It continues to accelerate, although less and less, till at T_3 it again has maximum velocity and no acceleration. Beyond this, the same sequence is repeated in the opposite direction, until one cycle is completed. This is a case where the electron's shape is clearly changing and radiation is the result.

TURNING

One aspect of the electron's characteristics that has no counterpart in contemporary physics is a result of its shape change with motion. By expanding laterally to the direction of its motion, the electron has an

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1. J.D.Jackson, Classical Electrodynamics, J.Wiley & Sons, N.Y. (1962).
W.K.H.Panofsky & M.Phillips, Classical Electricity and Magnetism, Addison-Wesley Publ.Co., Cambridge, MA (1955).

established shape axis; and it could be expected that, in certain situations, that axis could shift direction. In other words, *the electron shape could turn*. It might then reasonably be expected, that whether or not it turned, as its path deviated from a straight line, could have a profound effect on its physical operation. At this point, it cannot be emphasized enough that this turning is not the least like the spin examined earlier; and often, when turning is discussed, the spin will be ignored, because the nature of the fields allows them both to operate without interfering with each other.

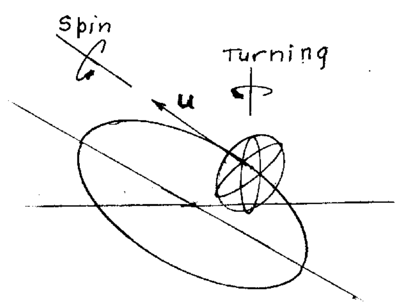

Figure 9. Turning and spin.

Figure 9 illustrates both spin and turning for an orbiting electron. The spin aligns itself with the shape axis, pointing along the orbit. The shape turns one full turn per orbit cycle. This is known as full turning. In the full turning case field elements move with a pattern that corresponds to rigid body rotation.

An extended e/p orbiting in a central electric field always has full turning. Even the non-circular orbits have full turning; but, in those cases, the electron's shape changes with its orbital velocity, and thus it radiates and decays. A certain set of these (certain ellipses) have low distortion and low self interference, and these are pseudo-stable, having long lifetimes and small variations in orbit energy (narrow line widths).

All *circular* orbits also have full turning, which would allow stability. So now the shoe is on the other foot. Whereas the conventional attitude is that all orbits are unstable and so even one ground state orbit is **impossible**, a reason must be found to eliminate all but one of the stable, circular orbits.

Crisscrossing the universe are uncountable numbers of photons, neutrinos, antenna waves generated by binaries, exploding stars, etc. All this random energy adds up to what is referred to as zero point fluctuations (ZPF). Thus, even stable, circular orbit electrons are constantly buffeted by small variations in background. These are large enough so that after a time, the electrons in larger stable orbits are displaced enough to start them decaying to the next lower state. Only the one lowest, circular stable state manages to reach equilibrium with the ZPF, and remain stable. All the others radiate photons.

CONCLUSION

The foregoing represents almost all that is known about electron structure and behavior. It opens the way for the development of a complete, deterministic theory of atomic structure, orbits and all. Compared with the present quantum theory presentation of atoms, it is immensely simple and actually gives some results that differ from QM and are correct. It is not emphasized in modern textbooks that unless the energy inserted in Schroedinger's equation is an accurate representation of the mechanical system, the outcome is incorrect. Since the extended electron requires an energy and momentum balance different from that used in all present textbooks, until they are changed, the QM result has certain discrepancies that must be corrected.

Table on next page.

APPENDIX

TRUNCATION INTEGRALS

1. $\int_0^x \varepsilon^{-1/y} dy \quad = T(x)$ The truncation integral.

