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A Quantum Theory of Electrodynamics

After “Quantum Electrodynamics” by Dirac, Feynman

Introduction

It is a fundamental property of physics that the rate of energy transfer of a wave, its “intensity”, is given by the square of its amplitude. In classical electrodynamics, this is given the name, the Poynting vector, $\mathbf{P} = \mathbf{E} \times \mathbf{H}$. \mathbf{E} is the electric field amplitude and \mathbf{H} , or \mathbf{B} , the magnetic field amplitude. In this analysis the respective intensities of the electric and magnetic field intensities are given by E^2 and B^2 , these are both simultaneously in proportion to the Poynting vector, but it will be convenient to separate the Poynting vector into intensities of the two fields, separately.

For the bulk of the following discourse we shall deal with the interaction between an electron and the electric field amplitudes of the wave, $E = |\mathbf{E}|$. After the completion of this matter, we can deal purely by analogy with the dual theorem, the interaction of positrons, (magnetic charge rather than electric charge), and the magnetic field $B = |\mathbf{B}|$. The theory does not need to be repeated, it is valid for both components of the electromagnetic wave, purely by analogy. This is called “duality”.

Planck’s law

The person who essentially invented quantum physics was Max Planck. He discovered, in the analysis of radiation originating in “black bodies”, energy was quantized, the energy being in proportion to the frequency of the radiation, $E = h\nu$. Einstein then showed in his theory of the photoelectric effect that this quantisation was a property of the radiation itself, not the black body. Einstein proposed that electromagnetic radiation is composed of “photons”, whose energy is given by Planck’s law, and that the quantity of photons in the field is in proportion to the rate of energy transfer, or the intensity of the wave. A natural consequence of Einstein’s theory is that if one doubles the frequency, hence energy of the photons in the wave, but not the intensity, then the number of photons in the wave is halved, according to the conservation of energy which is a fundamental law of physics. Einstein was awarded the Nobel prize for his theory of the photoelectric effect, and not for his theory of special relativity, somewhat surprisingly. However both of his cornerstone theories, special relativity and the theory of the photoelectric effect, combine and lead onto Dirac’s relativistic quantum mechanics, subsequently quantum electrodynamics, to which Feynman made a substantial contribution. It will be our purpose to explain how the theory presented in this paper relates to quantum electrodynamics, its “namesake”.

Doppler shift

In physics there are two kinds of “Doppler shift”, relativistic and non-relativistic. Doppler shift arises when the speed of an observer is varied with respect to a wave source, or visa-versa. It is not clear which kind of Doppler shift one should use in a given physical theory, but by the completion of this work we shall have some idea of which Doppler shift to use in a given situation in the quantum theory of the electromagnetic field. To begin with, it should be noted that the non-relativistic Doppler shift formula is significantly less complicated, so if we are to build a physical theory based on Doppler shift we stand a much better chance of success if we begin with the simpler, non-relativistic Doppler shift formula.

Relativistic Doppler shift

Let's call the boost to the velocity of the source or observer “v”. Then we define:

$$\beta = v / c.$$

c is the speed of light and v can be positive or negative. Then the Doppler shifted frequency is given by:

$$f = ((1 + \beta) / (1 - \beta))^{1/2} f_0,$$

where f_0 is the original (non Doppler shifted) frequency.

Non-relativistic Doppler shift

Let us derive the non-relativistic Doppler shift, and hence compare it with the relativistic formula. Consider the period of the wave, $T = 1 / \nu$. If we give the observer a boost, $\pm v$, then the extra time or lesser time it takes for the wave to get to the observer is:

$$t = d / v,$$

where $t = T$, and $d = \Delta\lambda$, the shift in wavelength. The observed wavelength in the new inertial reference frame is $\lambda + \Delta\lambda$. So if the observer is moving away from the wave source the observed frequency decreases and if toward the wave source the observed frequency increases. Now consider the wavenumber:

$$k = 2\pi / \lambda \leftrightarrow \nu,$$

wavenumber and frequency are qualitatively the same thing. So:

$$\begin{aligned} \lambda' &= \lambda + \Delta\lambda \\ &= \lambda + vT \\ &= \lambda + v / \nu \end{aligned}$$

$$= c / v + v / v$$

$$= (c + v) / v.$$

Now $k' = 2\pi / \lambda' = 2\pi \times v / (c + v)$.

So $k' = k.c / (c \pm v)$.

Let's check for consistency. If we have no Doppler shift $\leftrightarrow v = 0$,

Then $k' = kc / c = k$,

the expected result.

Quanta and wavepackets

If we add a lot of waves together over a continuous span of frequencies, we get a “wavepacket”, according to the theory of the Fourier transform. The Fourier transform arises out of the continuous limit of a Fourier series. That is how we make a particle out of a wave, crucial to all of quantum mechanics and crucial to all of quantum electrodynamics, also crucial to the theory presented in this paper. It was from this that Heisenberg achieved his famous “uncertainty principle”.

Uncertainty principle for electrons

$$\Delta x \Delta p_x \geq \hbar.$$

Uncertainty principle for photons

$$\Delta t \Delta E \geq \hbar.$$

The interaction between photons and electrons, crucial to Heisenberg's theory, is also crucial to “A quantum theory of electrodynamics”. The quantisation of one hinges on the quantisation of the other. In due course we shall achieve Dirac's theory of the magnetic monopole, the “electromagnetic duality”, out of this. Refer also to “Duality and M-theory”, (Farmer, 2001), Imperial College, London. In the formulae above t, \mathbf{x} are the components of the space-time 4-vector, which we'll discuss in due course, E the photon energy and p_x the x -component of the electron momentum.

So we have two types of wavepacket, the energy wavepacket, or photon, and the mass wavepacket, or electron, (positron in the dual electromagnetic theory). One obtains a wavepacket if one adds waves over a continuous distribution of wavenumbers, (we have seen that wavenumbers are akin to frequencies). Below we illustrate the addition of waves of different frequencies to get a wavepacket.

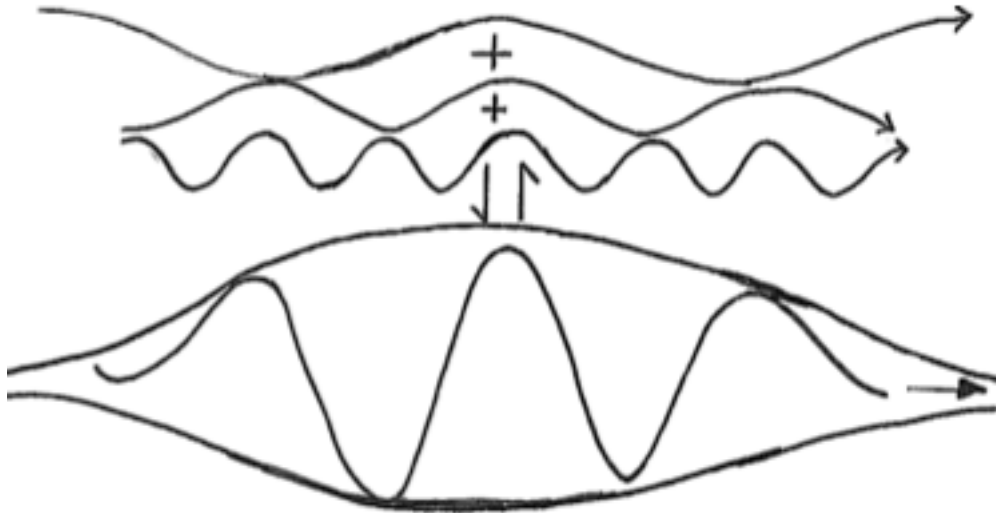


Figure 1: Addition of waves of different frequencies to get a wavepacket

Consider the frequency spectrum out of which arises the wavepacket. There is a certain wave amplitude associated with each frequency. The spectral height or amplitude, E , of the electromagnetic wave, discussed above, will be a constant over the range of frequencies discussed in this paper although this does not have to be the case. Each “wavelet” is a plane wave, wavenumber k , electric field amplitude E , or amplitude given by mass, m , in the case of the mass (electron) wavepacket.

The wavepacket spectrum is illustrated below. At the centre of the wavenumber spectrum is our electromagnetic frequency, k_s . To the right are the higher wavenumbers given by the observer moving toward the source. To the left are the smaller wavenumbers given by the observer moving away from the source. To find these wavenumbers we use the non-relativistic Doppler shift formula.

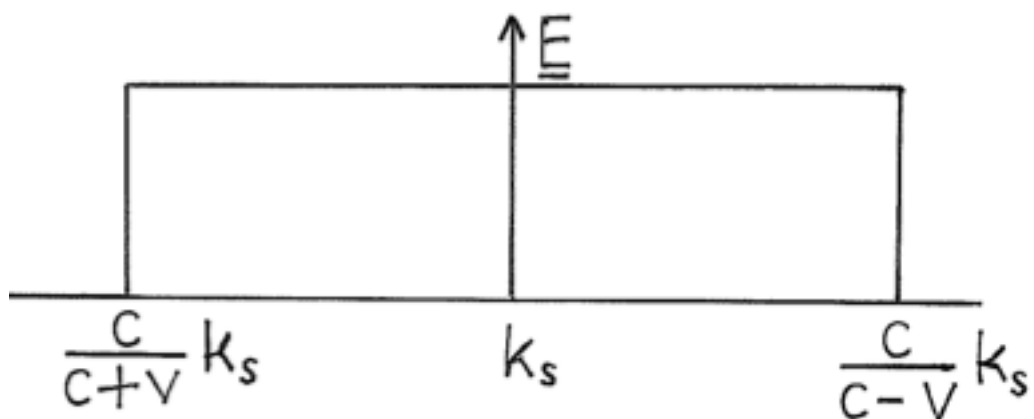


Figure 2: Non-relativistic Doppler shift spectrum

Fundamental property of wavepacket spectrum

Now for wavepacket spectrum and consequential wavepacket, we have the following results:

- (1) Height of wavepacket is in proportion to the height of the spectrum, and
- (2) Height of wavepacket is in proportion to the width of the wavepacket spectrum.

What if the photon frequency k_s is not dependent on the electromagnetic amplitude E or the electron velocity v ? (For surely QTE is concerned exclusively with electrons insofar as they are connected definitively with the photoelectric current of Einstein). Both the behavior of the electron and the amplitude of the electromagnetic wave, E , is quite distinct from the frequency of the electromagnetic wave, k_s .

If E , v , do not depend on k_s , then upon inspection of the wavepacket spectrum above we see that its width is in proportion to k_s , and its height invariant, such that we have the required Planck identity:

$$\text{Energy} = hk_s,$$

the height of the photonic wavepacket is in proportion to the electromagnetic wavenumber and is independent of the electromagnetic amplitude, E , and consequently the electromagnetic intensity, E^2 . That is, the photon energy is in proportion to:

$$k_s \times (c/(c - v) - c/(c + v)),$$

where v , like E , does not vary with k_s .

What we are really saying is that electron velocity, v , varies with E and not k_s . Now we try to proceed beyond Planck's law to Einstein's photoelectric effect. The first requirement will be that the rate of photonic transfer, or number of photons in the field, will be in proportion to the electromagnetic intensity E^2 . The second requirement will be that the rate of photonic transfer, or number of photons in the field, will be inversely in proportion to the electromagnetic frequency, or wavenumber k_s .

So when we vary the photon number, or rate of acquisition of electrons which want to be excited by photons, keeping k_s constant, we are concerned with the above spectrum insofar as its area does not depend on E^2 , only on k_s .

Insofar as the photonic energy is independent of the electromagnetic intensity, E^2

As mentioned above, the wavepacket height is in proportion to both the height and the width of the wavepacket spectrum. To keep the photon energy constant

then, we required that the area of the spectrum is a constant, that is, if we double its height we must halve its width, and visa-versa.. The requirement will be that as we vary, E, consequently E^2 , the area of the spectrum, that is, its height times its width, will be a constant.

Leaving aside for the moment what happens when k_s is varied, we start with wavenumber k_s and keep this constant as we vary E. We require the spectral area to be a constant:

$$E \times k_s \times ((c/(c - v) - c/(c + v))) = \text{constant},$$

$$E \times 2vc / (c^2 - v^2) = \text{constant},$$

$$E \times v / (1 - v^2/c^2) = \text{constant}.$$

4-vector theory, Melrose, Wheatland and Farmer

Before we proceed to analyse the above equation obtained by the requirement that the height of the photon wavepacket be a constant, note that we are describing an interaction of electron waves and electric field waves. But isn't this what we are doing with the theory of acceleration of charges, which produces the electromagnetic theory of radiation? We have the electron and the radiated photon, and they interact in some manner. This is precisely what is described by "Feynman diagrams", in quantum electrodynamics. Electrons can scatter off other electrons, or off photons. What about photons scattering off photons?

We arrive at the same result, anyhow, with the Melrose-Wheatland-Farmer 4-vector theory. Considering classical electromagnetism, this theory is not quantized. That is, photon energy is in proportion to acceleration, not current. We propose two 4-vectors, along with all the other 4-vectors that are known to exist in physics. In the analysis of electromagnetic flux tubes in solar flare theory, we proposed that $(\mathbf{J} \cdot \mathbf{E}, \mathbf{E} \times \mathbf{B})$ is a 4-vector. In "extremising" this 4-vector, we put its two components equal to one another. One of these is an energy dissipation, and the other an energy propagation. The extremising condition is:

$$\mathbf{J} \cdot \mathbf{E} = |\mathbf{E} \times \mathbf{B}|.$$

However Wheatland wants to know, these two quantities that we have equated do not have the same dimensions. Where has the extra spatial dimension gone? We propose that this spatial dimension is equal to the distance between the helical electric and magnetic fields at the surface of the electromagnetic flux tube. In putting these two quantities together in the manner above, for a solar electromagnetic flux tube, some interesting results came out in the algebra.

We propose another 4-vector, for electromagnetic flux tubes. This 4-vector will be $(\hbar\omega, \mathbf{v} \times \mathbf{B})$. The angular frequency, ω , is associated with the helical path at the surface of the flux tube. The $\mathbf{v} \times \mathbf{B}$ term unifies Maxwell's equations and the Lorentz force. An electromagnetic flux tube is identically a charged particle,

(electron), propagating in a magnetic field, it drifts in the direction of the field lines, \mathbf{B} , and its motion has a circular component across the field lines, as pictured below where the field lines go into the page and the motion across the field lines necessitates a circular component of the motion in consequence of the centripetal Lorentz force.

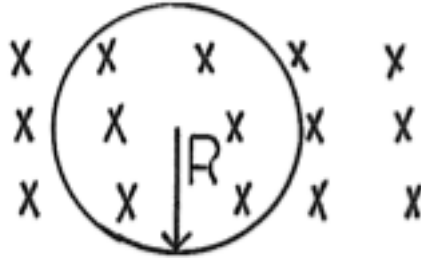


Figure 3: Helical motion of electron, field lines \mathbf{B} into page

The centripetal force is:

$$F_c = mv^2 / R,$$

and multiplying out the unwanted spatial dimension, this time the radius R of the flux tube and not the distance between the surface helical electric and magnetic fields, we find:

$$mv^2 = \hbar\omega.$$

Now there are two fermions at the surface, electron propagating on a field vector, \mathbf{B} , and positron propagating on a field vector, \mathbf{E} . The two kinetic energies add,

$$\frac{1}{2} mv^2 + \frac{1}{2} mv^2 = mv^2.$$

The fermions, electron and positron, interact with a photon, $\hbar\omega$. This photon is not propagating in free space, it has no “ghosts”. So the electron and positron are associated with a single photon, not two photons. This is by analogy with atomic physics whereby the orbiting electron and the protonic positron in the nucleus are together associated with a singular orbiting photonic wavepacket, which defines the atomic orbital.

The extremising of the 4-vector occurs in such a manner that we have a kinetic energy equal to a photonic energy, upon doing away with the unwanted dimension as we did in the case of the dissipation-radiation 4-vector, $(\mathbf{J}\cdot\mathbf{E}, \mathbf{E} \times \mathbf{B})$. This is identically what we have done in associating an electron velocity with a doppler shift of an electromagnetic wave, the two energies are equal insofar as the quantisation of the fermion (electron) is related identically to the quantisation of the boson (photon). The existence of a photonic wavepacket is related identically to the fact that the electron is quantized, and because it is

quantized it can move in a range of velocities, $v: 0 \rightarrow c$. Because they interact in this manner, their energies are equal. And we have the result, mentioned above, that the photonic energy will be in proportion to the electronic acceleration, as indicated in the above equations.

Two 4-vectors for flux tubes

The two 4-vectors we have discussed above each have a discrepancy of a spatial dimension. The one space cancels out the other space, such that the critical matter to address is the ratio of the radius of the flux tube to the distance between the helical electric and magnetic fields at the surface. Obviously, this ratio is dimensionless, and it defines the physics of the flux tube in question. These two 4-vectors are associated uniquely with electromagnetic flux tubes, which are numerous in nature. Some hypothesized electromagnetic flux tubes are as listed below:

- (1) Solar flare electromagnetic flux tubes,
- (2) Flux tubes associated with terrestrial electromagnetic circuits,
- (3) Mechanisms for phloem movement of substances in plants, which amazingly is not understood by plant scientists at the present time, while movement of water in xylem vessels in plants is understood, and has nothing to do with electromagnetic flux tubes,
- (4) Flux tubes across membranes in cells, a proposed mechanism for getting metal complexes inside cancer cells to destroy their DNA, and
- (5) Flux tubes associated with helical motion of free electric charge in a uniform magnetic field, a consequence of the Lorentz force, $\mathbf{F} = q\mathbf{v} \times \mathbf{B}$.

Dependence of photon number in the field on electromagnetic intensity

We have to account for variation of photon number in the field with:

- (i) intensity, E^2 , and
- (ii) frequency, ν .

The latter, (ii), is comparatively easy, and took a couple of years to work out. (i) is somewhat more involved, and took a quarter of a century to establish a successful theory for.

Above, we have established a relation between E , the electromagnetic field amplitude and v , the electron velocity, by demanding that the photon energy stay constant as amplitude, intensity of the electromagnetic wave are varied. Analysing the consequential equation, we find two important limits.

- (1) As $E \rightarrow 0$, $v \rightarrow c$.

This is an interesting result, and it accounts for the fact that in the superconductive limit, (resistance $R \rightarrow 0$), the electrons in the circuit travel at

the speed of light, c . The notion that electrons travel at c in conducting wires, (non-resistors, linking resistors), is known to physicists, but not understood. How can electrons travel through conducting wires at c when Einstein's special relativity implies they would have to have an infinite mass to do so? We shall address this problem in due course. It is sufficient for the moment to note that electrons do travel at c in atomic orbitals and at the surfaces of flux tubes, their rest mass having been converted to a total mass, i.e. in incorporation of electrons onto these pathways, they have lost their rest mass. Further, when the axial field at the interior of an electric circuit / flux tube vanishes, (perfect conductor), the quanta carrying electric charge internally, the positrons, also lose their rest masses. Positrons are magnetic charge quanta when they are associated with electrons, but they also have the ability to carry electric charge, opposite in sign to that of an electron, when they are not associated with electrons, as occurs internally in flux tubes, when the internal positrons are separated from the electrons following helical paths at the surface.

(2) As $E \rightarrow \infty$, $v \rightarrow 1/E \rightarrow 0$, and

Electric field lines per electron wavelength $\rightarrow E^2$, the electromagnetic intensity.

We achieve this result by the de Broglie hypothesis. De Broglie suggested that in consequence of Planck's law for radiation, $E = hv$, we should conclude $p = h/\lambda$ for electrons, such that if Einstein proposed radiation comes in quanta, or wavepackets, so matter or electrons should behave simultaneously as waves, whose wavelengths are described by this de Broglie identity. From that Schrodinger got his wave equation for electrons in atomic orbitals, by addressing the question of what is the amplitude of the electron wave, given its wavelength, and the rest is history.

So:

$$p = h / \lambda = mv.$$

Consider the rest mass of the electron, $m = \text{constant}$.

$$\text{Then } v \propto 1 / \lambda.$$

And using the result $E \propto 1 / v$ as $v \rightarrow 0$, $E \rightarrow \infty$, let's double the wavelength for $m = \text{constant}$:

$$\lambda \rightarrow 2 \lambda,$$

$$v \rightarrow \frac{1}{2} v,$$

$$E \rightarrow 2E.$$

Below we illustrate what happens as we vary the electron wavelength, the electron wavelength and consequently the field amplitude E of the electromagnetic wave. If one counts the number of electric field lines per

electron wavelength, one arrives at the pleasing result that the energy transfer of the electromagnetic radiation, E^2 , derived classically according to the Poynting vector, is in proportion to the number of electric field lines per electron wavelength. With this result, we found the inspiration to press ahead with trying to arrive at a theory which explained this interesting result. As mentioned, it took 25 years to achieve such a theory in its completeness.

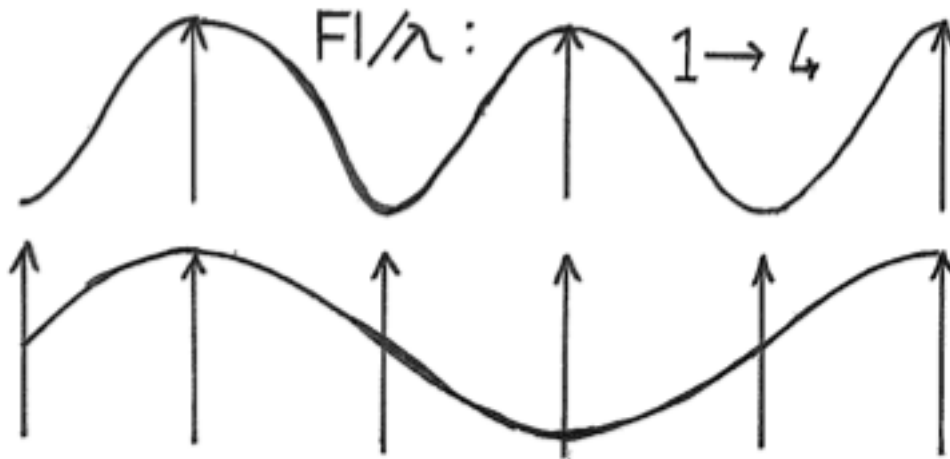


Figure 4: Electromagnetic amplitudes normal to the propagation of the electron wave, as v , E are varied

So if one doubles E , Field lines per wavelength or Fl/λ quadruples, as does E^2 obviously, and we have our result. So:

$Fl/\lambda \leftrightarrow E^2$ in the limit $E \rightarrow \infty$, $v \rightarrow 0$. In the figure above we go from two field lines per wavelength to four field lines per wavelength.

To interpret this result, firstly consider that it is arbitrary how we choose the spacing between electric field lines, it is just a matter of definition. So, for example, we can choose the spacing between field lines to coincide with electron wavelengths, as we did above before we doubled the electron wavelength. Perhaps such a requirement would coincide with Einstein's equivalence of mass and energy, $E = mc^2$, such that:

$$m \leftrightarrow |\mathbf{E}|.$$

In wave-space, (defined by " $\lambda = \text{constant}$ "), and in the limit $v \rightarrow 0$, the transfer of mass-energy is given by the amplitude, m , not the velocity, ($v \rightarrow 0$ as $\lambda \rightarrow \infty$), and subsequently by $|\mathbf{E}|$, such that $E^2 \propto Fl/\lambda$, E^2 not in wavespace and $p = h/\lambda \rightarrow mv\lambda = \text{constant}$ does not apply to electron wave space. Planck's law and de Broglie's subsequent hypothesis apply to "physical space", as does the relativistic Doppler shift, for example, whereas non-relativistic Doppler shift applies to electron wave-space. More of this in due course. Just as the rate of energy transfer, E^2 , applies to "physical space", not electron wave-space. To interpret the

fact that $E^2 \propto Fl / \lambda$, we need to go into electron wave-space. Note that if $p = h / \lambda$ did apply to wave space, we would have the unwanted result that $m \rightarrow \infty$. It can be no coincidence that simultaneously we are not interested in the result from special relativity that $m \rightarrow \infty$ as resistance $R \rightarrow 0$, $v \rightarrow c$. Mass will indeed increase infinity-fold, but that will not be from a finite rest mass, it will be multiplied infinitely from a zero rest mass, $0 \times \infty = m_e$, the rest mass of the electron. More of this later.

That's fine, but what about $Fl/\lambda \propto E^2$? In this analysis, we are not permitted to define field lines to coincide with peaks or troughs in the electron wave. We require a variation of numbers of field lines incorporated by each electron wavelength. In the precursor to this work, published in the Toth-Maatian Review, 1990-1993, it was appreciated that the measurement of the velocity of a moving body, such as by radar on a moving car, involves a measurement of a point on the car that is moving with the car. That is, making a measurement involves transformation to a point that has zero velocity with respect to the car. In later analysis where we seek to find the variation of photon number with electromagnetic frequency, we transform ourselves into such a frame. Simultaneously, we propose that in investigation the variation of photon number with electromagnetic intensity, to count the photons involves getting into the reference frame of the electron, $v \rightarrow 0$.

Two electric field definitions

In this analysis, there are two electric field definitions we are concerned with. There is the electric field line associated with the electron wave, $|\mathbf{E}| \leftrightarrow m$, according to $E = mc^2$. We define this to coincide with troughs or peaks of the electron wave, as per above.

Then there are the field lines associated with the electromagnetic wave. These are independent of the electric field propagation associated with the electron wave. So we are looking for $E^2 \propto Fl/\lambda$ to coincide with a measurement of photon number or intensity of the electromagnetic wave, such that to count them we need to get into the frame of the electron, $v_e \rightarrow 0$, $\lambda_e \rightarrow \infty$.

Two field lines E – electronic and electromagnetic

Let's keep the electric field lines associated with the electromagnetic wave constant, and get into the frame of the electron, $v_e \rightarrow 0$.

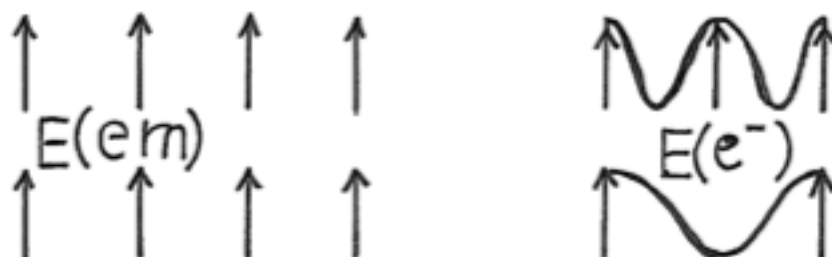


Figure 5: Electromagnetic versus electronic field lines, E

According to the de Broglie relation, $mv\lambda = \text{constant}$, if we double λ , we halve the electron velocity v_e . Correspondingly we halve the electronic electric field, $E(\text{electron})$, according to our earlier hypothesis that we can define the electronic field amplitudes to coincide with the peaks or troughs of the electron wave. This is as pictured in the figure above.

We're looking for halve $v_e \leftrightarrow$ double $E(\text{electromagnetic})$, as per the Doppler shift formula in the Fourier analysis which is the subject of this paper. But if we consider things relative to the electron wavelength and the field lines associated with the electron wavelength, ($|E| \leftrightarrow m$), we have this result, for as the spacing between field lines associated with the electron wave doubles, relatively speaking the spacing between field lines associated with the electromagnetic wave doubles, giving us the required result, $E(\text{electromagnetic}) \propto 1 / v_e$, and in the limit of a measurement, $E/\lambda \propto E^2$, as required. We've discussed briefly how the Heisenberg uncertainty principle for photons and electrons comes into all of this, it is crucial to observe that the central hypothesis of this uncertainty principle is that in making a measurement of say which state of spin an electron is in, $\pm \frac{1}{2}$, the physical quantity is undefined until the measurement is made. The physical state of the system does not exist in the absence of a measurement.

This coincides with the hypothesis, (QTE, Farmer, the Toth-Maatian Review, (1990 – 1993)), that expansion of electron wavelengths corresponds to a spatial expansion, in contrast to the Lorentz contraction of special relativity, such that:

- (i) $v \rightarrow c$, space contracts to zero, and
- (ii) $v \rightarrow 0$, space expands to infinity.

That is, in the case of QTE, we're looking for a distribution of field lines, $E(\text{electromagnetic})$ across an electron wavelength, which corresponds to a measuring rod. That is, as the electron wavelength expands to infinity, our measuring rod expands to infinity such that space itself expands to infinity, by direct (opposite) correspondence with what occurs to our spatial measuring rods in the Lorentz contraction of special relativity, $v \rightarrow c$ such that space itself contracts to zero. So in QTE, as in all other areas of physics, specifically in classical electromagnetism, where electric field lines vary, we are concerned with the spatial distribution of electric field lines, i.e. we are concerned with the density if electric field lines across space.

So, an electron wavelength is a measuring rod of space.

Above, we have considered $m = \text{constant}$, the amplitude, which will be akin to an electronic amplitude, λ variable. This is not in electron wave-space, it is in "physical space", the space which describes Maxwell's equations and the Schrodinger equation. Accordingly in physical space, we have a rate of transfer of energy E^2 variable and proportional to number of photons in the field, to be explained by QTE.

What about $\lambda \text{ constant}$, m variable? But not in wave-space, in physical space. That is, we are considering two things that are distinct from each other, one

being $\lambda = \text{constant}$ because we are in wave-space as opposed to $\lambda = \text{constant}$ despite the existence of wave-space, i.e. we are in consideration of physical space, where the de Broglie relation applies.

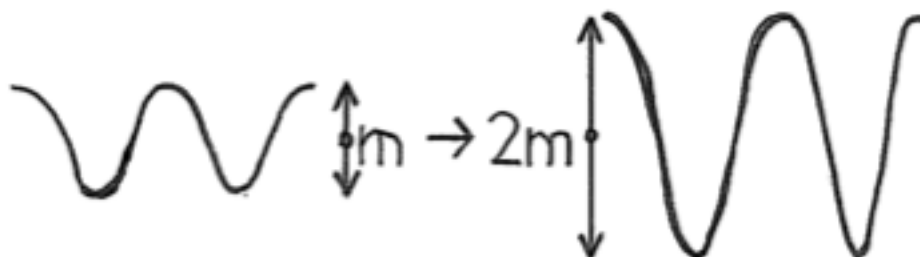


Figure 6: Amplitude $m \rightarrow 2m$ in physical space, λ constant

That is, mass, m , gives amplitude of the electron wave, (regardless of electron speed, v). So double $m \leftrightarrow$ halve v , so that rate of transfer of mass-energy is invariable. That is, where space does not vary, neither does the transfer of mass-energy.

So what about $v = \text{constant}$? (★★)

$p = h/\lambda \rightarrow mv\lambda = \text{constant}$, (de Broglie).

$v = \text{constant} \leftrightarrow v = c$, the speed of light. In this instance the electron wave coincides with the electromagnetic wave.

$m\lambda = \text{constant}'$,

double $\lambda \leftrightarrow$ halve m ,

that is, we stretch out the wave, reducing its amplitude.



Figure 7: Double the electron wavelength \leftrightarrow halve its amplitude, m

But since the speed is constant, doubling the wavelength halves the frequency \leftrightarrow halve the photon energy, $E = h\nu$ for the electromagnetic wave. This coincides with halve the electron amplitude, equivalently halve its mass, (mass \leftrightarrow energy, $E = mc^2$). So halving the electron energy.

That is, when the electron wave and the electromagnetic wave coincide, (same speed, wavelength), so too does their energy. The above discussions take care inclusively of all three possibilities for constancy of variables in the de Broglie relation $mv\lambda = \text{constant}$, being:

- (i) $m = \text{constant}$,
- (ii) $\lambda = \text{constant}$, and
- (iii) $v = \text{constant}$.

When electron and electromagnetic waves coincide

When an electron wave coincides with an electromagnetic wave, as per the discussion above, with both electron and electromagnetic components of mass-energy travelling at c , the electron wave is massless, (it has lost its rest mass, such that the rest mass has become a total mass), as per “Atoms and duality – from Dirac to Supergravity, Superstrings and M-theory” – Farmer, 2001, and subsequent works, whereby we have a spherical electron propagating on an electromagnetic pathway – that is, electrons propagating in atomic / molecular orbitals and electrons propagating at surfaces of electromagnetic flux tubes.

The meaning of electron spin

Bell’s theorem tells us that the spin of an electron is completely undetermined in the absence of a measurement. It is not even defined. We propose that the spin oscillates one way and then the other such that when a measurement is made the recorded spin is whatever way the spin is occurring when the measurement is made. Consider the electron moving out of the page, as pictured below.

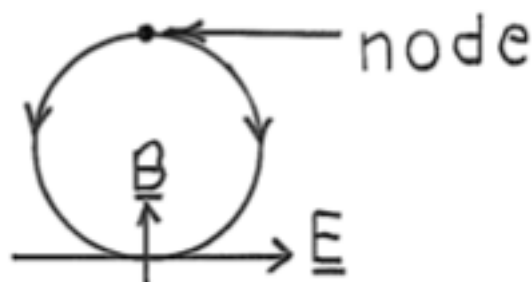


Figure 8: Electron propagating out of the page, spins one way and then the other

We have a “node” at the top, the electron oscillates from side to side, one way and then the other, without any charge quanta penetrating beyond the node at the top. At the bottom is the component of the electromagnetic wave the electron

is propagating upon. Is this **E** or **B** ? The other component, normal to this vector, carries (positron) ghosts.

As well as spinning sideways one way and then the other, the electron “rolls” like a snooker ball along the surface of the electromagnetic wave, pictured, (**E** or **B** ?). Methinks it is the electric field vector the electron is “rolling” upon. Were it not “rolling”, only spinning, the charge quantum, (wavepacket), would not trace out a wave, it would just move one way and then the other along the (stationary) field lines. The field lines are stationary because we are in the frame of the electromagnetic wave. However because the electron is “rolling”, too, the charge quantum (wavepacket) traces out the sinusoidal electric field wave, as pictured below.

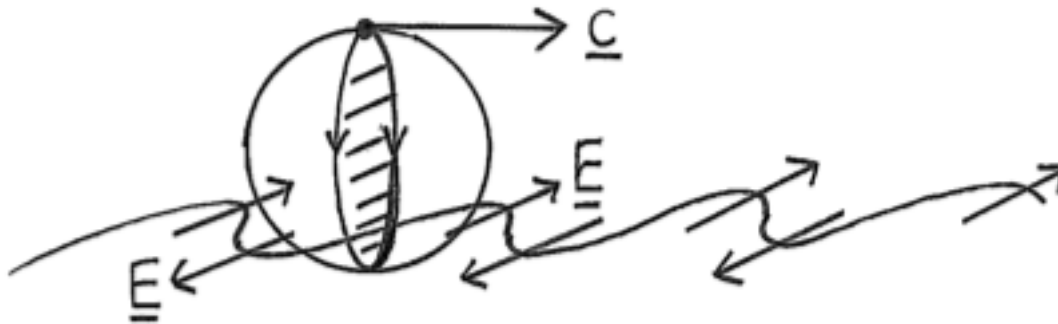


Figure 9: The “rolling” of the electron causes its charge quantum to trace out a sinusoidal path on the electromagnetic wave as it spins from side to side

Finally note that when a “measurement” occurs, the electron moves onto a new, orthogonal path, such that what previously defined its spin now defines its roll and visa-versa. In figure 9 the electron will now propagate into or out of the page depending on the state of its spin, $\pm\frac{1}{2}$, at the time when the measurement was made. Further, note that when say an electron and a positron interact and then move apart, such that spin is conserved and if the one is at a later time determined to have spin $+\frac{1}{2}$, then the other must have spin $-\frac{1}{2}$, the above analysis explains Einstein’s “spooky action at a distance”. Both fermions are spinning one way and then the other, in accordance with the above discussion, but they do it in unison, such that when the one is spinning at say $+\frac{1}{2}$ then the other is at $-\frac{1}{2}$. That is, the spins were in unison to begin with, and they remain in unison such that if at a later time the one is spinning one way then the other is spinning the other way at this point in time. This occurs in the absence of any “messages” being transferred between fermions at the time of the measurement, either bounded by the speed of light or otherwise. The same result applies to photons pairs, spin ± 1 .

In the absence of such a situation where an electron propagates upon an electromagnetic pathway at c , we have the possibility of an electron moving in free space, i.e. not upon any electromagnetic pathway, the other possibility occurs whereby we have a massive spherical electron propagating in free space at speeds such that:

$$0 \leq v < c,$$

the electron being spherical because it consists of a quantum (wavepacket) of matter / charge, locked into a spherical orbit, in such a manner that it is either massive, (finite rest mass), or massless, (zero rest mass, all rest mass has been converted to total mass, such that there is a potential for the stationary electron, rest mass m_0 , zero kinetic energy, to accelerate to the speed of light, c , giving an energy $E = \frac{1}{2}mc^2 =$ kinetic energy, in accordance with Einstein's special relativity, the other mc^2 comes from the positron, we hypothesise, giving a total energy $E = mc^2$).

Lorentz expansions and contractions

In accordance with this, an infinite Lorentz spatial contraction resulting from the acceleration of an electron from zero to c , whereupon it loses its rest mass, corresponds to an infinite contraction of wavelength, from infinity to some finite value which corresponds to the wavelength of the photon upon which the electron is propagating, some finite value, on this atomic / molecular orbital or on the surface of an electromagnetic flux tube.

To accelerate an electron onto a photonic wavepacket, i.e. to destroy its rest mass and put it onto an orbital or the surface of an electromagnetic flux tube, first choose a reference frame where the photon energy, $h\nu$, is equal to m_0c^2 , the rest energy of the electron. Then add or subtract kinetic energy of the electron to put it into this frame. Then the electron is ready to be incorporated onto the photonic wavepacket, losing its rest mass.

(★★) The known laws of physics apply to “physical space”, not electron wave-space

For example, $E^2 \propto$ rate of energy transfer in the electromagnetic wave does not apply to electron wave-space, i.e. in electron wave-space the rate of energy transfer $\propto |\mathbf{E}|$ instead.

In wave-space, defined by “ $\lambda = \text{constant}$ ”, and in the energy conservation limit $v \rightarrow 0$, (the necessary limit for a physical measurement), we have:

$$mv\lambda = \text{constant, implying } m = \infty, (0 \times \infty = \text{constant}),$$

and so we see that de Broglie does not apply to wave-space either. We have rather the alternative result that in electron wave-space the rate of energy transfer is given by

$$m \leftrightarrow |\mathbf{E}|.$$

But to get into wave-space, we start with de Broglie in “physical space”, not electron wave-space, and $m = \text{constant}$, whereupon we in due course arrive at the completed QTE, ($\rightarrow m = \text{constant}, \lambda \text{ variable}$).

The rate of energy transfer in “physical space” is variable, $\propto E^2$. Now consider “real space”, but λ constant (outside electron wave-space), and m variable.

\rightarrow de Broglie, $mv\lambda = \text{constant}$

\rightarrow double $m \leftrightarrow$ halve v ,

such that the rate of energy transfer is invariable.

So, in physical space;

$m = \text{constant}, \lambda \text{ variable} \rightarrow$ rate of energy transfer is variable $\propto E^2$,

and what we have is a space-time curvature, as opposed to:

$m = \text{variable}, \lambda \text{ constant} \rightarrow$ rate of energy transfer invariable \leftrightarrow no space-time curvature.

In such a manner, we unify Einstein’s General Relativity, with its space-time curvature, and the electromagnetic force.

Physical space versus electron wave-space

So, we have discussed the fact that in electron wave-space, the normal laws of physics do not hold.

Firstly: We must use “ordinary” Doppler shift in electron wave-space, not relativistic Doppler shift.

Secondly: In electron wave-space, electric field lines do not get closer together, (Lorentz contraction), as the speed of the observer increases from 0 to c . So the height of the wavepacket spectrum is a constant, as we have assumed.

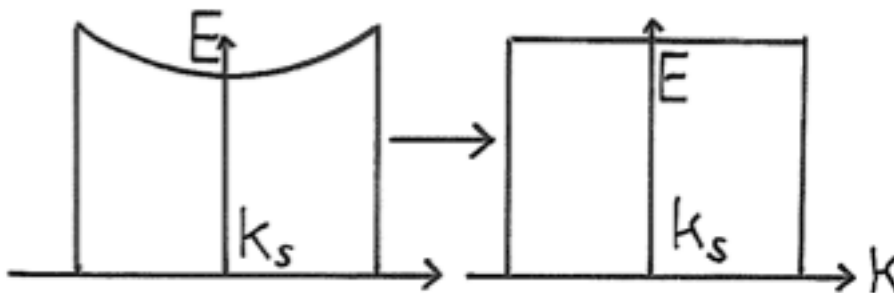


Figure 10: If we took a relativistic Doppler shift spectrum and then transformed into electron wave-space, we might expect something like this

Thirdly: In electron wave-space, the rate of energy transfer is in proportion to the spatial density of electric field lines, $|\mathbf{E}|$, not \mathbf{E}^2 . The electromagnetic intensity is a description of the rate of energy transfer in physical space. Further, the de Broglie relation $p = h/\lambda$ does not apply to electron wave-space, either.

Note that there is nothing in classical electromagnetic theory in its analysis leading to the rate of transfer of energy $\mathbf{P} = \mathbf{E} \times \mathbf{B}$ or $\mathbf{E} \times \mathbf{H}$; $|\mathbf{P}| \propto \mathbf{E}^2$, that depends on the speed of the wave. It is an analysis only of the electric fields themselves, not in any way related to the aspects of Maxwell's equations that predict what speed the wave travels at. Certainly the rate of energy transfer will increase if the speed of the wave increases, but special relativity does not come into it. We could hypothetically increase the speed of the wave, thereby increasing the Poynting flux in proportion.

Intensity and the Poynting vector

When speaking of the interaction between electrons and photons, we are concerned with the electrical intensity, E^2 , not $\mathbf{E} \times \mathbf{B}$ specifically, the Poynting vector, although it is very important to note that $|\mathbf{E} \times \mathbf{B}| \propto E^2$, and that further with regards to the dual theory of electromagnetism, $|\mathbf{E} \times \mathbf{B}| \propto \mathbf{B}^2 = B^2$.

In the next state of the analysis, we hypothesise that an electron can lose its rest mass, accelerate to c and then propagate upon the electric field component of an electromagnetic wave. Similarly a positron, the quantum of electromagnetic charge for electromagnetic processes can lose its rest mass, accelerate to c and then propagate upon the magnetic component of the electromagnetic wave. It is important to note that when it comes to electric charge, the positron is positively charged as per its name, so that we have no net charge in a radiation field.

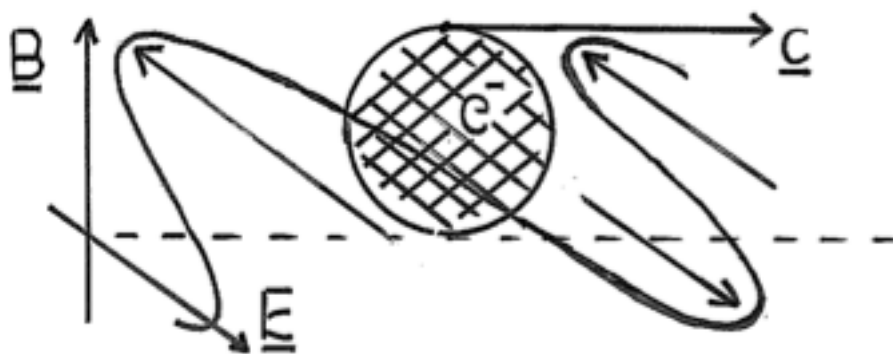


Figure 11: A massless electron will propagate upon the electric field component of the electromagnetic wave

So radiation in the field is a mixture of electronic photons, (negative charge) and positronic photons, (positive charge). When the photons in question are on the surfaces of atomic / molecular orbitals, the electrons can be removed, becoming massive again and propagating in free space, leaving an empty (unoccupied)

orbital. The positronic photon is the complete dual of “A Quantum Theory of Electrodynamics”, for positrons, not electrons. We might call this aspect of the theory “A Quantum Theory of Magnetodynamics”. Together, the original theory and its dual constitute a complete theory for photons. We might call the dual theory “An electromagnetic theory for photons”.

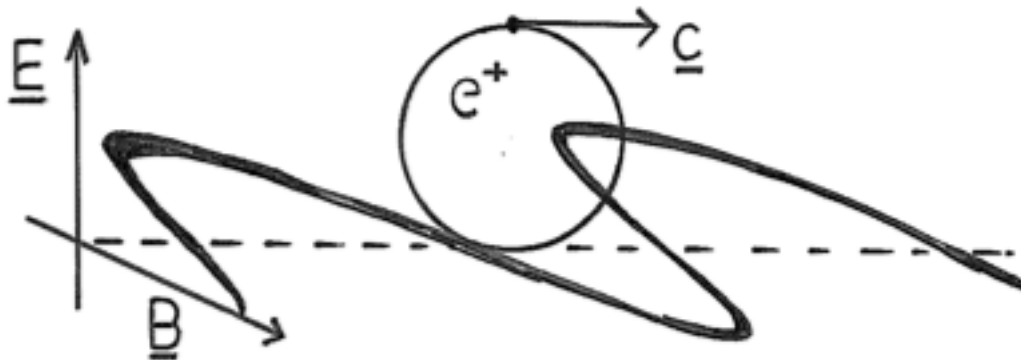


Figure 12: The dual theory: A positron propagates upon the magnetic component of the electromagnetic wave

We define a field vector “ \underline{E} ” along which an electron propagates by the oscillating component, \underline{E} , of the electromagnetic wave. Similarly we define a field vector “ \underline{B} ” along which a positron propagates by the oscillating component, \underline{B} , of the electromagnetic wave, as in the figure below.

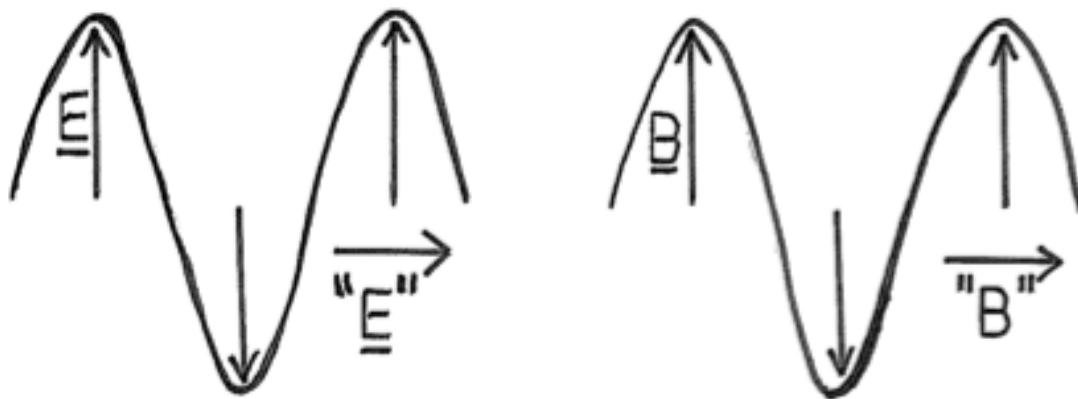


Figure 13: “ \underline{E} ” and “ \underline{B} ” field vectors, for electrons and positrons

In the latter case, for positrons, the field vector “ \underline{B} ” corresponds to the direction of propagation of the positron, $|\underline{E} \times \underline{B}| \propto B^2$, and the number of positronic photons in the field given by B^2 , the exact dual of “A Quantum Theory of Electrodynamics”.

The field vectors “ \underline{E} ” and “ \underline{B} ” then are simply vectors pointing along the direction of propagation of the wave front, as associated with the oscillating components \underline{E}

and \mathbf{B} respectively of the electromagnetic wave. “ \mathbf{E} ” describes the propagation of an electron, and “ \mathbf{B} ” describes the propagation of a positron.

Maxwell’s Equations for the dual theory

For electronic photons, (electrons propagating upon field vectors, “ \mathbf{E} ”, and whose quantisation, (Fourier wavepacket) is dependent on the oscillating electric field \mathbf{E} , we have the usual Maxwell’s equations which we are familiar with.

$$\nabla \cdot \mathbf{E} = (1/\epsilon_0) \rho_e$$

$$\nabla \cdot \mathbf{B} = 0$$

$$\nabla \times \mathbf{E} = - \partial \mathbf{B} / \partial t$$

$$\nabla \times \mathbf{B} = \mu_0 \mathbf{J}_e + \mu_0 \epsilon_0 \partial \mathbf{E} / \partial t$$

For positronic photons, (positrons propagating along field vectors “ \mathbf{B} ”), we have Maxwell’s dual equations, (for magnetic charge).

$$\nabla \cdot \mathbf{E} = 0$$

$$\nabla \cdot \mathbf{B} = \mu_0 \rho_m$$

$$\nabla \times \mathbf{E} = - \mu_0 \mathbf{J}_m - \partial \mathbf{B} / \partial t$$

$$\nabla \times \mathbf{B} = \mu_0 \epsilon_0 \partial \mathbf{E} / \partial t$$

(David Griffiths, “Introduction to Electrodynamics”, Third Edition, p327)

In the first set of equations the charge and current densities are electronic, while in the second set of equations the charge and current densities are positronic.

Maxwell’s equations and the Lorentz force

We can incorporate the Lorentz force, $\mathbf{F} = q\mathbf{v} \times \mathbf{B}$, into Maxwell’s equations in accordance with the following discussion.

Consider an electron propagating along a field vector “ \mathbf{E} ” of an electromagnetic wave. Its velocity is $\mathbf{v} = \mathbf{c}$, in the direction of “ \mathbf{E} ”. The oscillating magnetic field, \mathbf{B} , is orthogonal to the oscillating field electric field, \mathbf{E} . Note that the field, \mathbf{E} , is a force (per unit charge) – it is, furthermore, non other than the Lorentz force.

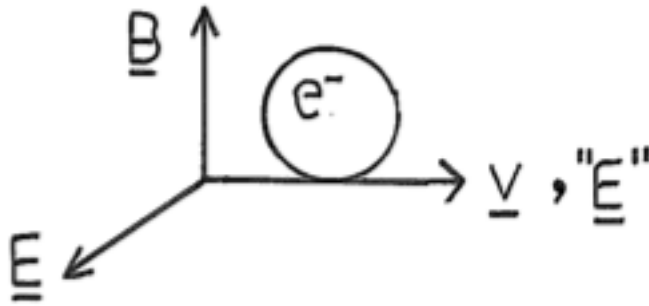


Figure 14: The electron, velocity $v = c$, propagates on the field vector "E"

Consider the Lorentz force, $\mathbf{F} = q\mathbf{v} \times \mathbf{B}$. But an electric force is given by $\mathbf{F} = q\mathbf{E}$, for an electric field \mathbf{E} . Then:

$$\mathbf{E} = \mathbf{v} \times \mathbf{B}.$$

Indeed when one considers the vectors \mathbf{E} , \mathbf{B} , \mathbf{v} in the figure above, we have the correct orthogonality, $\mathbf{v} \times \mathbf{B}$ is in the direction of \mathbf{E} . Note then that the speed of light, c , and that of the electron which is propagating on this wave is, from classical electromagnetic theory:

$$v = |c| = 1 / (\epsilon_0 \mu_0)^{1/2}.$$

How do we get this result merely in consideration of the Lorentz force and the first of each set of Maxwell's equations? If we can achieve this it will be a monumental discovery – it will certainly unify the Lorentz force and Maxwell's equations, for we determine the speed of the electromagnetic wave in consideration of Gauss's law for electrical and magnetic divergences and the Lorentz force alone. Truly, we shall have arrived at a complete theory of mathematical physics.

Consider $\nabla \cdot \mathbf{E}$ and $\nabla \cdot \mathbf{B}$ in the Maxwell equations above. Divide one by the other:

$$\nabla \cdot \mathbf{E} / \nabla \cdot \mathbf{B} = (1/\epsilon) \rho_e / \mu \rho_m.$$

The result we are looking for is $v = c = E/B$.

If we ignore the divergences, $\nabla \cdot$, we find $E/B = 1 / \epsilon\mu$. So the quantity in question is the square of what we're looking for. Of course, one is not mathematically permitted to just cross out the divergences as we have done above, saying one divided by the other cancels them out. We need to do a bit more work to get the required result.

Consider the divergence of the electric field.

$$\nabla \cdot \mathbf{E} = (1/\epsilon) \rho_e,$$

and then integrate over the volume of a sphere, using Gauss's theorem.