2. $\int_0^x \varepsilon^{-a/y} dy \quad = a\, T\left(\frac{x}{a}\right)$

3. $\int_0^x y\, \varepsilon^{-a/y} dy \quad = \frac{x^2}{2}\varepsilon^{-a/x} - \frac{a^2}{2} T\left(\frac{x}{a}\right)$

4. $\int_0^x y^2 \varepsilon^{-a/y} dy \quad = \left(\frac{x^3}{3} - \frac{ax^2}{2\bullet 3}\right)\varepsilon^{-a/x} + \frac{a^3}{2\bullet 3} T\left(\frac{x}{a}\right)$

5. $\int_0^x y^3 \varepsilon^{-a/y} dy \quad = \left(\frac{x^4}{4} - \frac{ax^3}{3\bullet 4} + \frac{a^2x^2}{2\bullet 3\bullet 4}\right)\varepsilon^{-a/x} - \frac{a^4}{2\bullet 3\bullet 4} T\left(\frac{x}{a}\right)$

6. $\int_0^x y^n \varepsilon^{-a/y} dy \quad = \left(\frac{x^{n+1}}{n+1} - \frac{ax^n}{n(n+1)} + \frac{a^2 x^{n-1}}{(n-1)n(n+1)} - \ldots\ldots\right.$

$$\left.\ldots\ldots\ldots\ldots \pm \frac{a^{n-1}x^2}{(n+1)!}\right)\varepsilon^{-a/x} \mp \frac{a^{n+1}}{(n+1)!} T\left(\frac{x}{a}\right)$$

7. $\int_0^x \frac{\varepsilon^{-a/y}}{y^2} dy \quad = \frac{\varepsilon^{-a/x}}{a}$

8. $\int_0^x \frac{\varepsilon^{-a/y}}{y^3} dy \quad = \frac{\varepsilon^{-a/x}}{a^2}\left(1 + \frac{a}{x}\right)$

9. $\int_0^x \frac{\varepsilon^{-a/y}}{y^4} dy \quad = \frac{2\varepsilon^{-a/x}}{a^3}\left(1 + \frac{a}{x} + \frac{a^2}{2x^2}\right)$

10. $\int_0^x \frac{\varepsilon^{-a/y}}{y^n} dy \quad = \frac{(n-2)!\varepsilon^{-a/x}}{a^{n-1}}\left(1 + \frac{a}{x} + \frac{a^2}{2!x^2} + \frac{a^3}{3!x^3} + \ldots\ldots + \frac{a^{n-2}}{(n-2)!x^{n-2}}\right)$

11. $Q(x) = \varepsilon^{1/x} T(x) \quad , \quad T(x) = \varepsilon^{-1/x} Q(x)$

12. $\frac{dQ(x)}{dx} = 1 - \frac{1}{x^2} Q(x)$

Table on next page.

x	T(x)	x	T(x)
0.05	4.7024×10^{-12}	7.00	4.5615
0.10	3.8302×10^{-7}	7.50	4.9971
0.15	2.2539×10^{-5}	8.00	5.4365
0.20	1.9929×10^{-4}	8.50	5.8794
0.25	7.9955×10^{-4}	9.00	6.3254
0.30	2.1277×10^{-3}	9.50	6.7742
0.35	4.4403×10^{-3}	10.0	7.2254
0.40	7.9190×10^{-3}	11.0	8.1345
0.45	1.2674×10^{-2}	12.0	9.0512
0.50	$1..8767\times10^{-2}$	13.0	9.9743
0.55	2.6207×10^{-2}	14.0	10.9029
0.60	3.4990×10^{-2}	15.0	11.8362
0.65	0.04508	16.0	12.7737
0.70	0.05645	17.0	13.7149
0.75	0.06903	18.0	14.6593
0.80	0.08279	19.0	15.6067
0.85	0.09766	20.0	16.5567
0.90	0.11361	25.0	21.3385
0.95	0.13057	30.0	26.1594
1.00	0.14850	35.0	31.0076
1.20	0.2288	40.0	35.8759
1.40	0.3214	45.0	40.7595
1.60	0.4241	50.0	45.6552
1.80	0.5351	55.0	50.5608
2.00	0.6532	60.0	55.4746
2.50	0.9734	65.0	60.3952
3.00	1.3207	70.0	65.3216
3.50	1.6881	75.0	70.2531
4.00	2.0709	80.0	75.1890
4.50	2.4660	85.0	80.1287
5.00	2.8710	90.0	85.0719
5.50	3.2842	95.0	90.0181
6.00	3.7044	100.0	94.9671
6.50	4.1304	$x\to\infty$, $T(x)\to x-\log_e x$	