We obtain:

$$\int \nabla \cdot \mathbf{E} \, d\tau = (1/\epsilon) q_e,$$

for q_e a total electric charge. Then:

$$E_S \times 4\pi R_e^2 = (1/\epsilon) q_e,$$

where E_S is the field at the surface of the sphere, radial, and R_e is the sphere's (electron) radius. If $E_S = 4\pi R_e^2$ we would have the required result, since we find $E \sim (1/\epsilon)^{1/2}$ and similarly for $B \sim \mu^{1/2}$ by the dual theorem, giving the required result for $v = c$. We are concerned here with the total charges, $q_e = "1"$ and $q_m = "1"$, $q_e/q_m = 1$, electronic and positronic, only insofar as they are integer – this is the nature of the integration sphere, radius R_e – it corresponds to discrete particles, electrons and positrons. Again it is a quantum theory of electrodynamics, and we have found a solution to the question posed by Einstein, in what manner do these continuous distributions of charge correspond to discrete particles?

So, taking differentials, we have the following requirement:

$$dE_S = 8\pi R_e \, dR_e$$

Now since the electron is moving with the wave, $R < R_e$, and we are concerned only with the spatial variation of the wave, not its temporal dependence. We are concerned with the interaction zone of electron and electromagnetic wave,

$$R \leq R_e \ll \infty.$$

That is, $R \rightarrow 0$, relatively speaking.



Figure 15: Interaction point of electron and electromagnetic wave

Consider then an oscillating electric field wave, component of the electromagnetic propagation. "R" becomes the spatial coordinate, and we have the wave solution to Maxwell's equations:

$$E_S = E = e^{jR} = \cos R + j \times \sin R.$$

Taking then only the real part of the wave solution, as is customary in classical electromagnetics, and then doing a Taylor expansion, we find:

$$E = \cos R = 1 - R^2/2! + R^4/4! - \dots,$$

$$dE_S / dR = -R + (1/4!) \cdot 4R^3 + \dots$$

$$dE_S \rightarrow -R_e dR_e \text{ as } R \rightarrow 0.$$

Comparing this with the differential for dE_S above, we find we are close enough to the required result that we can conclude indeed:

$$c = 1 / (\epsilon_0 \mu_0)^{1/2},$$

where this result has been achieved only on consideration of the Lorentz force and the divergence laws for electric and magnetic fields about electric and magnetic charge quanta. The matter of establishing an exact equality between the two differentials above, the one with a constant 8π and the other with a constant -1 is left to subsequent investigators. However, it doesn't matter for this analysis, as whatever the value of this constant, it will be the same for electronic and positronic photons, by duality, for example the radii of electrons and positrons will have to be the same, and the respective constants for the electronic and positronic case will cancel each other out in the equation above where the ratio of electric and magnetic divergences is taken, giving us the required result for the speed of light.

What of the requirement, above, that $R \rightarrow 0$? Very simply, we are only considering the fermionic interaction with the boson in the vicinity of the electronic / positronic radius, $R \sim 0$, (electronic radii are indeed very small). The electromagnetic wave extends all the way to infinity, effectively, in comparison with the portion of the wave that is interacting with the fermion. And the fermion propagates with the wave, so it never gets to infinity or anywhere near it. In comparison to $R \rightarrow \infty$, R_e is indeed very small, and remains that way in the passage of time.

It is evident that the foregoing analysis will incorporate the 4-vector $(\hbar\omega, \mathbf{v} \times \mathbf{B})$, into Maxwell's equations. In particular it becomes evident that our decision to omit the charge, q , from this 4-vector was a good one. Note that for a given photon, it carries only the one quantum of charge. Say the electron is propagating on a field vector, " \mathbf{E} ", then it will not be possible for a positron to be simultaneously propagating upon the field vector, " \mathbf{B} ", as the electron and positron would overlap in space, which is clearly not an acceptable outcome. It is a positron ghost which is propagating on the field vector, " \mathbf{B} ". It has the same energy as a positron but no electric charge. Therefore the energy of the photon is:

$$E = \frac{1}{2} m_0 c^2 + \frac{1}{2} m_0 c^2 = m_0 c^2,$$

in accordance with Einstein's special relativity. This is a better solution than our previous one of suggesting we double the kinetic energy to account for real (non-

ghost) electrons and positrons, for it applies to a single quantum or photon, not two.

In the dual theory, we have a positronic photon with positron propagating on field vector “**B**” and electron ghost propagating on the field vector, “**E**”. We have in this instance a dual Lorentz force,

$$\mathbf{B} = \mathbf{v} \times \mathbf{E}.$$

Electromagnetic flux tubes

Consider the flux tube associated with the “terrestrial” electromagnetic circuit, as opposed say to the solar flux tube regulating the processes of solar flares. The magnetic field wraps around at the surface, carrying surface electrons, while the quanta of magnetic charge, positrons, propagate in the interior, such that the same current, and direction of current, is carried by the positive and negative electric charge quanta.

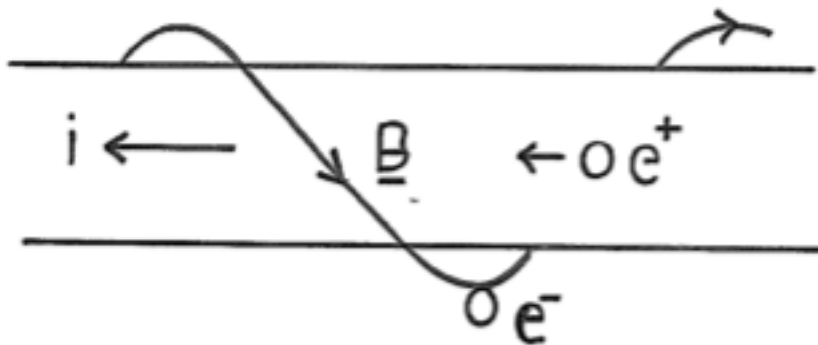


Figure 16: Electric charge quanta, electrons and positrons

Classical electromagnetism tells us that static electric charge resides at the surface of a conductor. In the non-static case, we expect there to be surface currents, as pictured above. The electrons at the surface propagate along the surface field lines such that the Lorentz force $q\mathbf{v} \times \mathbf{B}$ vanishes, according to the extremisation of the 4-vector, $(\hbar\omega, \mathbf{v} \times \mathbf{B})$. We expect a similar 4-vector for positrons and an helical electric field, **E**.

We hypothesise that indeed the circulating magnetic field, **B**, as pictured above, is equivalent to our previously discussed electric field vector, “**E**”. This is required since quanta of electrical (not magnetic) quanta appear to propagate upon them in the same manner. Similarly, a positron propagating on an electric field **E** is entirely equivalent to a positron propagating upon a magnetic field vector, “**B**”.

The internal (positronic) currents in the terrestrial electromagnetic circuit propagate upon the internal electric field, **E**. They are not moving in an helical

fashion in the manner the surface electrons are, so with no circulatory behavior, $\hbar\omega = 0$ in the 4-vector.

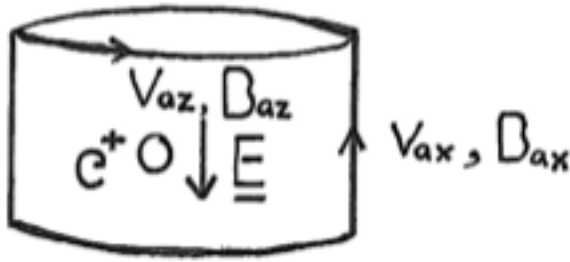


Figure 17: Internal positrons do not interact helically

Heat is generated by positrons not moving parallel to the internal field lines, \mathbf{E} , in which case $\mathbf{v}_p \times \mathbf{E} \neq 0$ and the 4-vector extremism becomes $(\hbar\omega, \mathbf{v}_p \times \mathbf{E}) \Rightarrow (0, \mathbf{v}_p \times \mathbf{E})$ such that $0 \neq \mathbf{v}_p \times \mathbf{E}$. When a 4-vector extremism cannot be satisfied, heat is generated. Such a scenario occurs in the case of the space-time 4-vector, (t, \mathbf{x}) where a body propagates at constant velocity, in a manner expected for bodies in free motion, according to Newton's first law, but where this constant velocity is the result of work done by a non-conservative force, generating heat from the friction. Along the field lines \mathbf{E} , no heat is generated as the 4-vector becomes $(0,0)$, satisfying the extremism condition.

The space-time 4-vector

Consider the space-time 4-vector, (t, \mathbf{x}) . To extremise this vector, we put

$$|\mathbf{x}| = t, \quad |\mathbf{x}| / t = "1", \text{ the speed of light.}$$

In the case of a free-moving object, this relation describes Newton's first law of motion. The body will move in a straight line at a constant speed:

$$\mathbf{x} = t \boldsymbol{\alpha},$$

where $\boldsymbol{\alpha}$ is say a unit vector in the direction of motion. Alternatively, the 4-vector extremism can indicate the circular component of an helical motion, where the total displacement from the "origin" is a constant in time. Putting the two together, we have a circulating displacement and a constant velocity orthogonally, such that we conclude the electromagnetic flux tube is a law of nature, arising in consequence of the space-time 4-vector.

But let's take the result for constant rectilinear motion, as per the equation above, and differentiate w.r.t. time.

$$\begin{aligned} d|\mathbf{x}| / dt &= (dt / dt) \boldsymbol{\alpha} \\ &= 0. \end{aligned}$$

We have a new 4-vector arising from the differentiation, but it cannot be satisfied except in the trivial case of a stationary body. Instead of a free-moving body we have a heat-diffusion relation associated with a body moving at a constant velocity, $P = F.v$, in consequence of friction generating the heat, whereupon we are doing work as opposed to operating in respect of a space-time curvature. We have already discussed the unification of the gravitational and electromagnetic forces in terms of space-time curvature. While gravity may for example be considered to be doing work, according to this discussion space-time curvature cannot be regarded as a force doing work, and that work is only considered to be done when the space-time 4-vector cannot be extremised and dissipation of heat occurs.

Taking the derivative of a 4-vector does not alter the extremism condition, therefore the resultant is also a 4-vector. We have seen that taking the derivative of the space-time 4-vector gives a new 4-vector that is equivalent in its results for electromagnetic circuits to the "Lorentz 4-vector". The only sensible way to define the vector, \mathbf{x} , from above is radially to the electromagnetic flux tube. The vector \mathbf{x} is just the radial vector, such that the extremism condition can be satisfied for axial movements, in which case no heat is generated. For radial movements, heat is generated and it moves radially.

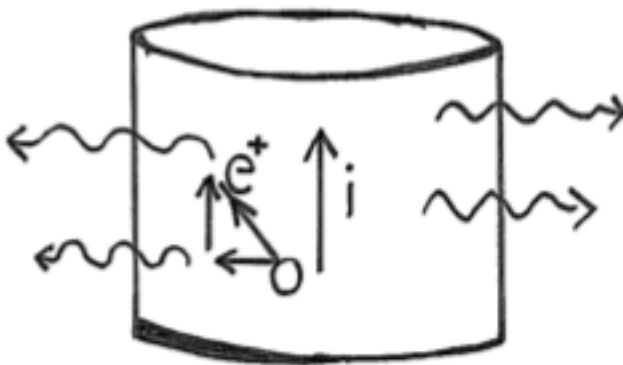


Figure 18: Quanta (positrons) moving axially do not generate heat; heat generated results in consequence of radial movements of quanta and moves outward in unison with these charge quanta

Electrons and positrons simultaneously

Where we have electrons and positrons in the picture simultaneously, what do we do with our two sets of Maxwell's equations? Can these be solved simultaneously? Evidently not. We've seen that an electron cannot overlap in space with a positron, either one or the other must be a "ghost" in the case of an individual photon.

Where electrons and positrons interact in some manner, ghosts disappear and the two sets of equations are replaced by a single equation which describes both electrons and protons; protons consist of a positron locked into a spherical orbit and they are the source of the electronic orbitals in atoms and molecules,

electromagnetic wave-packets propagating in certain geometries about the “nucleons”, upon which electrons propagate in the manner we have described.



Figure 19: Proposed configuration for positrons locked into “protonic” orbits; the p-orbit proton and the d-orbit proton. The electronic orbitals produced by these protons have similar geometries, but on a much larger scale

The equation which describes the interaction between electrons and positrons (protons) is the Schrodinger equation, and it replaces the two sets of Maxwell equations which cannot simultaneously be satisfied.

$$(\nabla^2 + V) \psi = E\psi,$$

where V is the potential generated by the protons in the nucleus, an inverse square interaction according to Coulomb’s law, ψ is the amplitude of the electron wave, akin to the \mathbf{E} and \mathbf{B} field amplitudes of electromagnetic theory, and E the energy of an electron locked in a given “orbital”. With this transformation we move from the realm of quantum electrodynamics into the realm of atomic physics. We have already described the manner in which electrons propagate on photonic pathways, at length. Similarly, protons describe photonic pathways upon which positrons propagate.

Variation of photonic frequency

We have described at length the manner in which the number of photons in the radiation field is proportional to the Poynting vector, simultaneously the electric or magnetic intensity.

$$|\mathbf{E} \times \mathbf{B}| \propto E^2 \propto B^2.$$

Now the other aspect of Einstein’s photoelectric theory that must be satisfied is that doubling the frequency / photon energy at constant intensity halves the number of photons in the field.

Recall that in varying the intensity we wished to keep the photon energy, or height of the wave packet, constant. So if one doubles the height of the

wavepacket spectrum, one halves its width, for doubling either the height or width of the spectrum doubles the height of the wavepacket.

Recall further the mathematical relation we arrived at in consequence of demanding that the photon energy be invariable, (a constant):

$$E \times k_S \times v / (1 - v^2/c^2) = \text{constant.}$$

In that analysis the frequency k_S (wavenumber) was a constant and did not come into proceedings. What if we vary k_S ? But still keeping the photon energy constant ? We know however that if one doubles k_S then the photon energy doubles too, i.e. it is not a constant.

However there is a frame in which the photon energy does not double, but stays a constant, if we double k_S . To find out what happens in this frame, we make use of an identity from classical electromagnetic theory, with the provision that we are referring to electrons not positrons, and that therefore we are concerned with $|\mathbf{E} \times \mathbf{B}| \propto E^2$, and not $|\mathbf{E} \times \mathbf{B}| \propto B^2$.

$$E_{2y} = \gamma (E_{1y} - v' B_{1z}).$$

We eliminate the v' term perhaps because the matter (electron) wave and the photonic electric wave are unidirectionally in the plane of the page, for this analysis. Whatever the reason for its elimination, it is clear that we cannot make progress in QTE without this term being absent. So, we have the following identity:

$$E_{2y} = E_{1y} / (1 - (v/c)^2)^{1/2}, \text{ or}$$

$$E_{2y}^2 = E_{1y}^2 / (1 - (v/c)^2).$$

Then on comparison of this equation with the original equation we got by putting the spectral area equal to a constant, we find that:

$$E_{2y}^2 / E_{1y}^2 = k_S' / k_S ,$$

where k_S' is a constant and k_S is variable.

So, keeping the intensity of the radiation constant, and doubling the photon energy, or radiational frequency, then in a reference frame where the photon energy is constant, the intensity E^2 is halved:

$$E_{2y}^2 \rightarrow \frac{1}{2} E_{1y}^2.$$

Thereby the rate of photonic transfer or photon number in the field is halved. This is the most striking mathematical feature of A Quantum Theory of Electrodynamics. Finally, note that for E^2 , E , v constant, spectral width $\propto k_S$, height is invariant and therefore wavepacket height = energy of photon = $h k_S$, Planck's law.

How this relates to the space-time 4-vector

An appropriate choice of k_s' , the “fundamental photonic constant”, might be equivalent to a choice of the unit vector α whereby $\mathbf{x} = t\alpha$, the relation obtained by extremism of the (t, \mathbf{x}) 4-vector whereby two possibilities arise:

- (a) Newton’s first law of motion for a free moving body and electromagnetic flux tube interactions, or alternatively where this vector cannot be extremised, whereby we choose the unit vector, α , and
- (b) The heat-diffusion relation of statistical mechanics.

A final word on the Lorentz force

Consider the electromagnetic flux tube associated with the terrestrial electromagnetic circuit. The surface electrons propagate on the helical magnetic field lines, $\mathbf{B} \leftrightarrow \mathbf{E}$, at the surface. Both the electron velocity vector, \mathbf{v} , and the surface \mathbf{B} , have axial and azimuthal, not radial, components. Above we have speculated that the Lorentz force, $q\mathbf{v} \times \mathbf{B}$, should be zero as the electron pathway is upon the field line, $\mathbf{v} \times \mathbf{B} = 0$. However this cannot be the case since the helical motion has a circular component, which requires a centripetal force. Let’s break down \mathbf{v}, \mathbf{B} into axial and azimuthal components. Then:

$$\mathbf{v}_{az} \times \mathbf{B}_{az} = 0,$$

$$\mathbf{v}_{ax} \times \mathbf{B}_{ax} = 0,$$

But:

$$\mathbf{v}_{ax} \times \mathbf{B}_{az} = \mathbf{F}_r, \text{ (radial force), and}$$

$$\mathbf{v}_{az} \times \mathbf{B}_{ax} = -\mathbf{F}_r.$$

\mathbf{F}_r is the radial, centripetal force associated with the circular component of the helical motion of the surface electrons. $-\mathbf{F}_r$ is the force associated with the radial expulsion of phonons of heat and photons of light by the radially moving positrons, or subsequent to the radial component of their motions. These two balance one another exactly, they have the same magnitude but opposite directions, obviously. Newton’s third law! The reaction force for the expulsion of photons / phonons radially provides the necessary centripetal acceleration to hold the surface electrons in their helical orbit. Do the mathematics! One will see that this is the case if one breaks the vectors into their two components and takes cross products. The reaction force to the pulling out of heat and light radially provides the required centripetal force to keep the surface electrons in their helical orbits. Thus we have shown the manner in which the Lorentz force operates equivalently on vectors, $\mathbf{B} \leftrightarrow \mathbf{E}$, and consequentially also $\mathbf{E} \leftrightarrow \mathbf{B}$, by duality. The theory is complete and we have incorporated the Lorentz force and its electrical dual into the full set of (eight) Maxwell’s equations.

A final word on helicity

Consider the space-time 4-vector, (t, \mathbf{x}) . To extremise this, we require:

$$t = |\mathbf{x}|.$$

We have only two ways to satisfy this identity, really.

- (1) constant velocity, (speed and direction), according to Newton's first law, and
- (2) uniform circular motion, (constant speed, not constant velocity), such that:

$$v = \text{constant} = |\mathbf{v}|.$$

Suppose we put these two together on the surface of a flux tube. The part of the motion satisfying Newton's first law is the axial velocity, \mathbf{v}_{ax} . The circulating part of the motion is the azimuthal velocity, \mathbf{v}_{az} . By Pythagorus, we have:

$$c^2 = \mathbf{v}_{\text{ax}}^2 + \mathbf{v}_{\text{az}}^2.$$

What about when we lose the helicity?

$\mathbf{v}_{\text{az}} \rightarrow 0$, and we have:

no dissipation, (no radial generation of heat and light),

no flux tube, and we have:

Photons in free space! ($\mathbf{v}_{\text{ax}} = c$).

A final word about 4-vectors – the energy-momentum 4-vector

Consider the energy – momentum 4-vector, (E, \mathbf{p}) .

Extremising in the usual manner $\rightarrow E = |\mathbf{p}|$.

Consider the de Broglie relation, $p = h / \lambda$;

RHS is the modulus of $p = \hbar k$, and so we have:

LHS = $E = hv \sim \hbar k =$ RHS, the quantum identity! Provided we use $v = "c = 1"$,

(See previous discussions of the space-time 4-vector).

In our discussions of the space-time and energy-momentum 4-vectors, we have chosen these 4-vectors such that the speed of light, $c = 1$. The 4-vectors in question we have chosen are (t, \mathbf{x}) and (E, \mathbf{p}) . If, on the other hand, we wish to proceed with $c = 3.00 \times 10^8 \text{ ms}^{-1}$, we must modify these two 4-vectors such that they become:

Space-time 4-vector is (ct, \mathbf{x}) , and

Energy-momentum 4-vector is $(E/c, \mathbf{p}) = (mc, \mathbf{p})$.

In particular this will give us the sought-after flux tube identification,

$$\mathbf{v}_{ax}^2 + \mathbf{v}_{az}^2 = c^2,$$

as already proposed.

It is at this point unclear whether the other 4-vectors we have discussed so far in this work, specifically the “dissipation-Poynting 4-vector”, and the “Planck-Lorentz 4-vector”, will also have to be modified in such a fashion. The discrepancies in the dimensionalities of these would appear to imply this is the case.

For example when we extremise the dissipation-Poynting 4-vector, there is a discrepancy of a spatial dimension, and in our investigations of solar flare flux tubes we have concluded this spatial dimension corresponds to the distance between helical fields \mathbf{E} and \mathbf{B} at the surface of the flux tube. Similarly, for the Planck-Lorentz 4-vector, when we extremise we put an energy equal to a force per unit charge, leaving a discrepancy of a spatial and a Coulomb dimension, although given that we’ll associate the energy term $\hbar\omega$ with a voltage or energy per unit charge, the Coulomb discrepancy comes out of it, leaving only a discrepancy of one spatial dimension. We hypothesise that this spatial dimension corresponds to the radius of a flux tube. When we extremise then, for these latter two 4-vectors, we’ll need to multiply one side of the equation by these spatial dimensions to get an authentic equality.

Is $\hbar\omega$ then an energy per unit charge? Indeed it is, for it is an energy per photon, and each photon contains one unit of charge, either positive, (positronic photon), or negative, (electronic photon).

As a final note, when discussing the Planck law, it is useful to make the identification that:

$h\nu = \hbar\omega$, as we have done in the Planck-Lorentz 4-vector, and that in the QTE discussions presented in this paper, the identification we have made that $E = h\kappa_s$ in our analysis of the Fourier spectrum should really be modified to $E = \hbar c\kappa_s$, where $\hbar = h/2\pi$. Note the identification we made above that $p = h/\lambda = \hbar k$.

Photonic charges and the Lorentz force

“The light will not be deflected by the darkness”

As discussed above, photons have electrical charge, positive or negative, such that the charge of an electric monopole (electron) is opposite to the electric charge of the corresponding magnetic monopole (positron). So why are photons not deflected by electric or magnetic fields? An earlier hypothesis was that since photons travel at such an enormous speed, it would require very large fields operating over very large distances to detect any deflection. However this is clearly nonsense, as massive electrons, (ones not propagating on photonic wavepackets), while not normally so exceedingly massive that they approach the speed of light, still have detectable curvature through electric and magnetic fields at say 1/10 of the speed of light. In our analyses of the quantization of light, we are clearly not concerned with factors of ten.

Consider our unification of the Lorentz force with Maxwell’s equations. We took the magnetic component of the Lorentz force, $\mathbf{F}_m = q\mathbf{v} \times \mathbf{B}$, and then speculated that this force has an electrical source;

$$\mathbf{F}_m = q\mathbf{E} = q\mathbf{v} \times \mathbf{B} \rightarrow \mathbf{E} = \mathbf{v} \times \mathbf{B},$$

for no good reason. The latter identity is correct, it led to the unification of the Lorentz force and Maxwell’s equations, along with its dual, $\mathbf{B} = (\pm?) \mathbf{v} \times \mathbf{E}$. We can better explain these two identities by proposing that the total Lorentz force, $\mathbf{F} = q(\mathbf{E} + \mathbf{v} \times \mathbf{B})$, and its dual, $\mathbf{F} = q(\mathbf{B} (\pm?) \mathbf{v} \times \mathbf{E})$, vanish, for photons.

$$\mathbf{F}(\text{Lorentz}) = 0 = q(\mathbf{E} + \mathbf{v} \times \mathbf{B}),$$

$$\rightarrow \mathbf{E} = -\mathbf{v} \times \mathbf{B}.$$

We are not at this stage of proceedings concerned with the negative sign insofar as the Lorentz force will be unified with Maxwell’s equations whether we put a plus sign or a minus sign in there. However upon inspection of the complete set of Maxwell’s equations and their duals, (from Griffiths, see previously), it would be a good bet that if the one “Lorentz unification vector” has a particular sign, then the dual will have the opposite sign.

We then conclude that the state of Maxwell’s equations and their duals, and the Lorentz force and its dual, are such that the photons they describe are not affected in their space-time passage by the presence of any external electromagnetic fields, \mathbf{E} and/or \mathbf{B} , that exist in addition to the fields that define the “propagation vectors”, “ \mathbf{E} ” and “ \mathbf{B} ”, i.e. that exist in addition to the fields that define the photons themselves.

The Lorentz spatial contraction

$$\infty + \infty = \infty \rightarrow \infty - \infty = ?$$

We have discussed the fact that when a stationary (massive) electron accelerates from speed zero to the speed of light, c , so that it can propagate upon a photonic wavepacket, it undergoes an infinite contraction of its wavelength, $\lambda : \infty \rightarrow K$, some nonzero, non-infinite wavelength, corresponding to the wavelength of the electromagnetic radiation in question, such that:

$$\infty \times 1/\infty = \infty \times 0 = K.$$

Russell Farmer, School of Mathematics and Statistics, University of Sydney,

After Refki Wahib, Egypt

The central purpose of this brief dissertation is to find a suitable mathematical or physical interpretation of what we have when an infinite quantity is subtracted from another infinite quantity, a question so succinctly put by Refki, above.

It turns out that to get a suitable interpretation of what possibilities exist in this process, we are looking at three. Either $\infty - \infty = 0$, (an obvious possibility), or equals ∞ , or equals something between these two possibilities, i.e. any finite number. As we shall see, zero itself is not a finite number any more than ∞ is.

To find solutions where one or other of the above three possibilities exist, a useful mathematical tool will be to multiply a zero by an infinity. There are three mutually exclusive possibilities, none of these can coexist. Either

$$0 \times \infty = 0, \text{ or}$$

$$0 \times \infty = \infty, \text{ or}$$

$$0 \times \infty = \text{some } \underline{\text{constant}}, \text{ or } \underline{\text{finite number}}.$$

The meaning of $0 \times \infty$, zero times infinity

Sam's "Squeeze theorem"; $0 \times \infty = 0$.

The logic is as follows.

$$0 \times 1 = 0,$$

$$0 \times 10 = 0,$$

$$0 \times 100 = 0,$$

$$0 \times 1000 = 0,$$

→ it therefore follows that $0 \times \infty = 0$.

However using the same logic employed by Sam, we can argue that simultaneously $0 \times \infty = \infty$, making a mockery of his squeeze theorem. Where such a contradiction is sought to be avoided, it will in some cases be necessary to rule out both of the non-infinite (numerical, or “constant” possibilities), for that is a certain way to avoid a contradiction. But, in other work, an in-depth study has made it quite plain that while often it will be deemed useful to assume $0 \times \infty =$ (finite) constant, zero is an infinite constant as we shall see. Not always, this study which has been highly mathematical, (implying it uses calculus), has found it necessary that on some occasions indeed $0 \times \infty = 0$ and sometimes, (not simultaneously, obviously), $0 \times \infty = \infty$. Our final conclusions will be that $\infty - \infty$ can equal anything, zero, infinity (∞) or anything in between = finite number.

Anti- corollary to Sam’s squeeze theorem

$$1000 \times \infty = \infty,$$

$$100 \times \infty = \infty,$$

$$10 \times \infty = \infty,$$

$$1 \times \infty = \infty,$$

$$0.1 \times \infty = \infty,$$

→ it therefore follows that $0 \times \infty = \infty$. So using the same logic two mutually exclusive possibilities exist. Sometimes we rule them both out in consequence. Sometimes we modify the logic such that one or other of the Sam squeeze outcomes applies and the other is ruled out.

Armed as we are now with the three possible outcomes of a zero times infinity multiplication, we shall use this to determine mathematically that infinity minus infinity, $\infty - \infty$, can similarly equal zero or ∞ or “any constant”. Any of these three possible outcomes can occur.

Call $\infty - \infty = \alpha$, $\alpha =$ finite or infinite

We investigate two alphas, $\infty - \infty$ and $\infty + \infty$.

$$(I) \quad \infty - \infty = \alpha,$$

so multiply both sides of this equation by zero →

$$0 \times \infty - 0 \times \infty = \alpha = \infty \text{ or not } \infty:$$

$$(i) \quad \alpha \neq \infty \rightarrow$$

$K_1 - K_2 = 0$, (K s both > 0 as the interval in question is between zero and ∞ not minus ∞). $K_1 = K_2$.

$$(ii) \quad \alpha = \infty \rightarrow$$

$$K_1 - K_2 = K_3 \rightarrow K_1 > K_2.$$

$$(II) \quad \infty + \infty = \alpha$$

$$(i) \quad \alpha = \infty,$$

multiply both sides of (II) by zero \rightarrow

$$0 \times \infty + 0 \times \infty = 0 \times \alpha$$

$$K_1 + K_2 = K_3, \text{ and}$$

$$(ii) \quad \alpha \neq \infty \rightarrow$$

$$0 \times \infty + 0 \times \infty = 0$$

$$K_1 + K_2 = 0, \text{ forcing}$$

No allowable solutions, K_1 and K_2 both positive, both zero.

In total summary, it has become evident that $\infty + \infty = \infty$, whereas $\infty - \infty$ can equal ∞ itself, or any non-infinite number, i.e. any constant and can equal zero itself which as we shall see is not a finite number.

$$\infty - \infty = \infty, \text{ add } \infty \rightarrow$$

$$\infty = \infty + \infty,$$

(obviously, we simultaneously expect this to be the case).

As an anti-corollary to Sam's Squeeze theorem we conclude that it is not possible that $0 \times \infty$ could be equal simultaneously to zero and infinity. So the safest thing would be to assume, in the absence of any further conjecture, that it is equal to neither of them, i.e. $0 \times \infty$ is equal to any (finite, nonzero) constant.

$$\infty - \infty = K,$$

K is either zero or infinity or anything in between, i.e. a finite number. (Obviously ∞ is not a finite number. However, neither is zero \rightarrow zero is simply a place holder in a particular digital quantity).

For example, consider that 68 and 68.0 mean different things but it is easy to confuse the two and make a critical error. You can get as close as you like to zero but never get there just as you can get close to ∞ but never get all the way there.

The origin is not a number. We have started with counting numbers, introduced fractions and irrational, imaginary numbers all about the origin.

We can only specify zero to a given number of decimal places or significant figures, cannot necessarily specify to infinitely many significant figures, only get closer and closer to absolute zero.

($\leftarrow \rightarrow$ we cannot specify a number to infinitely many zeros or critical decimal places. One can only get closer to absolute zero as defining a larger number of “place holders”. It is the same for the definition of ∞ , but in the opposite sense).

The final connection

We have declared the quantity $\infty - \infty$ to be a “universal number”, i.e. it lays claim to all possibilities whereby it can be equal to zero, or infinity or anything in between, i.e. any (finite) constant. But we already know this to be true of the quantity $0 \times \infty$, by Sam’s squeeze theorem and its corollary. What if these two terms are in fact equal to each other, as they have the same outcome? Let’s see what happens in consequence of this conjectured equality.

$$0 \times \infty = \infty - \infty$$

$$0 \times \infty + 1 \times \infty = \infty$$

$$(0 + 1) \times \infty = \infty$$

$$\infty = \infty.$$

That is, equating zero times infinity with infinity minus infinity results in a statement which is universally true, confirming our observation that the equality of these two terms seems likely.

The ($\hbar\omega$, $\mathbf{v} \times \mathbf{B}$) 4-vector, electrons and positrons

Consider the above-mentioned 4-vector. It bears a striking resemblance to the identity we got by putting the Lorentz force equal to zero:

$$\mathbf{v} \times \mathbf{B} = -\mathbf{E}.$$

Perhaps we can make them entirely equivalent by multiplying the RHS by a displacement, in a manner similar to how we multiplied the time component of the (t, \mathbf{x}) 4-vector by c . Or divide $\hbar\omega$ by this displacement. We use this as an application to terrestrial electromagnetic circuits, whereupon we have the photon-photon annihilation equation:

$$\gamma + \gamma \leftarrow \rightarrow e^+ + e^-.$$

We assert that an electron and a positron are the same thing, the only thing that separates them from one another is that they are out of phase. What gives them their electrical charge with respect to one another is that there is a phase shift between them of 90 degrees. In the process of putting two photons, initially in phase with one another, out of phase, one winds up with oppositely charged fermions.

Consider a flux tube carrying an helically oriented electron into the page. The central positron, propagating on the central field line, \mathbf{E} , is barely moving as the drift velocity is so tiny, (the helical field lines are so tightly wound). That is, the electron radius is so tiny. Now what does it mean to say the electron and positron are out of phase with one another? For the electromagnetic current into the page, and \mathbf{v} , \mathbf{B} initially at the same point, (i.e. parallel to one another, we rotate the arrow on the field line, \mathbf{B} , about its circular path by 90 degrees, so that $\mathbf{v} \times \mathbf{B}$ is a maximum, into or out of the page). Thereby, extremising of the $(\hbar\omega, \mathbf{v} \times \mathbf{B})$ 4-vector requires that the electron and positron be out of phase with one another. We started with two photons, in phase with one another, and wind up with a fermionic pair that are perfectly out of phase with one another. At 180 degrees, $\mathbf{B} \times \mathbf{v}$ is zero and at 270 degrees it has the same magnitude, opposite direction as at 90 degrees.

The central outcome is that the net potential in the circuit (average value) is given by:

$$\hbar\omega / d = |\mathbf{E}| = \frac{1}{2} |\mathbf{v} \times \mathbf{B}|_{\max} = -d\Phi_B/dt,$$

this is a perfect measure of the total rate of energy transfer through the circuit, and “d” is the displacement discussed above.

Application to the Diels-Alder [4 + 2] chemical reaction

The Diels-Alder [4 + 2] cycloaddition reaction is a kind of pericyclic reaction, whereby electrons move in a swarm. The movement of electrons is concerted – they all move at the same time. We have simultaneous making and breaking of bonds. This occurs via cyclic transition states, with no intermediates.

In the figure below, we represent the cyclic movement of the electrons using curly arrows – the “cyclisation” can go one way or the other, as pictured. Both mechanisms are equally correct. However, the electrons do not really “rotate” at all. Instead, two π orbitals are replaced by two σ orbitals. The electrons move from the π to the σ orbitals. We end up with two less π orbitals than what we started with, and two more σ orbitals than what we started with. Because a σ orbital is of a lower energy than a π orbital, this plays a crucial part in the energetics of the reaction. As we shall see when we examine the energetics of the π interactions for the reaction, there is a net increase in energy. Without the stabilization afforded by the movement of electrons from π into σ orbitals, the reaction would not proceed.

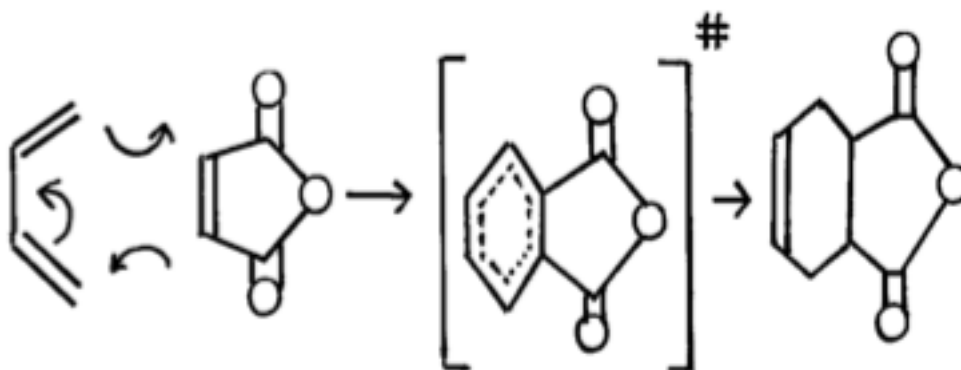


Figure 20: Concerted movement of electrons, (all at the same time), via a cyclic transition state

In the Diels-Alder cycloaddition, a diene reacts with a “dienophile”. The diene consists of two π bonds separated by a lone σ bond as per the 1,3-butadiene reactant molecule in Figure 20 above. The dienophile, which likes to react with the diene as its name suggests, contains a lone π bond which is crucial to the reaction. The dienophile is the reactant, maleic anhydride, in Figure 20 above. This reaction was first reported in 1928 by Otto Diels and Kurt Alder.

So the diene partner contains at least two conjugated alkenes, and needs to be able to adopt the *s-cis* conformation, as does 1,3-butadiene above. The dienophiles need to have an electron-withdrawing group attached to the alkene. In this respect, maleic anhydride above is an amazing dienophile.

Recall that the reaction proceeds through a single transition state with all bonds breaking and forming at the same time ... There are no polar reagents. Therefore the solvent has no effect. This reaction can be carried out with no solvent. So we have bonds breaking and forming at the same time with no intermediates ... what actually happens?

Key orbitals of an alkene

Consider the key orbitals in an alkene. In order of increasing energy we have σ (bonding) $\rightarrow \pi$ (bonding) $\rightarrow \pi^*$ (anti-bonding) $\rightarrow \sigma^*$ (anti-bonding). In the figure below, shading indicates sign of the wave function, + or -. The two bonding orbitals are occupied, π is the “highest energy occupied molecular orbital”, HOMO, and the π^* is the “lowest energy unoccupied molecular orbital”, LUMO.

In the discussions below, putting two orbitals together such as the two in “HOMO” below constitutes a maximal wavefunction probability, $(\phi_1 + \phi_1)^2 = 4\phi_1^2$ for the ϕ_1 component, similarly for the ϕ_2 component, (shaded below, not above). When we have ϕ_1, ϕ_2 together as in “LUMO” below, what is maximized is the overlap between the two orbitals, $2\phi_1\phi_2$, and this is a maximum when the two boson-fermionic particles are out of phase, such as when one has an electron interacting with a positron.

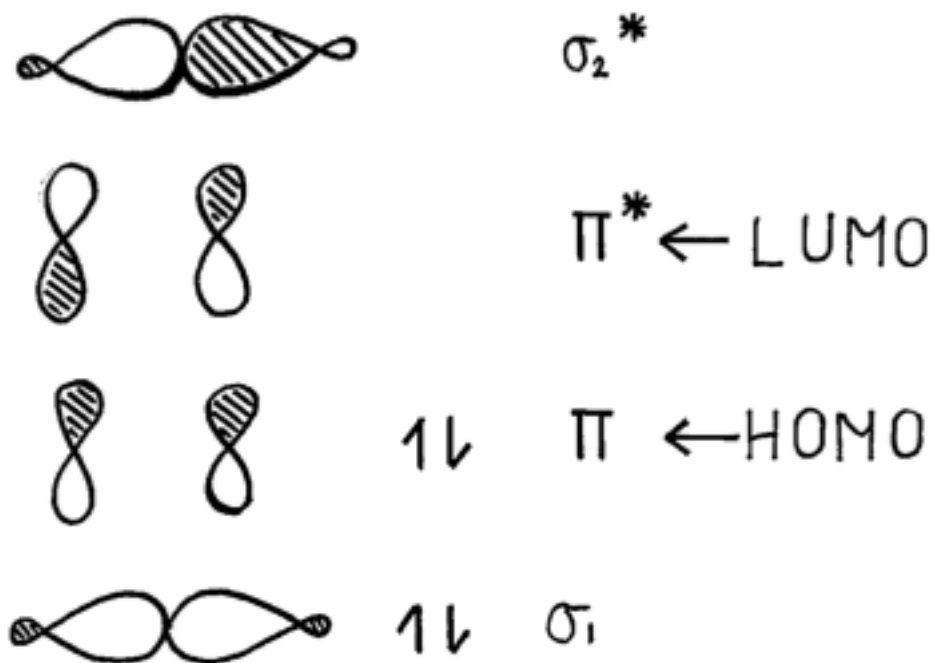


Figure 21: Alkene - key orbitals

So, considering only the π -bonding, for the diene we have four p-orbitals, with 4 electrons. Combining 4 atomic orbitals must give 4 molecular orbitals. Recall from 1st year that a node is a phase change between orbitals. Consider the diene. There are two electrons in the lowest energy molecular orbital. This orbital is without nodes, and the electrons in it "stay put". It is the two electrons in the HOMO that are going to move. This orbital has one node, as pictured above.

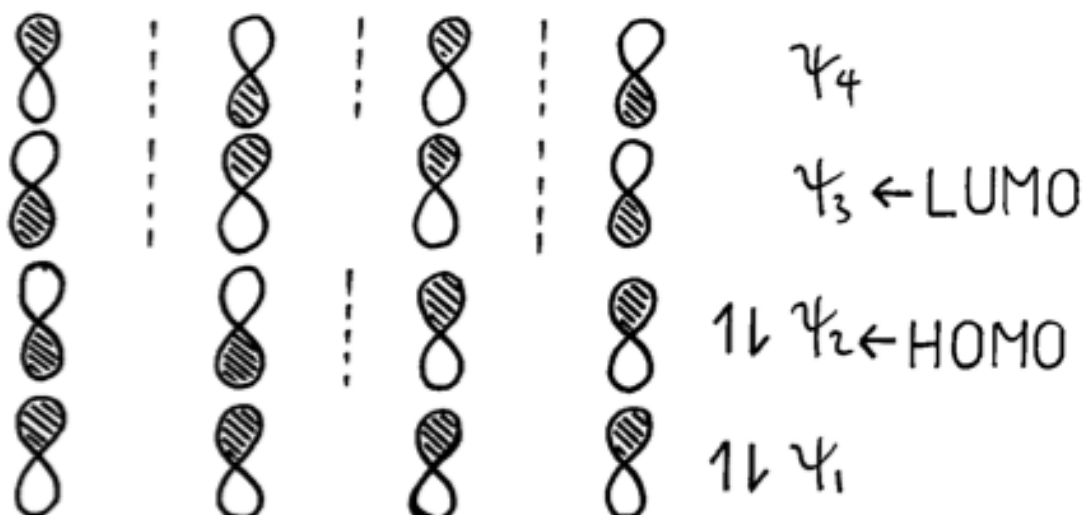


Figure 22: Diene - key orbitals; nodes indicated by dashed lines

Consider now the π -bonding for the dienophile. We have two p-orbitals, with two electrons. Combining 2 atomic orbitals must give two molecular orbitals. Then the two electrons in question are transferred from the HOMO of the diene, see Figure 22 above, into the LUMO of the dienophile, see Figure 21 above.

Frontier Molecular Orbital theory

So we start out with our diene in the ψ_2 configuration, (two electrons occupying the HOMO), a low energy orbital, (not the lowest), with a single, central node. The node corresponds to the separation of the two π -bonds.

Also, to begin with, we have our dienophile in the lowest possible energy configuration, two electrons occupying the π -bonding orbital which becomes the HOMO.

Consider the bonding interaction between the diene and the dienophile, as pictured below.

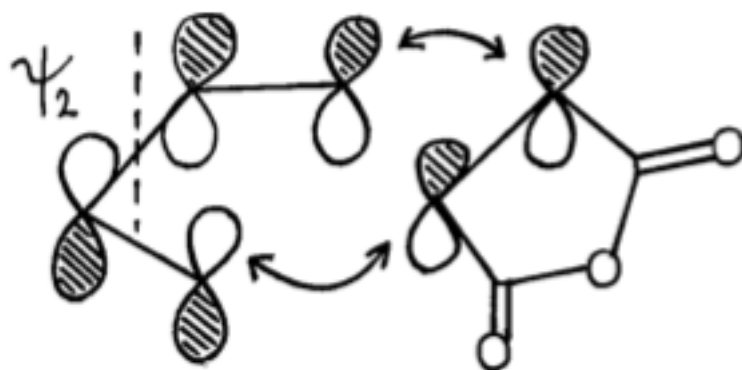


Figure 23: Initial configuration, (low energy, bonding), of diene and dienophile

The desired bonding interaction is as represented by the arrows above. However, symmetry tells us that such an interaction is not permitted by symmetry, in the molecular orbital configurations indicated above. To have such a bonding interaction we need to raise the dienophile π -electrons into the anti-bonding configuration, so that each of them has the same sign association with the atom of the diene to which they will be attached. Otherwise, we have an unsymmetric situation and bonding cannot occur, for we have a bonding of two symmetric molecules to give a symmetric product. The situation will be as depicted in Figure 24 below, whereupon the one p-orbit of the dienophile is in say the + configuration and attaches to its partner of the diene which is in a - configuration, whilst the other p-orbit of the dienophile is in the - configuration and attaches to its partner of the diene which is in a + configuration. So, for bonding to occur, we have to raise up the dienophile into the anti-bonding molecular orbital.

Consider Figure 24 below, whereupon in the process of the desired bonding interaction, we go from the alkene in a 4-atomic molecular π orbital state, (Ψ_2),

and the dienophile in a 2-atomic molecular π orbital state, (anti-bonding), to an entirely different situation. In the new situation, as π -bonds break and re-form, the two atoms of the diene which ultimately will have the double bond move into a 2-atomic molecular π orbital state, and the remaining atoms, two from the diene and two from the dienophile, move into a 4-atomic π molecular orbital state. However, quite obviously, upon inspection, the new 4-atomic molecular orbital state is now not the low energy Ψ_2 state, with one node, but the high energy Ψ_4 state, with three nodes.

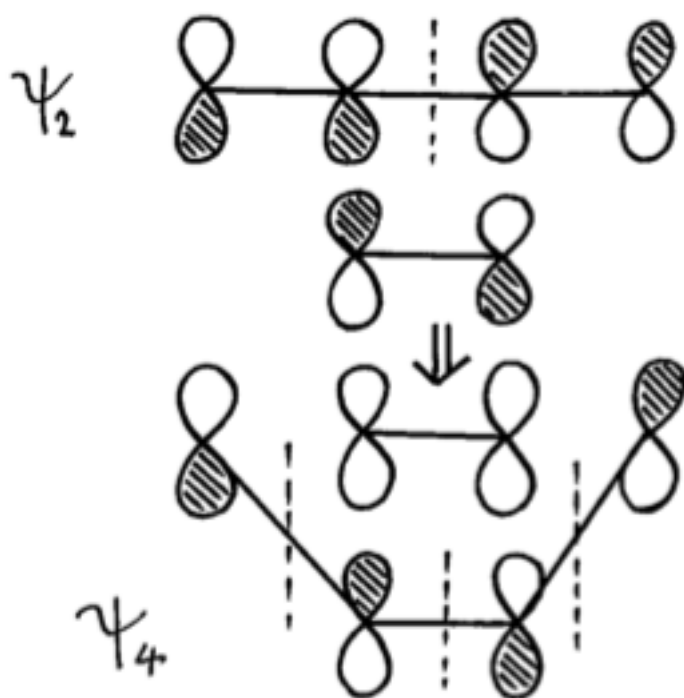


Figure 24: A 4-atomic / 2-atomic molecular orbital configuration \rightarrow a 2-atomic / 4-atomic molecular orbital configuration

Why, in Figure 24 above, have we left the two atoms of the diene which will ultimately share the double bond unshaded? The reason is to do with nodes. Before the bonding interaction occurs, the diene atoms are in the Ψ_2 state such that the “outside” two atoms are separated from the two dienophile atoms by a node, as pictured below.

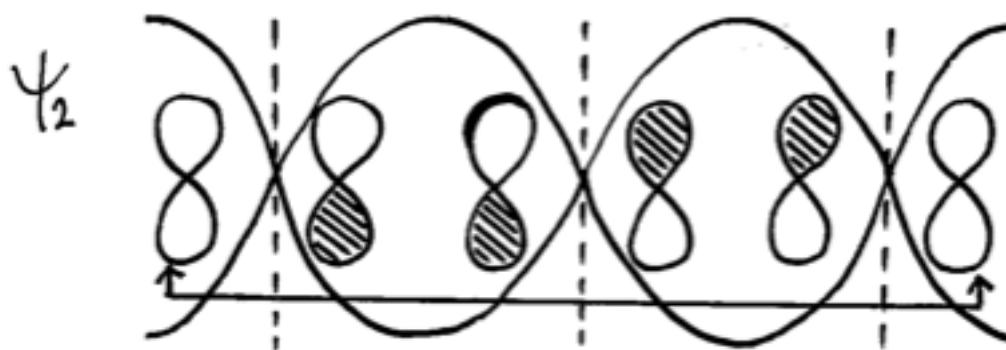


Figure 25: Node configuration for the Ψ_2 state

The crucial thing here is that the two atoms on the dienophile are separated from the Ψ_2 atoms of the diene by a node, and so are free to do as they wish. In particular, they are permitted to move into the 2-atomic π molecular orbital anti-bonding state, ready for interaction with the Ψ_2 electrons, as described above.

Now what happens when the new electronic configurations arise, in consequence of the bonding interaction. In particular, $\Psi_2 \rightarrow \Psi_4$. Consider the node profile of the Ψ_4 state.

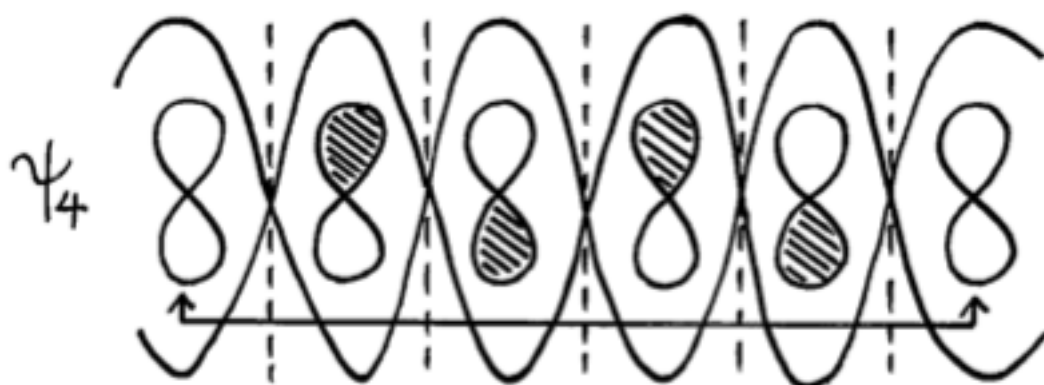


Figure 26: Node configuration for the Ψ_4 state

Again, we have a situation where the 4-atomic molecular orbital (Ψ_4) is separated from the 2-atomic orbital by a node, so the electrons in the 2-atomic orbital are free to do as they please. These are the two atoms unshaded in Figure 24 above. In particular, they are free to move from what would have been an anti-bonding configuration, (see reactants in Figure 24, opposite signs), to a low energy π bonding state.

Energetics of the reaction - σ orbitals

The two nodal processes above, the movement of electrons in the dienophile into an anti-bonding π molecular orbital prior to the bonding interaction, and the movement of electrons in the two atoms of the diene that ultimately acquire the double bond between them into a bonding configuration, (low energy), would not be possible if we didn't have the node distribution above, separating the ψ_2/ψ_4 from the diatomic molecular wave-function configuration corresponding to the formation / undoing of the individual double bonds in question. For example, it would not have been possible if the 4-atomic molecular wavefunction was the ψ_3 , with nodes as pictured below.

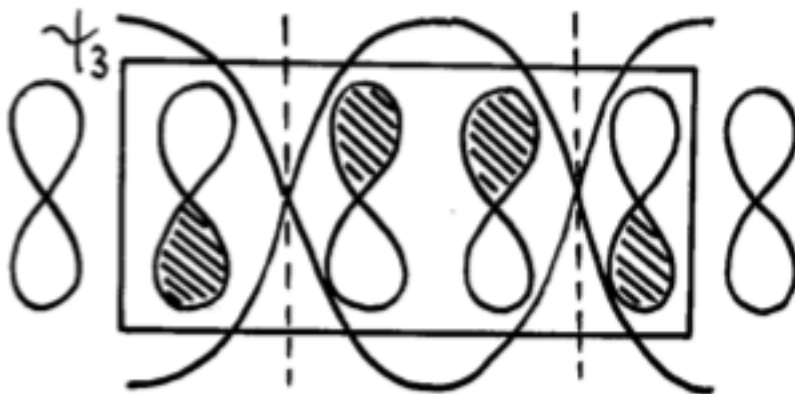


Figure 27: Node configuration for the ψ_3 state, with two extraneous atoms (unshaded) that cannot move independently into and out of π orbitals

The arrows in figures 25 and 26 above indicate the 2-atomic p-orbital electrons, connected to each other, moving into or out of π bonding orbitals. To begin with, we have the two electrons of the dienophile undergoing an increase in energy, (π -bonding \rightarrow π -antibonding). Then we have the two electrons associated with the diene, originally, falling down into the π -bonding orbital, that is, a decrease in energy by the same amount.

So that is an increase then a decrease in energy, of the same amount, no net change of energy for the bonding interaction process. But then we have the $\Psi_2 \rightarrow \Psi_4$ transformation. This is an increase in energy, so if there was no other factor in the energetics equation, the reaction would not proceed. But we have not discussed the σ -bonding interactions. We have a net formation of two σ bonds for the overall reaction, low energy bonds supplied with electrons from high energy π bonds, as discussed at the beginning of this paper. So, one would hope / assume that there is a net decrease in energy for the reaction, which can therefore proceed.

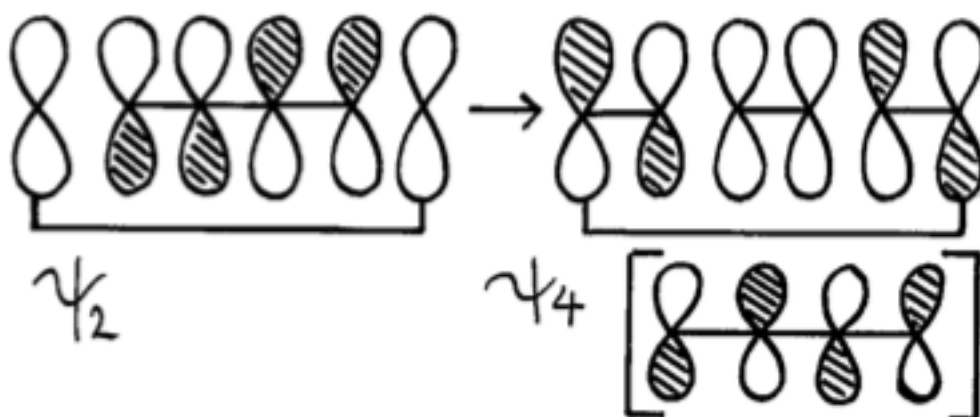


Figure 28: Unshaded orbitals indicate those which can move out of / into individual (diatomic) π bonds

In Figure 28, above, we have re-done Figure 24, but for clarity we have re-drawn an un-shaded orbital pair twice, once for reactants and once for products. In the case of the reactants, the unshaded pair belong to the dienophile, and they are unshaded because they move from a π bonding state to a π anti-bonding state before the reaction can proceed. In the products, the unshaded pair belong to the two atoms originally in the diene that ultimately acquire the double bond, where they had only a σ bond to begin with. They are unshaded because they must move from a diatomic π anti-bonding state to a diatomic π bonding state before the reaction can run to its completion, brought about by the lowering in the Gibbs' free energy this final π bond formation entails. These two atoms were in the anti-bonding state prior to the completion of the reaction because that was the state of their atomic p-orbitals when they were in the diene to begin with, with its 4-atomic molecular wave-function, ψ_2 .

Entropy considerations for the reaction

As we have discussed, enthalpy considerations make the reaction favourable, more than likely. A lowering in the total bonding energy of the atoms in the two interacting molecules corresponds to an exothermic reaction, if the reaction does in fact proceed, and a lowering of the enthalpic contribution to the Gibbs' free energy. What about the entropic contribution to the Gibbs' free energy? Our argument will be that this is minimal. To begin with, we have the two atoms in the π bond in question in the dienophile, and the four atoms in the ψ_2 state of the diene. At the end of the reaction, we have the exact same configuration, the four atoms in the newly acquired ψ_4 state and the two atoms sharing the new π bond. Two atoms has the same entropy as two atoms, any way you look at it. Further, ψ_2 has the same entropy as ψ_4 , the entropy is only concerned with the four nuclei, not their valence shell electron configurations. That leaves only the entropy change associated with the two molecules uniting to form one molecule; this is an increase in orderliness or a decrease in entropy, which is unfavourable to the reaction, but this contribution to the increase in the Gibbs' free energy (unfavourable), is more than likely out-weighed by the enthalpic decrease in the Gibbs free energy associated with the destruction of two π bonds, and the creation of two σ bonds, (favourable), less the enthalpic contribution associated with the molecular wave-function transformation $\psi_2 \rightarrow \psi_4$, an increase in energy, (unfavourable).

Electrons are out-of-phase with positrons

Consider the electronic wave functions, ψ_2 , ψ_4 discussed at length above. What is so special about these wave functions that they are at the basis of the Diels-Alder reactions? Line them up! Put ψ_4 on top of ψ_2 . Take the modulus. In the central position, one has $4\phi_1^2$, $4\phi_2^2$. (See above figure 21, above). In the external positions, one has $\phi_1\phi_2$, and two of these. $\Psi_4\Psi_2$ has been maximized in each case with respect to ϕ_1 , ϕ_2 (bosons) and with respect to $\phi_1\phi_2$ (fermions). The 4-vector in question has been extremised with respect to bosons, and with respect to fermions.

Consider two attenuating bosons, $4\phi_1^2$, $4\phi_2^2$, electronic and bosonic. There is no fermion associated with these, $\phi_1\phi_2 = 0$ in both cases. But these photons attenuate. As distance increases the probability of finding a photon at this location, given by the square of the wave function, decreases. Now the photonic probability dominates over the fermionic probability, for large fields ϕ_1 , ϕ_2 , (square versus linear). Relative to the attenuation that “squashes” down the photonic wavepacket for large distances, the wave packet Ψ becomes very large. $|\psi(\text{attenuate})|^2 \rightarrow 0$ as $x \rightarrow \infty$. If we want to analyse the fermionic potential without the attenuation interfering with it, we choose the fermionic potential $V = \phi_1\phi_2$ small. ($\rightarrow x$ small). This maximizes the fermionic interaction. The fermionic interaction is not interfered with by the attenuation.

The fermionic potential $\phi_1\phi_2$

Consider:

$$(\Psi_2 + \Psi_4)^2 \Leftrightarrow 4\phi_1^2 + 4\phi_2^2 + 2\phi_1\phi_2,$$

(maximum possible values of each component).

Now when there is no shared component, the wavefunction is purely ϕ_1 or ϕ_2 , the “fermionic potential” $2\phi_1\phi_2$ is zero. On the other hand, when the fermionic potential $2\phi_1\phi_2$ is maximized, (fermionic, exactly out of phase), the fermionic potential achieves its maximum value.

Consider the fermionic potential, $V = 2\phi_1\phi_2$. It takes its maximum value at the fermion boundary, e^+/e^- , whereupon we have fermions now and they are both out of phase with one another. In the bosonic interaction the value of this potential has been reduced to zero. So we have a fermionic potential constituted of some kind of wave travelling along the x-axis its minimum at $V = 0$, maximum corresponding to the maximal value of V , the fermionic interaction. In the fermionic interaction, exactly out of phase, we have $\phi_1\phi_2$ together, as in our discussions of figure 22, above.

Once created, the electron-positron pair continue propagating either on molecular orbitals (no attenuation other than that associated with the weak nuclear force, or in an attenuated process, (helical or free-space??) The fermionic pair is in evidence 90 degrees into the life-cycle that began when the photonic interaction originated. The molecular orbital or helical process are now in operation, and the process will continue indefinitely. What is the nature of the interaction which brought into existence this electronic state? What is the nature of an acceleration potential that brings about the existence of an electron and a positron existing in a molecular orbital or an electromagnetic circuit, or in free space?

Consider just the first quarter of the life cycle of electron-positron. It starts at $x = 0$, $V = 0$, and concludes at $V = V(\text{max})$, (electron-positron interaction, 90 degrees). Consider the hyperbolic sine function, \sinh . This passes through the origin. To make it consistent with an acceleration potential V which has no

negative values, we must translate the sinh curve to the left or the right so as to eliminate negative values, constricting V to be between V and $V(\max)$.

$$\sinh(V + V_0) = x,$$

$$V(x) = \sinh^{-1}x + V_0'.$$

If one applies such a potential, one will achieve creation of a fermionic pair, where the energy quantity V_0' under consideration is equal to the energy of the molecular orbital in question or to the potential of the electromagnetic circuit in question, or indeed equal to the sums of the kinetic energies of the fermionic pair and their interaction potential, in free space. The structure of the photonic pathway, if any, upon which the (massless) fermions will propagate, depends on the interaction potential V_0' .

What we have done is arrive at the Einstein photoelectric effect, complete with the “metallic work function”. Where the metallic work function is not relevant, the work function becomes the energy of the molecular orbital in question. Or the kinetic energies of electron-positron pair and their interaction potential, as for example in the case of “positronium”, an electron-positron interaction where the positron is not confined to a nucleus being stationary, or where the positron is not confined to a zero velocity state at the central position for positrons, (internal, inside the metal).

Conclusion: What subject are we dealing with here?

What is the subject matter? Is it high energy physics?

Indeed. We have derived an energy profile for an electron-positron interaction at a given molecular orbital energy or electromotive force. (Crucially, “energy” and “force” here are separated by the multiplication of a displacement, as in the case of what we have done with various 4-vectors). We have stated that we are not interested in the attenuation of photons at high displacements or low energies. We confine our bosons / fermions to interactions at a period of time smaller than would be associated with spatial attenuation of wave packets and any relevance they might have. We are maximizing the fermionic interaction, thereby putting the electron and positron out of phase with one another. This is equivalent to restricting our interests to small fields, not large. The bosonic terms, ϕ_1^2 , ϕ_2^2 dominate at high field. The (fermionic) interaction term, $\phi_1\phi_2$ dominates at low field. Our concerns here are with the high energy limit of electron-positron interactions. The limit where spatial attenuation of bosons does not occur.

Is it classical electromagnetics? Is it quantum mechanics?

A central outcome of classical electromagnetics concerns the constancy of the speed of light. Out of this springs Einstein’s special relativity. In our discussion of 4-vectors, we were concerned chiefly with adding simple dimensionalities to turn (E, \mathbf{p}) and (t, \mathbf{x}) into fully-fledged 4-vectors. To arrive at $E = h\nu$ through 4-

vectors, it was necessary to use $p = h/\lambda$, itself an outcome of the Planck law, and predicted by “A quantum theory of electrodynamics”. But QTE explains not only the Planck law but variation of photon number in the field with E^2 and ν . QTE is based solely on classical electromagnetism, the non-relativistic Doppler shift and the Fourier transform. We know quantum mechanics arises solely out of the de Broglie relation, $p = h/\lambda$. Not even $E = h\nu$. Although QM does predict $E = h\nu$ in consequence of de Broglie. We conclude that QTE is indeed the unique and fundamental theorem which quantum mechanics and the rest of physics arises from. Classical electromagnetic theory and the Fourier transform are at the basis of all physics. As we have shown in our discussion of 4-vectors, de Broglie is a consequence of Planck and not visa-versa.

Quantum mechanics cannot prove, in the absence of $p = h/\lambda$, that $E = h\nu$. However, QTE does confirm, in the absence of $p = h/\lambda$, that $E = h\nu$ - this relation is the very first point to emerge from taking a Fourier transform and putting Doppler-shifted frequencies, either relativistically or non-relativistically, on the axis of the frequency spectrum. So it doesn't even matter whether things are relativistic or otherwise; if we choose a relativistic spectrum we still get a wavenumber spectrum, but without a flat top. In special relativity, the electrical amplitude of a wave increases by the same amount whether your observer is moving one way or the other; as one transports oneself from physical space (relativistic) to electron wave-space, (non-relativistic), the top of the frequency spectrum flattens out. But the wavepacket is still there whether you use relativistic Doppler shift or otherwise. And it still obeys $E = h\nu$. So the fundamental things are classical electromagnetism and the Fourier transform. Special relativity itself is only a consequence of these things, as discussed above. 4-vectors arise purely out of these, as any student of special relativity will be aware.

Creating a photonic / fermionic wave packet

Of course atoms have no net mass-energy. In the nucleus the energy is positive, in the outer extremities whereby atoms have external chemical connections it is the same, negative. This is to be expected since the atoms composed uniquely of e^+/e^- and by conservation of electric charge all negative parts must have a positive.

The highest fermionic overlap of the potential wavepacket is in the entirely e^+/e^- configuration, (out-of-phase, $\phi_1\phi_2$ maximal) and it occurs at $x = 0$, $V =$ positive. Photons readily sit upon one another, you can build up a large intensity of photonic interactions, but when wave packets are out-of-phase, electron and positron, then only two are permitted to occupy an orbital, fermionic. You can incur positron upon electron but only at an energy cost. This is the higher possible of the potential $\phi_1\phi_2$ occurs when the particles are out of phase with one another.

The degree to which electron-positron sit into each other depends on the photonic pathway they had just exited, the orbital they occupied and continue to

propagate upon afterwards except in the case of annihilation, who knows what ratio of these two alternative outcomes arises?

That is what particle physics is about, we are putting or catching electron and positron in close proximity for example in a bubble chamber where they are observed to be interacting with one another, that is, in the high energy limit where translational attenuation does not occur in consequence of conservation of mass-energy.

Nuclei are such tiny places that electron/positron processes on adjacent protons interact with one another in this distance-dependenced manner, via the electromagnetic fields connecting the fermions, such that all the contributions from nuclei further and further away give outer reaches, smaller signal amplitude, of the total wavepacket. The central proton of the discussion is the one in the centre, with maximal intensity.

Each electron-positron is matched to itself and no external coupling, up to a point, depending on the times of creation of the pair and an interacting pair. Where their times of creation are correlated to a certain extent such that an interaction occurs, this interaction is pair annihilation. Only when exactly out of phase occurs the fermions can go right through one another albeit at a maximal potential, a very unstable state. This is the maximal negative part of the wave packet, a potential minimum and corresponding to emission of a photon, (two photons).

It is significant indeed that $\sinh^{-1}0 = 0$, and that this function is bounded. We conclude that potential = V_0 is a maximum at $x = 0$. $x = 0$ corresponds to the location of the positron within the nucleus, when the electron is sitting at this location, we have this energy maximum we are talking about. We are on the positive side of the wavepacket, at the centre. Electron and positron are perfectly out of phase with one another and the system will reward any subsequent maximization (extremisation) of energy. This is maximised when it is pure energy, emission of a photon, fermionic annihilation.

This is the positive energy part of the orbit. Electron and positron do not readily sit upon one another. Towards the extremities of the molecule, where chemical reactions happen, the energy takes this magnitude but it is negative, purely photonic. We are concerned with photonic pathways, as compared with pure fermionic where there is no pathway, therefore no electromagnetic interactions operating over this relatively localised region of space. The fermions are there in either scenario, it is just a matter of whether the energy is purely kinetic of massive fermions or part electromagnetic whereupon we have propagation of electromagnetic pathways and propagation of massless fermions upon these.

But there is more than one positive peak in a wavepacket, what are the others? Perhaps they are proton-proton interactions. If there is another electron-positron interaction occurring in a neighbouring proton at the same time, then the two processes can be unified through constructive / destructive interference of associated electromagnetic waves from each source, the sources in close

proximity. The further away the proton in question, the smaller the amplitude and further we are toward the extremities of the wavepacket. This is the story of NMR, the coupling between protons we can use to identify substances by the process of spectrophotometry.

That is, the interaction arrived at simply on consideration of the photonic wave packet upon which orbital electrons propagate versus the situation in free space where fermions are massive, travel at speed $< c$, and with no photonic pathway. This is possible because the tracks disappear. If they were still there there is no way they could be convinced to run into one another. But fermions in the massive state can readily be forced to annihilate one another and all energy be converted to photonic, (no free fermions), if there is even the most miniscule difference in phase from exactly out of phase. If the fermions are true partners they will not annihilate, unless the potential $V_0 = 0$.

What determines whether an annihilation occurs or the fermions go right through one another as in the case of the electron-positron nuclear confrontations? The atom as a whole is neutral. Half its energy is positive (inside the nucleus) and half negative (orbital electrons). So there is a net magnitude of energy of zero. The energy we speak of in chemistry is photonic, (no electron-positron interaction, we are talking in the low energy limit, and then we have, in the high energy limit, A Quantum Theory of Electrodynamics, or A Treatise in High Energy Physics, Arrived at in Consideration of the Basics of Electromagnetism.

Now because $V \rightarrow V_0$ as $x \rightarrow 0$, ($\sinh^{-1} 0 = 0$ and \sinh^{-1} a bounded function), we conclude that V_0 is a maximum positive value, corresponding to electron-positron, the maximal interaction $2\phi_1\phi_2 = \max$, out-of-phase. The value of that potential V_0 specifies the ease with which electron and positron get together, get out of phase with one another. This depends on what kind of orbit the would-be fermions were on prior to them leaving it, converting to massive propagation and interacting in this new kind of manner.

The degree to which $\phi_1\phi_2$ overlap depends on V_0 . If $V_0 = 0$, no overlap occurs and we have annihilation. With regard to other positron-electron pairs in near phases, even a slight difference in phase from the ideal out-of-phase puts you at the energy negative minimum, in which case you observe annihilation at the bottom of the wave packet. It is unlikely that two interacting fermion pairs were so finely tuned with regard to their time of creation that their interaction were other than annihilative. With regard to other pairs, even a slight difference puts you at a negative minimum of the energy, annihilation at the bottom of the wave packet. The fermions must be exactly tuned to one another. Otherwise, if closely enough matched to interfere, the interference will be exclusively annihilation.

Do we have a right to do these sorts of things with wave packets?

We have seen that one can make wave packets out of things like potentials. Is this justified? Perhaps wave packets are an end to themselves and we can use wavepackets to model things such as biological potentials.

Enzyme Report

Investigating cowpea phosphatase functionality

University old boy, 198449306, University of Sydney

Introduction

In this experiment the class investigates the phosphatase activity in the roots of two commercial cowpea cultivars, Sanzie (sample S) and ITH98-46 (Sample I). Phosphatase activity is measured under a range of pHs. (Is it acid or alkaline phosphatase? Which variety would better tolerate phosphorus starvation?)

To measure phosphatase activity, the ability of phosphatases to dephosphorylate PNPP to PNP is used. PNPP is colourless, while PNP appears yellow when reacted with NaOH. The amount of PNP product produced will be proportional to the amount of enzyme present. This can be determined spectrophotometrically .

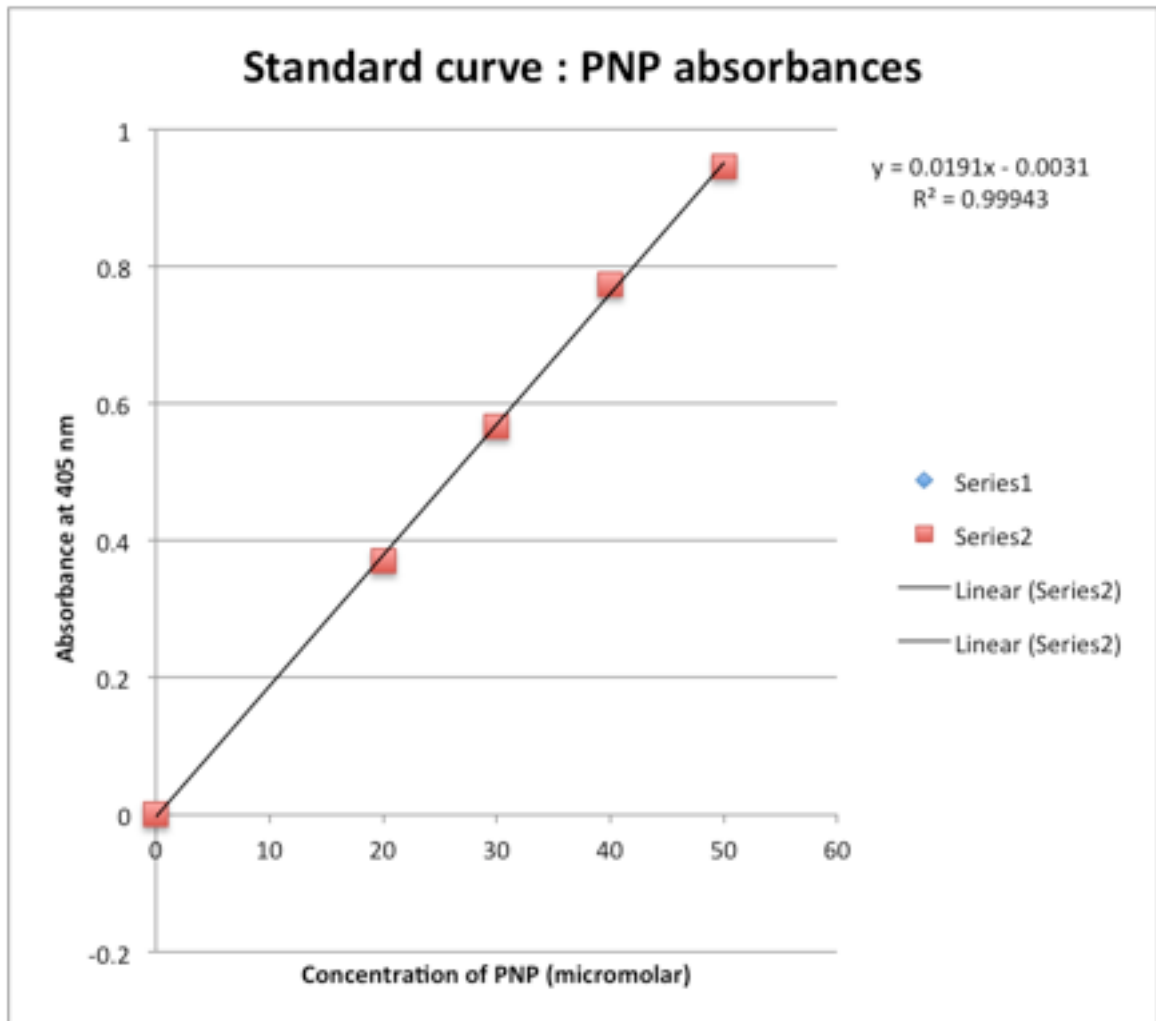
We measure the enzyme activity over a ten minute period, comparing the initial absorbance with the final absorbance, to determine the amount of product formed. We repeat the experiment with inactivated enzyme, then with no enzyme at all, and again with no substrate (no PNPP). The results of the experiment will be presented and discussed.

Relating absorbances to product PNP produced, a standard curve

In order to relate the absorbance carried by the PNP to its concentration, one simply goes and makes the measurements of absorbances over a series of known concentrations of PNP, hopefully it will behave linearly and that we shall in consequence be able to relate the spectra to concentrations by the simplest of mathematical algorithms, the linear equation.

Our part of the class experiment was to perform the experiment at a pH of 10 for our buffer. We were to investigate the S cultivar. We proceeded by taking absorbance readings over a concentration range 0 – 50 μM , in steps of ten. The result had a very high degree of linearity, $R^2 = 0.9994$.

Concentration	Absorbance
0	0
20	0.371
30	0.566
40	0.774
50	0.945



Making some investigations of phosphatase activity using absorbances and our standard curve

Tube	1	2	3	4	5	6
Absorbance at 405 nm	0.39	0.434	0.373	0.371	0.373	0.015
Calculated conc of PNP (micromolar)	20.6	22.9	19.7	19.6	19.7	0.948

The purposes of the six tubes as labelled above were as follows.

- (1) zero time-point,
- (2) end time point.
- (3) Zero time point, inactivated enzyme,
- (4) End time point, inactivated enzyme,
- (5) No enzyme control, and
- (6) No substrate control.

What can we make of these results? It is clear upon inspection of tube 6 that without any Substrate, PNPP, no PNP can form. By contrast large amounts of product are formed in tubes 1 to 5. But two of these tubes are at zero time point and yet are just as high in product as the reaction tubes that were analysed after ten minutes.

Consider tubes 3 and 4. A significant quantity of product is formed with the inactivated enzyme, just as many, in fact, as with activated enzyme. The inactivated enzyme itself absorbs, and in this “highly tuned” case, where it absorbs precisely the quantity of electromagnetic energy as were it were completely activated and converted exclusively to product, the equivalence of these two quantities creates a fine tuning whereby we can observe the contours of the wavepacket, a nonzero amplitude or momentum peak observed beyond the central wavepacket locality where the amplitude descends rapidly to zero, beyond this locality the momentum spike occurs.

Note that it is only in the “finely tuned” case where absorbance of deactivated enzyme is the same as what it would be if it were producing product at a rate consistent with full activity. Then there is no production of product between tubes 3 and 4 over this ten minute period. The Tube number 5, no enzyme control, has just the same absorbance as the inactivated enzyme. No Enzyme \leftrightarrow we lose activity. Lose activity, then lose activation energy, we pass over the “enzyme hump”, in between this location and the momentum spike is a node, this corresponds to an increment in displacement Δx between the two peaks, activation peak and momentum spike, $\Delta p = c\Delta m$, m an energy or wavenumber term, $\hbar k$, see Farmer, “A quantum theory of electro-dynamics”.

So consider what we have here. No enzyme control is the same as inactivated enzyme. By Comparison, when the enzyme is activated, over time there is an evolution of product, at the Remote region of our “pH wavepacket”, whereby a nonzero amplitude has been observed in a Remote pH region, \sim pH 10. The rate of PNP production at this remote pH location over the Ten minute time interval is:

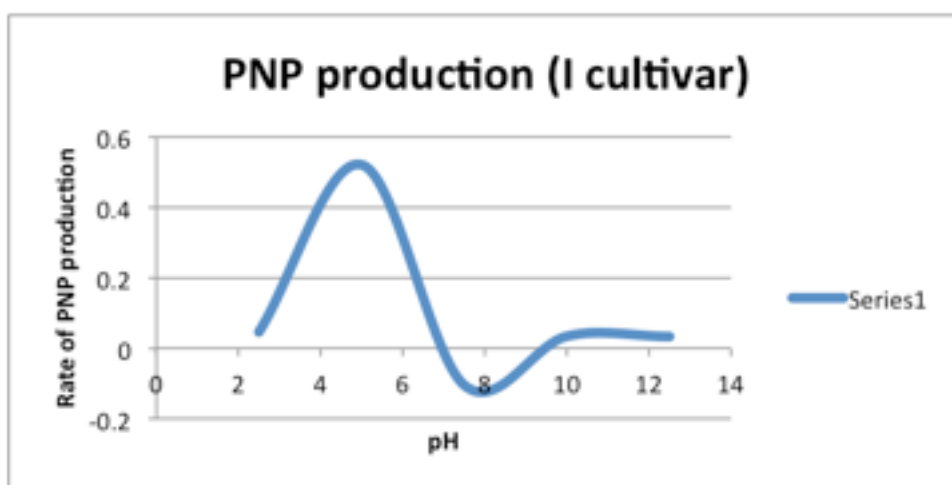
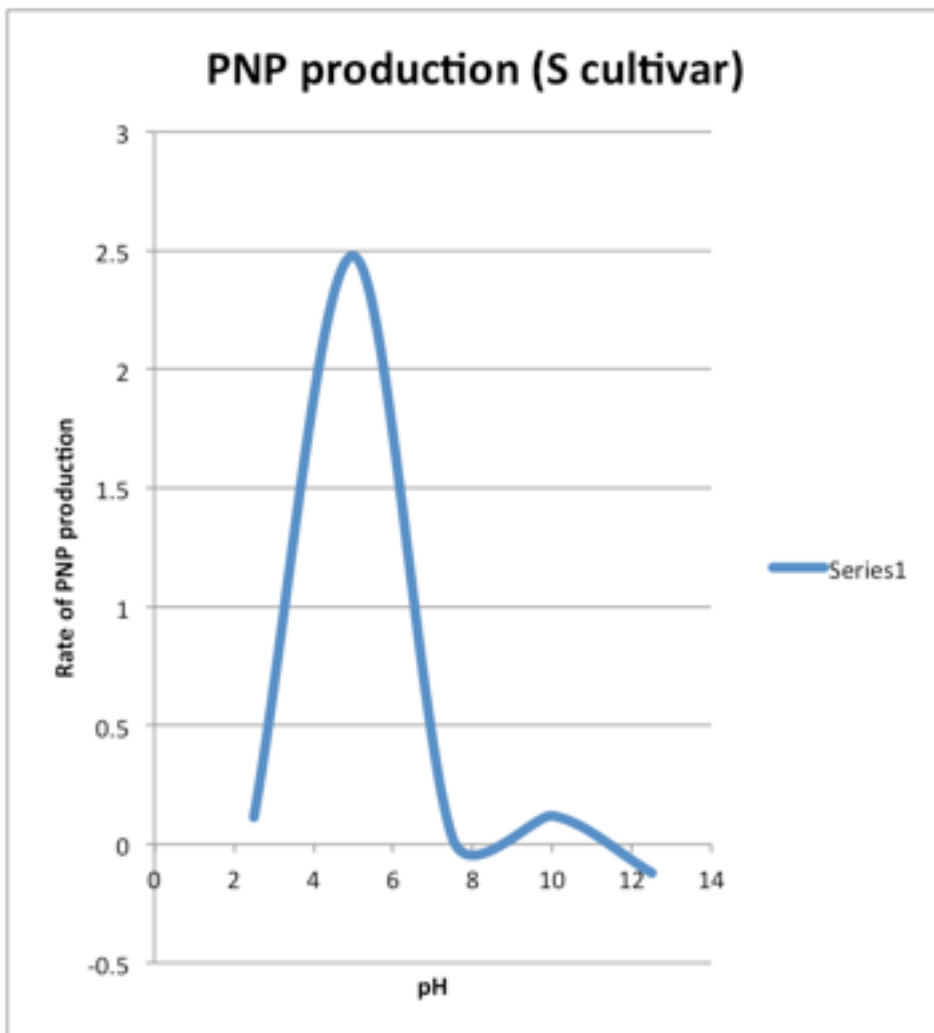
$$\begin{aligned}\text{Rate (PNP production)} &= ([\text{PNP tube 2}] - [\text{PNP tube 1}]) / \text{reaction time} \times 10^{-6} \text{ moles / minute} \\ &= (22.9 - 20.6) / 10 \\ &= 0.23 \times 10^{-6} \text{ mole / minute.}\end{aligned}$$

If the absorbances of de-activated enzyme and PNP product are then “tuned to equality” as They have been in this experiment, the wavepacket contour can be traced out such that Non-vanishing contours can be observed at large pH positions of the wavepacket, and well Beyond the central peak associated with the activation “hike” in energy.

Compilation of results for the class

In this class experimental exercise, rates of PNP production were measured for two Cultivars, S, (Sanzie) and I (ITH98-46), over a range of pHs. My partner and I specifically did the S-cultivar, at PH 10. The total results for the class are presented below. The results were averaged, For example four replicate experiments were performed for sample S at pH 2.5, three at pH 5,

two at pH 7.5 and one at pH 12.5. The PNP production results versus pH for the two cultivars investigated by the class are presented below.



Note the features of the two profiles above, the “wavepacket contour”, with a central peak at optimum pH, corresponding to an “activation

energy” for the chemical process, the conversion of PNPP to PNP, another peak in the vicinity of pH 10, the conditions investigated by my partner and I, and a series of “nodes”. Consider the negative peak for cultivar S. This occurs at around pH 8. Between the central peak, (enzyme activation position), and this first negative peak, we have a node where the wavepacket amplitude vanishes, (and its square, the “intensity” of PNP production) similarly vanishes. (Note that for a wave, the rate of energy propagation is proportional to the square of the amplitude). The experimental conditions have been chosen such that substrate and enzyme quantities are “finely tuned”, in accordance with the above discussions, whereupon we observe these nodes, if the experimental conditions had not been finely tuned in this manner, no negative amplitudes would have been observed and all amplitudes would have dropped to zero, (no PNP production), beyond the central peak which defines the activation energy for the process of PNP production. If the experimental conditions are not “finely tuned” in this manner, wave interference and hence nodes would not be observable and all one sees is a “wavepacket envelope”, which starts maximally in quantity, or intensity, at the optimum pH, and declines smoothly to zero intensity at some quantity of pH that defines the phosphatase activity.

So what are we saying? When one can only observe an intensity, as when the conditions for this experiment are not finely tuned, one observes a central intensity for the chemical reaction, declining smoothly to zero at large quantities of pH. This is what usually happens, only in a very narrow range of experimental conditions do we observe interference of waves and associated nodes, (zeroes in the pH “wavefunction”). For this reason this phenomenon has not been previously noticed, experimental conditions have not been chosen so exquisitely in prior performances of this experiment. In this experiment, we have due to finely tuned experimental conditions observed wave interference in both S and I cultivars, but with a definitely greater amplitude – intensity for the S-cultivar, (on inspection of the y-coordinates of the above reaction profiles). The central peaks are at approximately the same position for both cultivars, around pH 5 for both. (It is an acid phosphatase). That is, the action of the phosphatase in these cultivars occurs preferentially in acidic conditions. (Maximum at around pH 5).

Conclusions about the “wavepacket spectrum” for this reaction

With a wavepacket, there is just as great a tendency for the amplitude to be negative as positive. We have only observed a positive amplitude in the vicinity of the central peak. Where do we get a corresponding negative amplitude in this vicinity? We expect a large negative amplitude in the vicinity of the central peak for smaller pH values, indeed pH values in the range below pH 5, and indeed by extrapolation to negative pH values. (Indeed under conditions of exceedingly high acidity, pH values can be

negative). Of course such conditions are so extreme they cannot generally be observed in a chemistry laboratory, let alone in conditions conducive to phosphatase activity as observable in a biology laboratory. Such extremely acidic conditions would in any case destroy all plant matter before any useful enzyme activity could be observed. We expect a large “negative” activity in the vicinity of pH zero, were it possible to perform the experiment under these conditions.

What then is happening physically as we fine tune the experiment such that interference can be observed? (i.e. such that nonzero amplitudes can be observed at displacements beyond nodes or regions where the wave amplitude has dropped to zero?) Physically, it is akin to a diffraction grating, width Δx , (see uncertainty principle above), being replaced with a single slit of the same dimension, Δx . Interference still occurs from wavelets at the extremity of the slit, but these are drowned out by “noise” associated with wavelets passing through central locations of the slit that cannot propagate according to Huygen’s principle. According to this principle a wave propagates as a sum of all spherical wavelets emanating from a continuous distribution of “sources”. This principle makes sense when considering conditions where wave activity is constricted, such as in the case of waves passing through narrow slits. However it does not make much sense in regions of “empty space”. This is what we are concerned with when analysing non “finely tuned” experimental conditions for the pH related phosphatase. Interference can indeed occur for a single slit, associated with the propagation of wavelets from the extremities of the slit. But when this “slit” is acting like a diffraction grating, as in the “finely tuned” case, we observe the interference of the wavelets – they are not drowned out by noise associated with wave propagation in “empty” regions of space, i.e. in regions away from the extremities of the “slit”. When experimental conditions are “tuned”, the slit is forced into a “diffraction grating” configuration, whereby nodes, wave diffraction and negative amplitudes or rates of PNP production become observable.

Brief summary of where we’re at with experiment

Phosphatase is an enzyme (*-ase*) that removes an inorganic *phosphate* group from a number of organic compounds. Inorganic phosphate plays an important part in the energy transport, (e.g. it is incorporated into ATP), is found in many intermediate metabolic compounds (e.g. glucose-6-phosphate in glycolysis), and can help to regulate protein activity.

In this practical, we have extracted the proteins from roots of two commercial cowpea cultivars. To measure the activity of phosphatases in the samples, we exploit the ability of phosphatases to dephosphorylate p-nitrophenyl phosphate (PNPP) to p-nitrophenol (PNP). It is a useful assay because PNPP is colourless, while PNP appears yellow when reacted with NaOH. However, certain phosphatases are only active within certain pH

ranges. For example, an acid phosphatase placed in a pH 12.5 solution will be inactive, and no PNP would be produced.

The central wavepacket envelope – the “energy barrier” that our enzyme acts upon in this chemical reaction

Measurement of P concentrations in rhizosphere soils and different organs of cowpea plants

(Makoi, Chimphango, Dakora)

The P level was lowest (and therefore highly depleted) in the rhizosphere soil of the cowpea cv. Sanzie relative to Omondaw and Bensogla, and highest in cv. ITH98-46. The tissue concentrations of P were similar in roots, but differed significantly in shoots, with cvv. Sanzie, Omandaw and Bensogla, which showed the highest P depletion in the rhizosphere, exhibiting the highest accumulation in shoots.

When acid phosphatase and alkaline phosphate activities from the field experiments were correlated with rhizosphere pH, rhizosphere soil P, and the levels of P in nodules, roots, shoots and pods of cowpea plants, the data showed highly significant relatedness. In particular, alkaline phosphatase was only significantly correlated with rhizosphere pH, rhizosphere soil P, root P and pod P, but not to nodule P or shoot P.

Consider this “not to nodule P or shoot P”. What we are really saying is not photosynthesis. The only other items under consideration are associated with the soil, i.e. occur in darkness. Once you know the energy ΔE required to take some P out of the soil using phosphatase you can according to the uncertainty principle $\Delta E \Delta t \geq \hbar$ define an interval in time Δt . This is the time interval associated with the time interval which occurs between when the plant senses a deficiency of photosynthesis due to lack of P activity and when a subsequent flow of P from the soil to the shoots begins to occur, in consequence of the actions of the phosphatase. It is the time from the onset of the “mineralisation process” to when the particular location starts to receive the nutrient. Of course, when we are concerned with photosynthesis we are automatically concerned with ATP. (See connection, above).

When the plant realises it needs more P in that specific location, it is a matter of which part of the pH spectrum of the PNP production we are at. As we shall see, this spectrum represents a wavepacket which is travelling to the right at speed c , a photon in pH space. But pH is a measure of proton density, ideally a quantity of electricity. The whole purpose of both respiration and photosynthesis appear to be to set up electrical circuits in order to associate chemical items with the ultimate in physical measure, the electromagnetic wave, the wave that quantises energy and sets the

limits of communication between one place and another. See the analogy, above!

Now depending on the location of the wavepacket when the signal goes out, as we move to the right and up the wavepacket the energy peak, that associated with our enzyme, the distance from the present location to the top of the energy peak also changes. As the wavepacket moves to the right, i.e. we are moving from acid phosphatase to alkaline phosphatase, we “slide down” the energy gap and the energy gap to be overcome in order for the reaction to proceed becomes increasingly large. The more alkaline, the more this process is impeded.

So we have Δt the time between when the plant decides it needs some P to the time it gets it. Δt and ΔE are related through the uncertainty principle such that if $\Delta t \rightarrow \infty$, $\Delta E \rightarrow 0$. We put it another way. The longer the time interval the energy is borrowed, the smaller deviation ΔE from the maximum rate of energy transfer, that associated with a photon. Ideally in the case of pure photon there is zero transfer of information. The entropy is zero. Things are completely orderly. In the transfer through space of a photon we have a maximisation of energy and a minimisation in entropy. The thermodynamics of the photon is encapsulated in its electromagnetics. It is usually expressed in terms of energy minimisation and entropy maximisation, it is the same process, once you have taken an arrow of time.

It all hinges on the “PH wavepacket” being in a state of motion along a “pH displacement vector”. What is the space upon which the wavepacket is moving? pH is a concentration of protons, or “Hydrogen motive force”, by analogy with the ordinary “electromotive force” which arises from electron densities. It is interesting that the processes which operate in the oxidation / reduction chemical processes involve electrons and protons (hydrogen ions) occurring and interacting together. For some reason God has deemed that processes in chemical reactivity in photosynthesis and respiration should be associated with electrodynamics since this in some manner quantises them, such that where we started with the electromagnetic oscillation, pure wave, and then introduced the Fourier Transform, then we were able to convert to quantum electrodynamics but by-passing quantum mechanics, (Rivers: Quantum mechanics is quantum field theory in zero spatial dimensions).

The energy dissipation J.E

The dot product of the electric current density **J** and the electric field strength **E** we get the rate of energy dissipation through evolution of heat. Or more generally, release of free energy. Consider the “proton-motive force and ATP synthase; this occurs at a large enzyme complex spanning the inner mitochondrial membrane. This provides a way for H^+ to flow across the inner mitochondrial membrane down their concentration

gradient. We harness the flow such that $\text{ADP} + \text{P} \rightarrow \text{ATP}$. ~30 ATP are made per glucose molecule. (oxidative phosphorylation).

J.E the energy dissipated is a kind of disorderliness, heat flowing from hot to cold by analogy. This disorderliness pays for the creation of orderliness that occurs with the creation of ATP. When ATP breaks down free energy is released, when it forms things become more orderly.

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Classical electromagnetism stands on its own

In terms of "duality", we can divide physics up into three "regions". It is somewhat akin to the "sustainability triangle" of Agriculture and Environment. At the vertices of a triangle, one puts the three criteria of sustainability, environmental sustainability, economic sustainability and social sustainability. In order that the total system is sustainable in total, all these three criteria must be satisfied. Similarly, in physics, we put the three cornerstones of physics, classical electromagnetism (Maxwell), QED/QTE (Farmer, Dirac, Feynman) and quantum mechanics (Schrodinger, Heisenberg, Dirac) at the vertices of a triangle. We then classify these vertices in terms not of sustainability but in terms of duality.

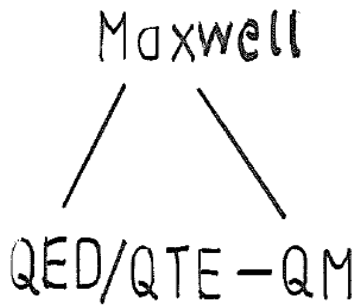


Figure 29: The duality triangle of physics

Firstly note that Maxwell's electromagnetism is not a dual theorem. It makes no reference to magnetic charges, only electric charges. It can however be converted to a dual theorem, with magnetic charges, in accordance with Griffiths, as we have seen above. By a marvelous stroke of fortune, Dirac himself devised a theory of magnetic monopoles, ("Duality and M-theory", Russell Farmer).

So we have Maxwell's theorem standing on its own; it makes no reference to magnetic charges or quantum mechanics. We might propose that Maxwell's electromagnetism is a "cornerstone" of physics, and it stands at one corner of the "duality triangle".

If we allow for the existence of magnetic charges, "positrons", we then put the theories of QED/QTE at another of the vertices of the duality triangle. We extend Maxwell's equations from a set of four to two sets of four equations. One has the existence of electric and magnetic charges, electrons and positrons, but not simultaneously. One has either an electronic or a positronic photon. One or the other, according to which set of four Maxwell's equations we are dealing with, the electric or magnetic Maxwell's equations.

What if we allow for the simultaneous existence of electrons (electric monopoles) or positrons (magnetic monopoles) in the system? Given that a proton is simply a positron locked into some kind of nucleonic orbit, and that atomic/molecular orbitals arise in consequence of putting an electric charge in a very small central region, (the "nucleus"), the final vertex of the duality triangle is concerned with the simultaneous existence of (i.e. "interaction between") electrons and positrons (protons). In this instance we put the eight Maxwell's equations into four equations incorporating both electric and magnetic charges, and conclude that we cannot find a solution. So when we have the interaction of electrons and positrons, i.e. the existence of both of these simultaneously, we need a new equation that we can find a solution for. This equation is the Schrodinger equation. We have seen that chemistry is an "entropy sink" for an elegant and simple piece of physics, $\Delta I = \pm 1$. The orderliness of this mathematical identity accounts

for the huge quantity of entropy associated with chemical knowledge. We are dealing here with the outcomes of solving the Schrodinger equation, such that for an electron to move from one atom to another, there is this restriction on the change in the atomic orbital number, l , i.e., $\Delta l = \pm 1$. All of this arises from seeking a solution to Schrodinger's equation.

So in summary of the duality triangle, the three vertices are respectively (1) no duality at all, (Maxwell), (2) duality, but not simultaneously, and (3) simultaneous duality, whereupon the matter and anti-matter exist simultaneously, and interact with one another.

The transformation of the frequency spectrum

Consider figure 10 above, whereupon we convert a frequency spectrum from physical space to electron wave-space. In electron wave-space, the spectrum is rectangular and the Doppler shift formula in use is the non-relativistic Doppler shift. By contrast, in physical space the spectrum is not rectangular, it dips in the middle, and it is the relativistic Doppler shift formula in use. In the middle of the spectrum, the field \mathbf{E} is at a minimum. It doesn't matter which way the observer moves, $+v$ or $-v$, the electric field lines of the radiation move closer together to the same extent in accordance with the Lorentz contraction. So the spectrum is symmetric; it rises to the same maximal \mathbf{E} at the left and right hand sides, and dips down to a minimum at the centre.

The fundamental equation of QTE

This is the equation, as we have discussed previously:

$$E_{2y} = \gamma (E_{1y} - v' B_{1z}).$$

Previously, to simplify matters, and because we didn't know what to do about it anyway, we ignored the magnetic term $v' B_{1z}$. However it is now evident that $v' = 0$ in our previous discussions because the electrical quanta are not moving along field lines, \mathbf{E} / \mathbf{B} , i.e. we have photons in free space, not photons carrying electric charge in a circuit. The photons are moving "horizontally" in the page, not "vertically".

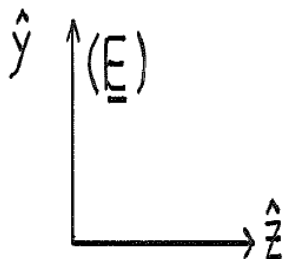


Figure 30: Charged photonic quanta carry current along \mathbf{E}/\mathbf{B}

So when electric / magnetic charges (photons) start moving along field lines \mathbf{E}/\mathbf{B} , we have an electrical/magnetic current, whereupon there is a net transfer of electric charge from one place to another. When there is conversely no electrical current, there are just as many positronic photons as electronic photons moving in a given direction, i.e. no net transfer of electric charge from one place to another.

So if we have a current-carrying situation, $v' B_{1z} \neq 0$, and we require that the Lorentz force is nullified as before:

$$v' B_{1z} = -E_{1y},$$

(unknown reason), (these are not photons in free space),

then we observe that adding the magnetic term $v' B_{1z}$ doubles the coefficient of E_{1y} in the fundamental equation of QTE:

$$E_{1y} - v' B_{1z} \rightarrow 2E_{1y},$$

and thereby in the current-carrying situation involves four times the intensity or four times the number of photons. We know that intensity \mathbf{E}^2 is a measure of the number or density of photons in the field. What do we do with four photons in a current-carrying situation? Consider Figure 31 below.

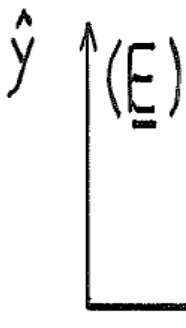


Figure 31: Four photons in an electrical current-carrying situation

That is, to the extent that currents exist, we have internal photons moving along internal field lines \mathbf{E} / \mathbf{B} , such that electronic photons move one way and positronic photons the other, and similarly at the surface such that the net movement of surface electrons has the same direction as that of the internal electronic photons and similarly for positrons.

That is, a negative photon travelling in one direction is the same, current-wise, as a positive photon travelling in the other direction. We have a contribution of four quanta to the electrical current, not one. All four photons contribute the same sign to the electrical current, although perhaps not the same magnitude. Otherwise, where an electrical current does not exist, in a given direction the number of positive photons is the

same as the number of negative photons and there is no net electrical or magnetic current.

So, when one has an electrical current, a single photon becomes four photons, as discussed. The electrical charges (negative electrical charges) move one way and the magnetic charges (positive electrical charges) move the other, and the sign of their current densities are the same. It is important to realize that positrons have both magnetic and electrical charges, and thereby that insofar as a positron has an electrical charge, then an electron simultaneously also has a magnetic charge, of opposite polarity to the positron magnetic charge. But not simultaneously. In accordance with the “duality triangle” above, whereupon in QTE/QED one can have a duality such that the system can be electronic or positronic, not both simultaneously, similarly here a positron has a magnetic charge when the electron has an electric charge, but where a positron has a (+1) electrical charge, the electron indeed has a magnetic charge, of opposite polarity to the magnetic charge of the positron.

The Lorentz force

In our discussions we have concluded that for photons “in free space”, we must demand that the Lorentz force is zero. What about photons in terrestrial electromagnetic circuits? There are “internal photons”, (inside the metal conductor), and “external photons”, (at the surface). Now the internal photons move in straight lines, so that according to Newton’s first law of motion they are “inertial”. Upon colliding with lattice points they will be deflected from pure axial propagation. Eventually these non-axial photons will leave the conductor, exiting through the gap between the fields, **E**, **B** at the surface. Or the photons can collide with oppositely directed dual-photons prior to eventually exiting the system. For these internal photons, we negate the Lorentz force.

By contrast we assert that the photons moving in their helical paths at the surface do have a Lorentz force. This is clear because they are moving in helical paths, not straight lines. They have a centripetal acceleration in connection with the circular component of their motion. For these we do not nullify the Lorentz force, $\mathbf{v} \times \mathbf{B} \neq -\mathbf{E}$. In accordance with this centripetal force, the radial path of the photons (electrons) at the surface of the conductor has radius:

$$R = mv / qB.$$

Because these are moving in curved paths, it is not possible that they have zero Lorentz force. What about the internal photons? They have no Lorentz force. We have seen that internally, the fields **E**, **B** are oppositely directed. So the Poynting vector, $\mathbf{E} \times \mathbf{B}$, is zero. Now this vector is an energy per unit time. So is force \times velocity.

$\mathbf{E} \times \mathbf{B} = \text{Force} \times \text{velocity}.$

So internally, there is no Poynting vector because there is no (Lorentz) force. Not so at the surface. At the surface, the modulus of the Poynting vector $|\mathbf{E} \times \mathbf{B}| \propto v_r$, the radial component of the velocity of the internal photon as it approaches the surface of the flux tube from inside. This too is in accordance with the above equation. Obviously, if $v_r = 0$, that is, the internal photon remains entirely axial, no radiation

$\mathbf{E} \times \mathbf{B}$ occurs from the system. Conversely, if $v_r = c$, we have “total radiation”. In due course, we shall see that we can make photons leave the system by applying an axial force, and that this force occurs at the surface of the flux tube, not internally.

The wavenumber spectrum in electron wave-space and in physical space

Supposing we take the wavenumber spectrum in electron wave-space and seek to convert to physical space. We must first make an adjustment to the “physical” spectrum. Choosing an acceptable zero for the system, i.e. choosing an “earth”, we apply the following transformation.

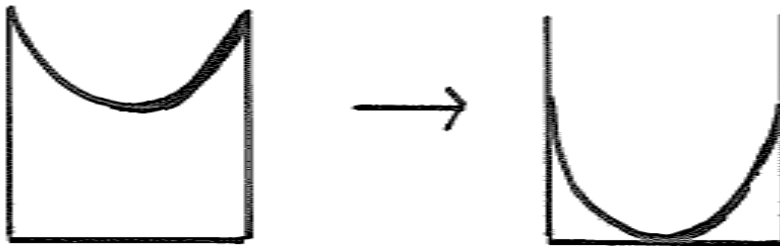


Figure 32: Choose an acceptable “earth” for the wavenumber spectrum in physical space

Now we are in a position to convert the wavenumber spectrum.

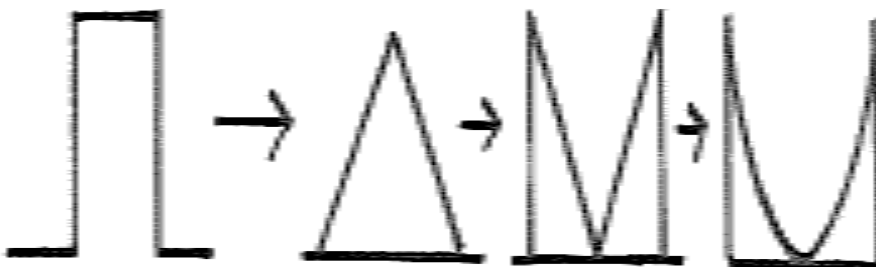


Figure 33: Electron wave-space \rightarrow physical space

The conversion (a) \rightarrow (b), above, one will find in any book of Fourier analysis. The subsequent conversion (b) \rightarrow (c) is a logical extension of this. It was used in “A quantum theory of electrodynamics”, by Russell

Farmer, the Toth-Maatian Review, Lubbock, Texas, Editor Harold Willis Milnes, 1990 - 1993 . At this time it was not however appreciated that this (c) was, or would lead to, a wavenumber spectrum in physical space. So, having chosen a suitable “earth” for the system, we now consider the transformation (c) \rightarrow (d) above. Since we are now in “physical” space, note that the Doppler shift in question is relativistic Doppler shift, not the non-relativistic Doppler shift we use in the electron wave-space.

Now in physical space, why should (c) and not (d) work? There is no reason for it. If we choose “physical space”, there is no reason why we should not make the conversion (c) \rightarrow (d), given that we are now using the relativistic Doppler shift. The symmetry dictates the outcome. The algebra is the same, so long as there is this symmetry.

The Dirac-delta function

What is this Dirac-delta function? It has the following requirement:

Area = constant.

Then surely the Dirac-delta function is none other than the wavepacket spectrum in electron wave-space. The Dirac-delta function is not the wavepacket spectrum in “physical” space – consider (d) above: owing to the non-linearity of this spectrum, it is unlikely that we can find anything useful by declaring the area of spectrum (d) to be a constant. By contrast, owing to the “trigonal symmetry” there is no problem in declaring spectra (a), (b), (c) to have constant areas.

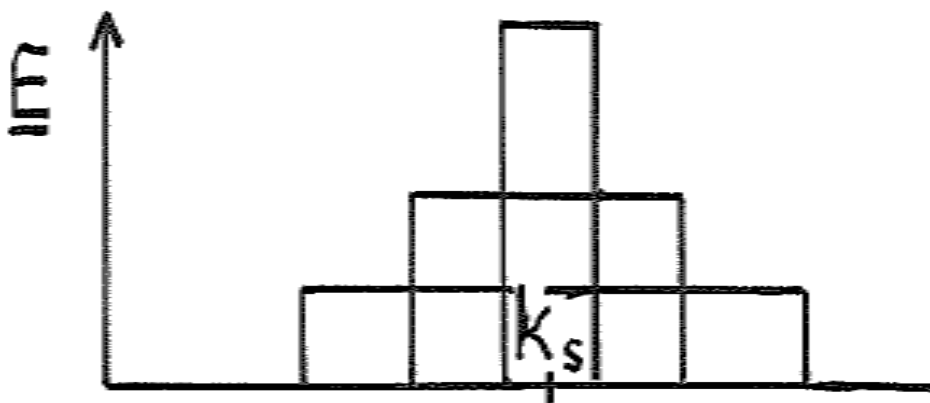


Figure 34: The Dirac-delta function is the wavenumber spectrum in electron wave-space, not physical space

Consider then the wavenumber in electron wave-space. It is clear that we must use the non-relativistic Doppler shift formula here. What happens for low intensities, (low amplitudes, **E**). That is, what happens as $E \rightarrow 0$? We know that for $E \rightarrow 0$, then $v \rightarrow c$. This is one of the first

deductions we made from our wavenumber spectrum in electron wave-space. So for $E \rightarrow 0, v \rightarrow c$, and we find the extremities of this spectrum. The left (small wavenumber) extremity of the spectrum $c/(c + v) \times k_s \rightarrow \frac{1}{2} k_s$, and the right (large wavenumber) extremity of the spectrum, $c/(c - v) \times k_s \rightarrow \infty$.

So for $v \rightarrow 0$, then $E^2 \rightarrow F/\lambda$.

And for $E \rightarrow 0$, then $v \rightarrow c$, and the spectrum behaves thus:

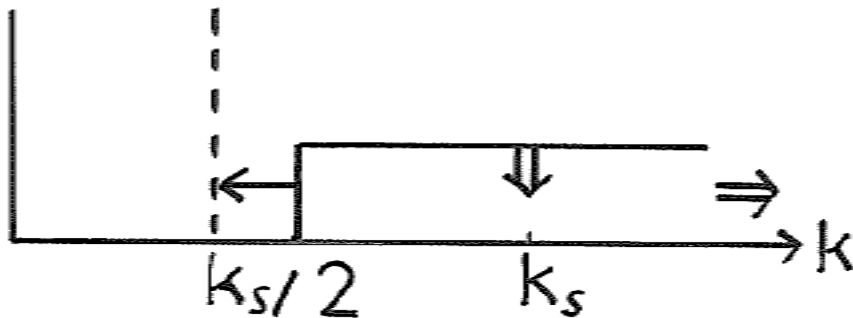


Figure 35: The wavenumber spectrum in electron wave-space, for vanishing amplitudes (intensities)

The work function of the metal

We have seen that when an electron (positron) acquires a component of velocity along field lines \mathbf{E}, \mathbf{B} , (internally to a circuit), dissipation occurs. Work is done and accordingly photons are released from the system according to $|\mathbf{E} \times \mathbf{B}| = \text{Force} \times \text{velocity}$. Now supposing that photoelectrons are emitted from the metal according to energy = $h\nu - W$, W being the work function of the metal, in accordance with Einstein's photoelectric effect. Now in our discussions, we have actually ascertained that electric field = $h\nu$, not energy = $h\nu$. To convert from an electric field to an energy, we must multiply by the distance d over which the electric field acts. What is this distance d ? Perhaps it is identically the amplitude, m_e , of the electron wave, as below.

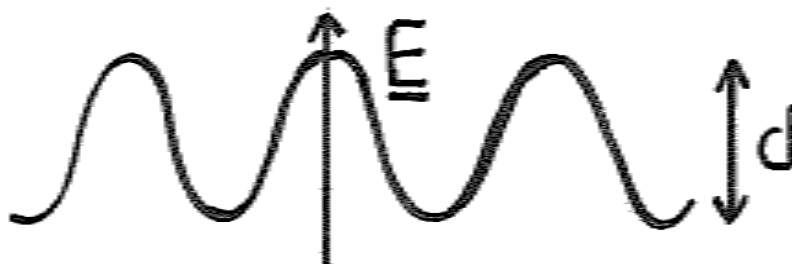


Figure 36: The direction of amplitude of the electron wave is the direction of the internal field \mathbf{E} through which dissipation occurs

So the electrons (positrons) move down the internal field lines by a distance $d = m_e$ through the operation of the field, $E = h\nu/d$. The work function of the metal then becomes:

$$W = qEd.$$

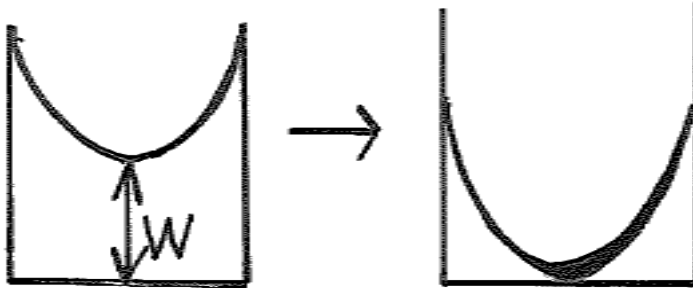


Figure 37: The work function of the metal in physical space; the massive electron becomes massless (photonic)

The work function of the metal is something we observe “physically”, that is, it is in physical space, not electron wave-space. We use W to find a spectrum in physical space, in accordance with the transformation in Figure 37 above.

So we are concerned with photo-electrons. These are emitted as massive (speed $< c$) entities. They are not photons, they have been separated from their photonic wavepackets, the latter having become a dual ghost. Now the work function of the metal is a connection between protons of the metal lattice points and the photoelectrons that are being emitted at the surface. In accordance with Figure 37 above, you go up in energy if you go from a photonic state to a (massive) electronic state. By duality, the same thing applies to the positrons in the lattice. If you go from a positronic photon to a massive positron, you go up in energy by an amount equal to the work function of the metal. However, “ W ” is very much smaller for protons than positrons / electrons. If you go from a positronic photon to a proton, you only go up in energy by a very small amount W .

So the proton, being of greater energy W than the positronic photonic state, will eventually decay into the photonic state. However, the lifetime for the decay could be longer than the age of the universe, as has been suggested, since the energy of the proton is greater than that of the positronic photon by only a miniscule amount. By contrast, the massive electron / positron decays quickly back into the photonic state because the energy difference, W , is relatively large. W becomes very small for protons because there is such a large energy difference between orbital fermions and fermions in the nucleus. $W(\text{positrons})$ is so much larger than $W(\text{protons})$ because of the status of the nuclear as opposed to the orbital fermions in the atomic state, the energy thereof. [Reference: Trevor Hambley, School of Chemistry, the University of Sydney].

All of this gives the required variation of amplitude with Doppler-shifted velocity according to special relativity, whereupon we are dealing with physical space and relativistic Doppler shift. By contrast, to put yourself in the reference frame of the electron, (“electron wave-space”), is to acquire the “flat-top” spectrum, and this is achieved by the transformation $v: 0 \rightarrow c$. This is where 4-vectors come into it. Consider specifically the space-time 4-vector, (ct, \mathbf{x}) . Operating with this 4-vector is equivalent to putting yourself into the reference frame of the (massive) electron. You are observing the laws of physics as they occur in the reference frame of the electron. It is still a wavepacket, and we still require the operation of Planck’s law, $E = h\nu$. But the Doppler shift is non-relativistic.

The Lorentz force $\mathbf{E} + \mathbf{v} \times \mathbf{B}$

Previously, we have established that the Lorentz force can be incorporated into Maxwell’s equations. We have further found it necessary to negate the Lorentz force altogether, for “photons in free space”, such that they are not found to have anything other than rectilinear propagation in external electric and magnetic fields, other than what one might expect for what the photons are, which is charged particles. We shall subsequently discover that even internal photons inside the metal lattice behave identically to photons in free space, apart from the fact obviously that they are involved in current conduction processes here. But in between entering the resistor, and their collisions with lattice points and their exiting the system by propagating between the helical fields, \mathbf{E} , \mathbf{B} at the surface, resulting in propagation in free space $\mathbf{E} \times \mathbf{B}$, they travel in straight lines. Not so the helically propagated photons at the surface, these have a net centripetal force to account for the circular component of the surface current. These do not have a zero Lorentz force, quite obviously, and they behave identically to massive electrons / positrons propagated along field lines \mathbf{B} (\mathbf{E}), with a radial component of velocity to the flux tube defined by the axial path of the current such that we get a helical propagation in both instances, and a centripetal force $\mathbf{v} \times \mathbf{B}$.

So where does $\mathbf{v} \times \mathbf{B}$ come from? It comes from the $(\hbar\omega, \mathbf{v} \times \mathbf{B})$ 4-vector. This can be included into QTE, (see later). What happens when we put a quantum (photon) into a “current-carrying situation”? The quantum can be massive (e.g. electron propagated in “free space”, (i.e. β -particles), or massless, i.e. surface photons in a terrestrial electromagnetic circuit; whichever it is, we get the fundamental helical electromagnetic pathway. The quantum has a component of velocity in the direction of the central (axial) field, \mathbf{E} , (\mathbf{B} , by duality). But the circuit has a curling vector \mathbf{B} . The surface fields \mathbf{B} , \mathbf{E} operate helically in accordance with what we already expect from extremisation of the space-time 4-vector. So do the β -particles.

The circuit has a curling vector, \mathbf{B} , ($\nabla \times \mathbf{B} = \mu\mathbf{J}$). This field operates according to the space-time 4-vector and carries an electron. Consider the Lorentz force $\mathbf{v} \times \mathbf{B}$ in the vicinity of the surface. We are concerned with the azimuthal component of the velocity of the surface currents. This is related to the energy $\hbar\omega$, of the system, $v_{az} = R\omega$, and we define the direction of the photon as being axial such that according to the right hand rule one's thumb points in the direction of the central field and the fingers point azimuthally to indicate the azimuthal speed.

When we consider photonic interactions at the surface, we are dealing with photons whose Lorentz force is not negated, which do not travel in straight lines between collisions, which in fact travel helically and so are undergoing some kind of interaction with external fields.

Consider the centripetal force for electrons, $\mathbf{v} \times \mathbf{B}$. Since the positron has an electric charge as well, we should not be surprised if it turned out that the centripetal force for positrons were $-\mathbf{v} \times \mathbf{B} = \mathbf{E}$. We are going to get an axial field \mathbf{E}_{ax} through the centre of the conductor. Positrons propagate on electric field lines, in the manner that electrons propagate on magnetic field lines. Because the central photon is in this instance a positron, the radial field in question which carries positronic photons who have acquired radial velocities towards the surface of the flux tube becomes a radial magnetic field line. So we take the cross product the velocity $R\omega$ azimuthally and the radial field \mathbf{B} to get a negative electric field, i.e. with respect to a dissipating process, ($\omega \neq 0$), and the magnetic field lines associated with this process. That is, the central axial field \mathbf{E} points in the opposite direction to the central axial field \mathbf{B} , and the surface electric field similarly points in the opposite direction to the surface magnetic field.

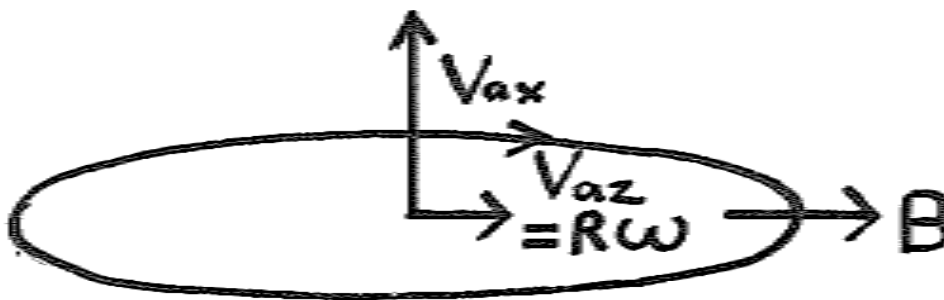


Figure 38: Surface fields for an internal positron

Since $\mathbf{E} = -\mathbf{v} \times \mathbf{B}$ is associated with surface processes, we take the dot product of current density \mathbf{J} and this vector. Then we invoke another 4-vector, the $(\mathbf{J} \cdot \mathbf{E}, \mathbf{E} \times \mathbf{B})$ 4-vector. Then it becomes obvious that the rate at which photonic energy $\mathbf{E} \times \mathbf{B}$ escapes from the system is in direct proportion to the “potential energy release”, $\mathbf{J} \cdot \mathbf{E}$, and this is in direct proportion to the radial velocities of the internal quanta. At the surface there is a certain radial field \mathbf{B} associated with the exiting photon, the

radial component of its velocity. The rate at which energy leaves the system, for a given axial current (photons per second) which defines the azimuthal velocity and hence the radial velocity, (axial velocity is zero at the surface), is in proportion to the photon energy $\hbar\omega$. This is zero when there is no dissipation, (when $\omega = 0$).

By duality we were equally concerned with the $(\hbar\omega, \pm\mathbf{v} \times \mathbf{E})$ 4-vector whereby the curling \mathbf{E} field line at the surface accompanies the curling \mathbf{B} line at the surface, although the arrows which define the direction in which fermions propagate on these vectors point in opposite directions by definition. Thus in addition to an electron, moving on field lines \mathbf{B} at the surface, we have an oppositely moving positronic fermion at the surface, moving on field lines \mathbf{E} .

So electrical current corresponds to positive quanta moving in one direction and negative quanta moving in the opposite direction, (e.g. electrons and positrons), both at the surface (helically) or internally. But to generate electrical current, we need (central) field lines \mathbf{E} , \mathbf{B} upon which photons can propagate in order to establish this movement of electric charge. These are provided by the helically moving electrons on the surface magnetic field \mathbf{B} , whose azimuthal component of velocity generates an axial field \mathbf{B} in the interior of the conductor, (Ampere's law). This is accompanied by the central axial electric field which is predicted by electrodynamics in its non-dual formulation. Obviously, we now are confident that these two internal fields point in opposite directions to one another.

This electromagnetic theory outlines what is happening electromagnetically with positive and negative quanta in an electrical current situation, a situation that applies to all flux tubes, but has nothing to say about what role the photonic atoms of the metallic lattice play in the passage of electrical current. Indeed we shall see that the magnetic field line itself is a kind of flux tube who has a central field \mathbf{B} by analogy with the internal current density \mathbf{J} of the electric circuit and a surface curling vector \mathbf{A} by analogy with the surface curling vector \mathbf{B} . This field \mathbf{A} is defined by $\nabla \times \mathbf{A} = \mathbf{B}$. It is purely analogous, yet we shall see that there is no internal lattice for the field \mathbf{B} itself, hence internal photons undergo no collisions which will direct them radially such that they might exit the system as photons truly propagating in free space. Thus, although magnetic field lines \mathbf{B} themselves, in their 3-dimensional form carry electrical current, that current cannot be directed out of the system and the potential dissipation $\mathbf{J} \cdot \mathbf{E}$ cannot live to its potential.

The QTE frequency variation

Now consider the fundamental equation of QTE, from which we derived the variation of photon in the field with frequency, in its non-simplified state, i.e. $v'B$ term not omitted.

$$E^2 \leftrightarrow v'B.$$

This equation comes out of classical electromagnetic field theory. E^2 is the sum total of all photons in the field. If you remove one photon and feed it into the circuit, it takes another three photons with it. We have discussed the electromagnetic outcome of this process.

We have seen that for photons in free space, simultaneously internal photons in electrical circuits, the Lorentz force vanishes. We have found that the corresponding equation $\mathbf{v} \times \mathbf{B} = -\mathbf{E}$, can be incorporated into Maxwell's equations. It becomes evident that $v'B$ above equals none other than the (modulus of) the Lorentz force $\mathbf{v} \times \mathbf{B}$, since force of one current on another gave us $\nabla \times \mathbf{B} = \mu\mathbf{J}$, and the $(\mathbf{J} \cdot \mathbf{E}, \mathbf{E} \times \mathbf{B})$ and $(\hbar\omega, \mathbf{v} \times \mathbf{B})$ combine in the manner we have described above.

4-Vectors

4-Vectors operate according to the operation:

$$E^2 \leftrightarrow v'B \leftrightarrow \sum \hbar\omega. \quad (\star\star\star)$$

Consider the $(\hbar\omega, \mathbf{v} \times \mathbf{B})$ 4-vector. To extremise we put the two quantities equal to one another such that we are equating two things that do not have the same dimensions. Supposing we multiply $E^2 \leftrightarrow v'B$ by a quantity of time Δt to get the time rate of propagation of energy. If we are in a position to ascertain $\hbar\omega$, then we know the number of photons in the field. Full knowledge of photons in the field entails complete knowledge of the system. If investigations have reached a point such that it is not possible that there is any more knowledge about the system to be gathered, for example General Relativity where Einstein's elegant and orderly equations of gravitation have investigated all that is known from observations, yet it is conclusive that these do not lead to a quantum theory of radiation, then we consider that we need a new theory. Classical electromagnetism simultaneously is a complete theory or one that cannot be extended. We might conclude that quantum electrodynamics, QED and QTE, must be where we shall find quantum gravity. It is therefore evident that a new theory of gravitational waves will have to be established from considerations of spectral analysis and Doppler shifts, as we did for QTE, and from there work out the energy of the gravitons or quanta associated with these waves. The only thing we know about gravitons to date, in consequence of previous works, (Farmer), is that it has been established that the speed of gravitons is not limited to the speed of light and is such that it is in proportion to the distance over which the force acts, the distance over which the graviton is transported. Therefore for any gravitational interaction between two particles, the time Δt associated with the interaction is independent of the distance of the interaction. The only geometric operation where we have a distance

proportional to a time, $\Delta x \propto \Delta t$,

is a rotation at constant angular velocity, identically providing the perihelion which General Relativity seeks to explain, and thus a full non-quantum description of the system such that to make any further progress it will be necessary to start with the wavenumber analysis of QTE.

Similar reasoning can be given for the undimensionalities of the other 4-vectors. We've already done this for space-time and energy-momentum 4-vectors. Subsequently we've achieved the same goal for the $(\mathbf{J}, \mathbf{E}, \mathbf{E} \times \mathbf{B})$ 4-vector by multiplying by the distance between helical fields \mathbf{E}, \mathbf{B} at the surface, although which side of the equation to multiply by this distance has been left as an exercise for the reader. So the full situation of the 4-vector has been considered, (as per Melrose, Wheatland, Farmer).

Also, it has now been established that with a circuit we have both internally and at the surface oppositely directed and whose relative strength dictates the quantity of electronic versus positronic components of the electrical current. For example, in Solar Flares the current is directed to flow in consequence of built up concentrations of electronic versus protonic plasma components in two regions known as "footpoints". Although protons relatively speaking contain magnetic charge, like positrons, they would not be expected to travel along field lines \mathbf{E} in the manner that positrons do. So for Solar Flares, the current will be carried between the two footpoints uniquely by an electronic current, not a positronic one. This is the limit of what can be established at present.

So the circulating (helical) electric (photonic) charges at the surface create the central axial field, but also, the converse: the central axial currents create helical fields at the surface by the same process, the right hand rule, (Ampere's law, and its dual). We have four photons in total, two positronic, two electronic. So you only have to consider for central currents that a positron moving in one direction is equivalent to an electron moving the other insofar as the sign of the current is concerned, and this is identically in accordance with the above discussions where the fundamental development was insofar as changing from fermion to anti-fermion only changed the sign of the relevant equation, not the algebra. That is, the duality comes down to a simple change of sign. Consider what we know about electromagnetic flux tubes. You start from the premise that current involves electrons moving in one direction and positrons moving in the other. That is, electric monopoles moving in one direction and positrons moving in the other. Insofar as an electron has a negative electric charge, a positron, the magnetic monopole, has a positive electric charge. Similarly, according to duality, an electron is simultaneously a magnetic monopole with polarity opposite to the magnetic polarity of the positron. So

current is simultaneously the movement of electric charges in one direction and simultaneously the movement of magnetic charges in the other. There is some knowledge required of the signs we should use for the magnetic poles of positron versus electron – this will be discussed in due course. As discussed above, the positronic and electronic components of current do not have to be equal.

Because classical electromagnetism becomes quantized in QTE, equal increments in time Δt become increments in radiation $\Sigma \hbar\omega$, i.e. individual photons. That is why missing temporal dimensions do not matter in the 4-vector operation, (★★★) above.

Currents

We have seen that when an electron travels on the **E** component of an electromagnetic wave, “**E**”, it is actually propagating along a magnetic field, **B**. It “slips down” the field line and any component of velocity orthogonal to the field **B** becomes a circular motion owing to the centripetal force, (Lorentz force). The propagation of quanta (photons) is mediated from rectilinear motion to helical motion, as predicted by extremisation of the space-time 4-vector.

Further, we have seen that the speed of light can be found just from the electric and magnetic divergences, without reference to the other Maxwell equations. This is because taking the divergences gives the radius of the electron / positron. The electron spin has already been ascertained independently, and if one knows the spin of a particle and its radius, then one has its speed:

$$v = c = R\omega.$$

Now Ampere’s law comes about by insisting that there is some way that charged quanta can be propagated through a system where there is a net transfer of electric charge from one place to another. The passage of electric current is akin to extremism of the space-time 4-vector, (**B** is helical). This includes electrons moving into and out of atoms. So chemistry is itself a study of electric currents. Chemistry is an entropy consideration, chemistry is a sink for entropy. Chemistry is disorderly. Take a look at an advanced book in organic or inorganic chemistry. Physics by comparison is more orderly, i.e. everything in it can be traced back to Maxwell’s equations or the Schrodinger equation, which are very orderly and elegant matters of reasoning.

Creating a passage of electric / magnetic current involves moving a quantum down a field line, **E**, **B**, according to the “ $v'B$ ” term in the fundamental equation of electromagnetism, the “frequency equation” which accounts for the variation of photon number with frequency. So from Maxwell’s equations, we have further simplification to this one equation, for the purposes of this investigation. Consider “Chemical

Physics”, (Farmer). The chemistry is very complex, while the physics is very simple. Primarily, that “ $\Delta l = \pm 1$ ”, the condition for electric currents to exist, carrying electric charge from one atom to another.

You have electrons moving one way and / or positrons moving the other for a net transfer of charge in one direction. If, by contrast, you have the same number of electronic and positronic photons moving in one direction, there is no net transfer of electric charge and furthermore we are left with photons in free space, an equal mixture of electronic and positronic photons moving in one direction which we know ordinarily as the “passage of light”.

The (t, x) and (J.E, E × B) 4-vectors simultaneously

We require that the surface current produce a central axial field, **B**, (**E**), so that electrical dissipation, **J.E** can occur, with respect to the internal current. So the surface current has to have an azimuthal component in the circuit, this component of current producing central axial fields. But this condition could be satisfied either by closing circular rings **B** or by an helical surface magnetic field **B**. Which is it? We propose that it is helical, the evidence being our previous analysis of the extremisation of the space-time 4-vector whereupon an helical path is predicted for something. For what? For the passage of electrical current in the manner we have described. Since magnetic field lines are electronic pathways, we require an helical surface field as otherwise the surface charge can go nowhere and the system will not operate in the manner we require.

Consider the electrical dissipation associated with a flow of current, such that photons are progressively liberated, (theory of the light bulb). The internal field **E** is given by the voltage. The greater the axial current, **J_{ax}**, such that **J.E** is maximized, (high dissipation and release of photons **E × B**), the greater the potential for deflection of internal photons by interaction with the lattice points or with each other, (oppositely directed electric and magnetic photons).

As previously conjectured, the missing dimension in the extremisation of the (J.E, E × B) 4-vector is a spatial dimension, and the equation is multiplied accordingly by this “constant”, and this constant is given by the distance between the **E**, **B** field lines at the surface which are carrying the surface charges. In the same way we found a missing constant or dimension in our (t, x) 4-vector, and multiplied accordingly by speed such that electromagnetic speed: $1 \rightarrow c$. In our solar flare analysis the “constant” did not come into it – we have discussed the reasons for this.

Consider then:

$$\text{Power} = V \times I,$$

$$\mathbf{J} \cdot \mathbf{E} = V \times I$$

$$= V^2 / R$$

$$\propto \mathbf{E}^2 \propto |\mathbf{E} \times \mathbf{B}| \text{ s}^{-1},$$

such that photons are emitted from the conductor (resistor) through their radial speed – the latter gives the intensity of the emitted light.

If you don't have a potential dissipation $\mathbf{J} \cdot \mathbf{E}$ then you don't have passage of electric current, i.e. you have photons in free space, electronic or photonic, not oppositely directed, in the same direction and in equal numbers. This is in the limit of infinite conductivity, or zero resistance. The amount of energy available to dissipate is maximized when $\mathbf{J} \cdot \mathbf{E}$ is greatest, i.e. when \mathbf{J} is axial throughout the interior of the metal. When \mathbf{J} has a radial component, this is no longer potential dissipation, it is radiating from the system and the potential for dissipation has been reduced as energy is radiated from the system. We seek the distance between surface fields \mathbf{E} and \mathbf{B} when this occurs, this will give us the radiated intensity $|\mathbf{E} \times \mathbf{B}|$.

Supposing we take a system where a given internal electron strikes a lattice point and acquires a radial component of velocity. The potential dissipation $\mathbf{J} \cdot \mathbf{E}$ is reduced as the radiation occurs. A photon is leaving the system, leaving a "gap" in the internal photon field. This gap is rapidly filled again by a surge of electricity in the system. \mathbf{J} acquires a radial component. It has been suggested previously that one possibility is that increasing $\mathbf{J} \cdot \mathbf{E}$ will increase the radiated intensity because doing so increases the distance between the surface field lines, \mathbf{E} , \mathbf{B} . Thereby to acquire a radial component of velocity is equivalent to an hypothetical increase in distance between the surface \mathbf{E} , \mathbf{B} , such that these provide the only gap in the cylindrical structure for internal photons to get out of the system, into "free space".

The amount of energy available to dissipate is maximized when $\mathbf{J} \cdot \mathbf{E}$ is greatest, i.e. when \mathbf{J} is axial throughout the interior of the metal, pointing in the direction of \mathbf{E} . We seek the distance between surface \mathbf{E} and \mathbf{B} when this occurs, if indeed that depends on $\mathbf{J} \cdot \mathbf{E}$ – it is more than likely it does not, and this becomes an extension to an exercise which has already been set for the reader.

An exercise which has been set for the reader

Consider the 4-vector expression, $\mathbf{J} \cdot \mathbf{E} \leftrightarrow |\mathbf{E} \times \mathbf{B}|$. There are two possibilities, with respect to the missing spatial dimension.

- (1) The greater $\mathbf{J} \cdot \mathbf{E}$, the greater the modulus of the Poynting vector, because increasing $\mathbf{J} \cdot \mathbf{E}$ increases the distance between surface fields \mathbf{E} and \mathbf{B} , increasing the rate at which (Poynting) energy leaves the system.
- (2) $|\mathbf{E} \times \mathbf{B}|$ is distinct from $\mathbf{J} \cdot \mathbf{E}$. First there is the “potential” $\mathbf{J} \cdot \mathbf{E}$ for deflection of photons, then the possibility that the deflected photons get through the gap between surface \mathbf{E} and \mathbf{B} .

Whichever of the above two descriptions gets the dimensionality of the vector extremisation process correct is likely to be the correct explanation. They are mutually exclusive possibilities.

Now $\nabla \times \mathbf{B} = \mu \mathbf{J}$ is just a means of getting quanta of charge (photons) to move down field lines \mathbf{E} , \mathbf{B} , such that there is a net transfer of charge from one place to another, such as in solar flares where the flux tube goes from one sunspot or footpoint to another. Because respectively lumps of protons and lumps of electrons have built up, for reason unknown, the flux tube acts to dissipate the potential which occurs in consequence of separation of electric and magnetic charge has occurred. This occurs when the electron propagates with a velocity component down the field line, not purely across, in an interaction $\mathbf{J} \cdot \mathbf{E}$ such that the internal positron not the electron determines the field dissipative interaction with the electronic current density. The internal electronic photon is propagating along a magnetic field \mathbf{B} , yet interacting dissipatively with the oppositely directed field \mathbf{E} .

Electrons will propagate in one direction, positrons the other, such that \mathbf{J}_e and \mathbf{J}_p , the electronic and positronic current densities, point in the same direction. But electric and magnetic fields, which carry positronic and electronic photons respectively, point in opposite directions, both internally and at the surface.

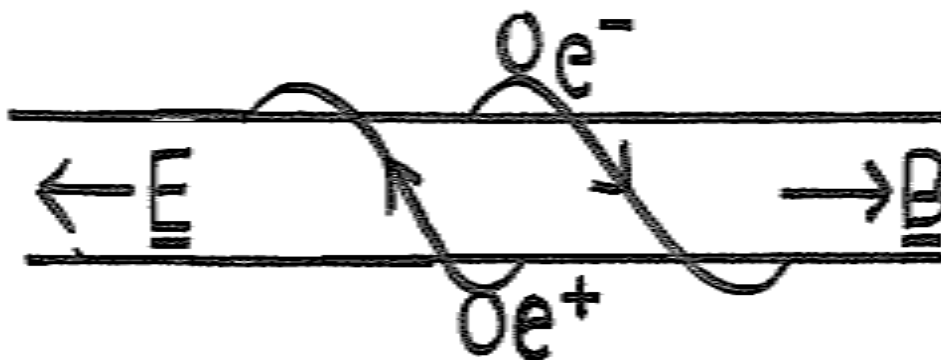


Figure 39: Electronic / positronic fields at the surface and internally; the electromagnetic duality

$\nabla \times \mathbf{B} = \mu \mathbf{J}$ is a means of getting charge to travel along field lines \mathbf{E} , (\mathbf{B}). Is $\nabla \times \mathbf{A} = \mathbf{B}$ similarly? We shall have a few things to say about this in due course. For the moment, just note that we expect there to be

something fundamental about the magnetic vector potential \mathbf{A} in these discussions, given that (φ, \mathbf{A}) is a 4-vector where φ is the electric (scalar) potential.

Mass of Higgs' boson

$\nabla \times \mathbf{B} = \mu \mathbf{J}$ does not necessarily apply one way or the other regarding concentric circular field lines \mathbf{B} or the helical configuration, as seen in "Mass of the Higgs' Boson", (Farmer), where there are two approaches.

- (1) The helical approach is the approach that has been followed in QTE. However there is another approach, (reference above):
- (2) In the second approach, we use closed concentric field lines \mathbf{B} but nevertheless find a way for the quantum to follow an helical path.

So what is not in question is the helicity of the pathway of the surface charge according to extremism of the space-time 4-vector.

Power = Force \times velocity

There are two components of current in a circuit, internally. There is the axial component of internal photon velocity – this results in a net movement of charge from one place to another. Then there is the radial velocity, which makes no contribution to any net transfer of charge. The rate at which photons exit through the surface of the flux tube is in proportion to this $\mathbf{v}_r \leftrightarrow \mathbf{J}_r$. Whether there is any axial movement, i.e. along field lines, depends on whether or not there is a $v'B$ term or not in the "Fundamental equation of quantum theory of electrodynamics". If there is, it follows that electrical dissipation occurs and further that we have component of velocity \leftrightarrow surface field lines azimuthally. It is this azimuthal component of current, ($v'B = 0$), responsible for the central field(s) along which the internal positrons / electrons flow.

$\mathbf{J} \cdot \mathbf{E}$ is a measure of the work done internally on the moving charges. This work is required to "squeeze photons out of the system", as energy-wise they undergo an unfavourable interaction with the atoms at the lattice points. Charge is pushed through the circuit, interacting with lattice points and possibly with the oppositely directed anti-fermionic photons, resulting in the expulsion of photons. Prior to exiting the system as photons truly in free space, the radially directed quanta that began their existence in the circuit as axial photons with a maximal unrealized potential for radiating out of the system due to radial components of acquired velocity in the circuit. We might call this a "phononic existence" such that the interior is filled with phonons of heat. At length, when they exit through the gap between the surface fields \mathbf{E} , \mathbf{B} , they become fully fledged photons of light. Work needs to be done for this to happen.

Now $\nabla \times \mathbf{B} = \mu \mathbf{J}$ supplies the azimuthal component of movement of the surface fermions. These supply the central axial field according to which the dissipation occurs. According to the interaction of this field, internal charges are pushed or forced, $P = \mathbf{v} \times \mathbf{F} = \mathbf{E} \times \mathbf{B} \text{ Js}^{-1}$.

Consider the $(\hbar\omega, \mathbf{v} \times \mathbf{B})$ 4-vector. We go into a dissipative situation by requiring that we have a $\mathbf{v} \cdot \mathbf{B}$ term in the fundamental equation. This is the dissipated power ,

$$\mathbf{v} \times \mathbf{F} \sim \mathbf{v} \cdot \mathbf{B} \sim \mathbf{v} \times \mathbf{E}.$$

So we are concerned with energy per unit time, $\mathbf{E} \times \mathbf{B}$. We extremise the 4-vector. The vector component of it is, according to the discussion above, an energy per unit time. So the energy per unit time is in proportion to the photon energy $\hbar\omega$. This would be the case for a given current, or quantity of photons in the field. But because the photon frequency is an angular frequency, we are here concerned with the helical surface interaction, the azimuthal component thereof, such that the axial force occurs at the surface. This is for a given photon number or $\mu \mathbf{J}_{ax} = \nabla \times \mathbf{B}$, identically a flux density. Because \mathbf{J} is multiplied by μ , we have a quantity of fermions, not a quantity of electrical current density.

If in a given direction one has non equal fluxes of electronic / positronic photons, then one has a net current, $\nabla \times \mathbf{B} = \mu \mathbf{J}$ applies and “Lorentz force = zero” does not necessarily apply. One no longer has “photons in free space”; the photons are restricted electromagnetically. So:

- (1) If you have a net current, you flow down electric / magnetic field lines, or
- (2) If you are moving down electric / magnetic field lines, you have a net current.

Two-dimensional field lines, \mathbf{B}

In our discussions of surface interactions in metallic conductors, we have made do with one-dimensional field lines in an helical configuration at the surface. In solar flares, this helical configuration of surface fields, \mathbf{B} , is readily observed. However, these field lines \mathbf{B} are anything but one-dimensional. They have a “thickness” to them. Inside the boundaries of a given field line, you have a continuous field or flux density, $\mathbf{B} = \nabla \times \mathbf{A}$, by analogy with $\mathbf{J} = \nabla \times \mathbf{B}$.

With these sorts of field lines, the electrons can travel in helical paths, \mathbf{A} , at the surface of the field line (region) \mathbf{B} . This is as opposed to “unilinear” \mathbf{B}/e^- interactions; the one line \mathbf{B} not a continuity of magnetic field over space, as observed in terrestrial electromagnetic pathways. In both cases the magnetic field line, whether individually or constituting a

“flux”, acts as a pathway for the transport of electric charge.

Because we have two curls to deal with, we have a 2-fold magnetic helicity. We have that associated with the field lines \mathbf{B} themselves and that associated with the field line configuration, i.e. the interaction between \mathbf{B} and a current density. The thicker the flux line \mathbf{B} , the more evident the helicity in the magnetic field line $\nabla \times \mathbf{B} = \mu\mathbf{J}$, since more of the photonic speed is used up in constructing \mathbf{B} and less is available for disguising the helicity. The greater the azimuthal component of the surface current, the hazier becomes the boundary between helicity and the “concentric” field lines assumption. The Higgs’ boson comes out of this limit of complete azimuthal velocity.

In this analogy between $\nabla \times \mathbf{A} = \mathbf{B}$ and $\nabla \times \mathbf{B} = \mathbf{J}$, and it will prove to be more than an analogy, we might expect that for the case of the 2D field line \mathbf{B} , there are no lattice points inside. Hence, though there might still be a potential for dissipation, it does not occur because there are no lattice points inside the region \mathbf{B} for the internal photons to bounce off on their way to radiating out of the system. Regarding collisions with oncoming antifermionic photons, we can only speculate at this stage that this is a different kind of interaction to collisions with lattice points, and that it may have something to do with the dissipation $\mathbf{J}\cdot\mathbf{E}$ which affects the electronic photons \mathbf{J} through a field \mathbf{E} which is conversely an expression of the opposite movement of positronic photons. This $\mathbf{J}\cdot\mathbf{E}$ is actually a force acting at the surface, but is defined in terms of internal interactions, as discussed above, such that information of these internal interactions is conveyed to the surface, from internal field configurations to external field configurations, from vanishing Lorentz force to non-vanishing Lorentz force, and this is identically the force which acts axially at the surface of the flux tube.

Consider internal positrons propagating initially on internal field lines \mathbf{E} . Or electrons on \mathbf{B} . $\partial\mathbf{E}/\partial t$ is the rate at which internal positrons are deflected from their axial movement such that they might radiate from the system. Then we have that no potential for dissipation $\mathbf{J}\cdot\mathbf{E} \rightarrow$ no radiation $\mathbf{E} \times \mathbf{B} \rightarrow$ no $\partial\mathbf{E}/\partial t$ term in Maxwell’s equations \rightarrow no conservation of electric charge $\leftarrow \rightarrow$ no transport of electric charge. It is only a transport of magnetic charge, the positron.

The only radiation results in consequence of $\nabla \times \mathbf{B}$, not $\nabla \times \mathbf{A}$, we know that much. Radiation does not come out of field lines, whatever their thickness. There can be no dissipation inside field lines \mathbf{B} . The tighter the helicity, the smaller the net current which is in direct proportion to the axial velocity of the surface fermions, therefore the axial magnetic field. In the limit of infinite helicity, (pure azimuthal velocity), we have the Higgs’ boson; it is associated with no surface current, hence no internal current either. The Higgs’ boson maintains its mass, it does not lose any mass, there is no flow of electric charge away from it. Since we have shown the Lorentz force is a part of Maxwell’s equations, hence the

charge to mass ratio of fermions can be obtained by experiments with static electric and magnetic fields, and we have so far that no electric charge is transported away from the Higgs' boson, we conclude that no mass is either, and that this is indeed the sought after Higgs' boson.

Because it does not lose any mass, it gives mass to particles like fermions. The Higgs' boson can give mass or take it away. For example, when an electron is accelerated onto a photon with an electronic vacancy, or "dual ghost", it loses its rest mass. It does retain a total mass insofar as it is now travelling at the speed of light, but in this reference frame there is no kinetic energy associated with this mass, $v' = 0$. This implies there is no dissipation $v'B$, associated with the Higgs'. The dissipation is given by $\mathbf{J}\cdot\mathbf{E}$, there is an internal field \mathbf{B} axially, in consequence of the helical electronic current at the surface. Internal electrons can move axially on these internal magnetic fields. But there is no internal field, \mathbf{E} , hence we conclude no positrons in the system, and no dissipation in the system.

That is one kind of field line, $\nabla \times \mathbf{A}_B = \mathbf{B}$. We should not be surprised to learn that it has a dual, $\nabla \times \mathbf{A}_E = \mathbf{E}$. This two-dimensional electric field line is by complete analogy an helically propagated positron with an internal positron too but again, no dissipation. This one has a central field \mathbf{E} upon which internal positrons also propagate. For 2D field lines \mathbf{B} , \mathbf{E} , the potential for radiation has disappeared with the lattice points, but simultaneously you have no possibility for dissipation owing to the status of the internal fields, for each of the dual possibilities in turn, and furthermore there are perhaps no gaps at the surface of the flux tube owing to there being only one surface field such that there is not a gap for radially directed internal photons to get through. For no less than three independent reasons, we establish that electric and magnetic field lines ought not radiate. One or more of these may occur in consequence of the other(s).

The argument will be that $\nabla \times \mathbf{B} = \mu\mathbf{J} \rightarrow \nabla \times \mathbf{A} = \mathbf{B}$, i.e. the latter is a consequence of the former. Consider when an azimuthally directed electron acquires an axial component of velocity. It is now moving along a field line, \mathbf{E} . Work is being done in the system, we have discussed this work at some length. Work = qEd , where d is the distance moved along the field \mathbf{E} . Since the azimuthal part of the motion is associated with a mass amplitude that points axially, the distance over which the axial force will be given by the (electron) mass.

So, in a field line \mathbf{B} that has a dimensionality greater than one, i.e. two, then in the comparison between Ampere's law and the definition of the magnetic vector potential, the progression between the former and the latter, \mathbf{A} takes the place of \mathbf{B} and \mathbf{B} takes the place of \mathbf{J} . So where we had an interior region of constant current density, we now have an interior region of constant magnetic field. This should come as no surprise, since magnetic field lines are we have observed simply lines of propagation

for electric charges, (electronic photons).

Now consider the vector \mathbf{J} . For the dissipation $\mathbf{J} \cdot \mathbf{E}$, only the axial field \mathbf{J}_{ax} comes into it, as \mathbf{E} is axial. Further, $\mathbf{J}_{ax} \propto \mathbf{v}_{ax}$, the axial component of velocity of an internal current-carrying photon. But the radial component \mathbf{J}_r gives the rate at which photons exit the system, as we have seen previously.

$$\nabla \times \mathbf{B} = \mu \mathbf{J} \quad \leftrightarrow \quad \nabla \times \mathbf{A} = \mathbf{B}, \text{ or}$$

- (1) $\mathbf{J} \leftrightarrow \mathbf{B}$, magnetic pathways are for propagation of electric charge, and
- (2) $\mathbf{B} \leftrightarrow \mathbf{A}$, what do we make of this equivalence?

Consider $\mathbf{B} \leftrightarrow \mathbf{A}$. Take the curl.

$$\nabla \times \mathbf{B} \leftrightarrow \nabla \times \mathbf{A},$$

$$\mu \mathbf{J}_{el} \text{ (electric current)} \leftrightarrow \mathbf{B},$$

the condition for this to occur is quite obviously:

$$\mathbf{B} = \nabla \times \mathbf{A},$$

Take divergences:

$$\begin{aligned} \nabla \cdot \mathbf{B} &= \nabla \cdot (\nabla \times \mathbf{A}) \\ &= 0, \end{aligned}$$

since the divergence of a curl is zero. It follows then that in the system under consideration, there are no magnetic charges, (no positrons).

Now consider the charge-conservation term $\partial \mathbf{E} / \partial t$ we have omitted from Ampere's law above. Magnetic charges occur with the introduction of this vector back into Maxwell's equations, where \mathbf{E} represents a density of positronic current in the same manner that \mathbf{B} represents a (flux) density of electronic current. Inclusion of this vector imposes the conservation of electric charge such that the time rate of change of positronic current density \mathbf{J}_p (axially) is associated with a radiation of energy in the opposite direction. To eliminate \mathbf{J}_p , put an electronic photon in synch with it, \mathbf{J}_e , such that the current vanishes altogether. In time, the positronic current is being reduced. All we are left with is an oppositely directed contribution to the internal current $\mathbf{J} \propto \mathbf{v}_{ax}$, the greater the axial component of velocity the greater the net (axial) current. We conclude that the internal currents are indeed Poynting vectors $\mathbf{E} \times \mathbf{B}$, or photon numbers in the field. It does not matter that they are segregated in terms of their electric charge, there is still a net rate of transfer of photons, and these photons carry energy regardless

of whether they are associated with a net transfer of charge.

So instantaneously we have the modulus of the Poynting vector, $|\mathbf{E} \times \mathbf{B}| \propto \mathbf{J}_r$, i.e. related to the radial component of the velocity or current density of an individual charge. This is the instantaneous radiation for a given internal photon approaching the exit point at the surface of the flux tube. By contrast the potential for radiation, $|\mathbf{E} \times \mathbf{B}|$ (potential) = $\mathbf{J} \cdot \mathbf{E} = J_{ax} \cdot E_{ax}$. It is not clear under what conditions this potential for radiation would not be realized, although it is possible such a condition occurs inside 2D-configured field lines \mathbf{E} , \mathbf{B} .

In conclusion, we note that an electronic / positronic current is identically a transfer of photons $\mathbf{E} \times \mathbf{B}$, that is, photons do carry electric charge, as we have suspected all along, and their propagation can be associated with a net transfer of charge, or otherwise, but the total energy of photons in the field is given by a current density, where there is a net transfer of charge.

As we have discussed, in an helical configuration, if either the positronic or the electronic component of current is missing, there can be no dissipation. We expect this to be the case for example inside magnetic / electric field lines, where these are 2D, such that the field lines themselves do not radiate. But even were there two current components inside a field line, we might expect that the radiation potential would not be realized as there are no lattice points off which axially directed photons would be deflected.

For 2D magnetic / electric field lines, if we eliminate one of the currents, say \mathbf{J}_p the positronic current density, then we eliminate the positron $\leftarrow \rightarrow$ electron contribution of the lattice points. But that is zero! Consider the two current densities, add them together and take the modulus (squared).

$$|\mathbf{J}_p + \mathbf{J}_e|^2 = \mathbf{J}_p^2 + 2\mathbf{J}_p \cdot \mathbf{J}_e + \mathbf{J}_e^2.$$

Now the middle term is zero, as one or the other of the fermionic currents will be absent. We are squaring a current density. As we have noted, a current density, say an axial one \mathbf{J}_{ax} , will be in proportion to the (axial) velocity. So in adding the currents and squaring them, we are actually calculating a kinetic energy in a given direction. It therefore seems natural to equate this kinetic energy with the energy of the Poynting vector:

$$|\mathbf{P}| = |\mathbf{E} \times \mathbf{B}| \propto \mathbf{E}^2 \propto \mathbf{B}^2,$$

Accordingly we associate \mathbf{B}^2 with the electronic current density, \mathbf{J}_e^2 , when it exists, and accordingly the dual process, whereby we associate \mathbf{E}^2 with a magnetic current density \mathbf{J}_p^2 , such that magnetic charges (positrons) move along electric field lines, \mathbf{E} .

We have seen that there are no positronic currents, internally or at the surface, associated with 2D magnetic field lines, \mathbf{B} . There are only electronic currents internally and at the surface of a field line, \mathbf{B} , in its helical configuration. By the principle of duality, only positronic currents exist at the surface of a (2D) field region, \mathbf{E} . According to the latter, the magnetic vector potential is defined:

$$\nabla \times \mathbf{A}_E = \mathbf{E}.$$

In total, for a flux tube, the generality of the electromagnetic circuit, we have a movement of electric charge, (electrons), in one direction and positrons in the other.

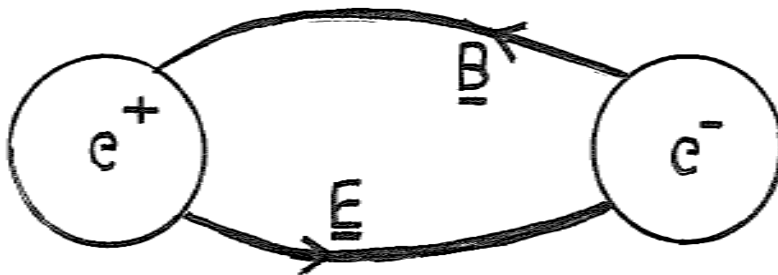


Figure 40: In an electromagnetic flux tube there is a net movement of electric charge in one direction and magnetic charge in the other

One might expect that a collection of protons in close vicinity to one another might constitute a region of magnetic charge, (a magnetic monopole). This, given that protons are in fact positrons, (positronic photons), locked into a particular kind of orbit. They are likely to stay in this orbit, not decay back into photons, on a life time scale comparable to the age of the universe.

However, one might expect that while electrons and positrons find it natural to move along field lines, \mathbf{B} , \mathbf{E} , conversely protons would not move along field lines \mathbf{E} in such a fashion. So in the case of solar flares, where you have two “footpoints” or sunspots, one protonic and one electronic, supplied by the plasma, connected by a flux tube, the only current in the circuit will be an electronic current, flowing from the electronic footpoint to the protonic footpoint. At the protonic footpoint, incoming electrons neutralize the charge of the excess protons.

The problem is, if there is no positronic current, then there is no internal field \mathbf{E} , and consequently no (internal) dissipation, $\mathbf{J} \cdot \mathbf{E}$. But we know that large amounts of energy are liberated in the process of a solar flare. It is not acceptable that there would be no dissipation in a solar flare, contrary to the case of 2D field lines \mathbf{E} , \mathbf{B} , where we expect no dissipation to occur internally. To get a dissipating flare, we might propose that the protons can be transported into a positronic configuration momentarily, for a time interval Δt , as determined by the uncertainty principle:

$$\Delta E \times \Delta t \geq \hbar.$$

At the other end of the flux tube, these positrons would revert back to their protonic state. For this we require Δt small, (compared to the age of the universe), such that a large ΔE is required. We shall discuss this further in due course. For the moment, note that there is a large difference in energy ΔE between a proton in the nucleus and an orbiting fermion, (electron \leftrightarrow positron). Otherwise, the only current will be electronic, not positronic, but the respective monopoles will be depleted during the process of a flare at the same rate, whether there is a positronic current or not.

Now in accordance with our discussions, we see that there are two ways of looking at things. One can regard the process as being a movement of electric charge (electrons) in one direction, from out of the electronic footpoint, and magnetic charge (positrons) moving in the opposite direction, from out of the protonic footpoint, if there is indeed a movement of positive charge (positrons). The problem is, both electrons and positrons have, as we have clearly discerned, electric charges, albeit of opposite polarity. By the principle of duality, we then require that electrons too have magnetic charge, of opposite polarity to that of the positron. When the electron is behaving like an electric charge, the positron behaves like a magnetic charge, as we have seen. Conversely, when a positron is behaving like an electric charge, the electron acquires a magnetic charge.

Let us assign polarities for the magnetic charge. We know that electric charge moves from the negative monopole to the positive monopole, in the case of electrons. Conversely, positrons carry positive charge in the reverse direction, such that these two current-carriers have the same sign for a given direction.

What about magnetic charges? By analogy, magnetic charge of one polarity moves in the opposite direction to that of the opposite polarity, such that again both make a contribution of the same sign to the total magnetic current density. By analogy with the electric case, we require that the positron has a negative magnetic charge and the electron a positive magnetic charge, such that positrons move from the region of negative magnetic monopolarity to the other, positively charged magnetic polarity.

Physical space versus electron wave-space

The introduction to 4-vectors is wrought from special relativity. This is where a physicist firstly, and lastly, encounters 4-vectors. Using the first of 4-vectors, the space-time 4-vector, one transforms the frame of reference into the frame of the (massive) electron, this is what the space-time 4-vector is about, it is about getting in the reference frame of this (massive) electron. The electron has come off a photonic wavepacket, it is no longer propagating at c , it is propagating at v : $0 \leq v < c$. You get in the reference frame of the electron, that is what this 4-vector does.

So you get in the reference frame of this massive electron. You then record the electromagnetic frequency, k_S . If $m_e c^2 = \hbar k_S$ in this frame, then the electron can be incorporated onto the photonic wavepacket, assuming there is a vacancy, i.e. assuming the photon is a dual ghost to begin with. If in “electron wave-space” the photon energy is not equal to the electron rest-energy, then one transforms the electron to a new frame where these energies are equal – then the photonic transformation can occur.

This is why, in physical space, the area of the wavenumber spectrum will not be expected to be a constant. To accelerate a massive electron, ($v < c$), onto a photonic wave, you first have to find out what reference frame you have to go into in order to make the observed electromagnetic energy in the electron frame equal to the electron rest mass, and then to put the electron in that frame. So it is not just a matter of accelerating to c , it is a dual process, put the electron in the correct frame and then accelerate. Some of the energy “goes missing”, or conversely “appears out of nothing”, depending on whether the kinetic energy of the electron has to be increased or decreased in order to put it in the appropriate frame for acceleration.

In accordance with this, in physical space we expect there to be no conservation of energy associated with the wavepacket spectrum. That is, we do not seek a spectrum of constant area. Looking at the proposed wavenumber spectrum in physical space, see Figure 10, it is clear that whilst it is natural to require a constant spectral area in electron wave-space, finding a corresponding spectral area constant in physical space is quite unlikely, particularly given that the relativistic Doppler shift formulae are more complicated than the non-relativistic Doppler shift formulae.

There is a certain Δv involved in this process, associated with a certain energy needed to be given to or taken out of the system in order to accelerate the electron onto this photonic wavepacket, $h\nu$, from physical space. You would expect an energy $h\nu$, but you get an energy, $h\nu \pm \frac{1}{2} m_e (\Delta v)^2$. In the system, there is violation of conservation of energy because energy is escaping from or being added to the system from the outside.

What system is this? It is a system of energy categorization whereupon physical quantisation is associated with conservation of energy, (constancy of spectral area). Now the photoelectric effect is to do with electrons. Massive photoelectrons which are ejected from the surface of a metal, by irradiation whereupon the incident photons transport their energy onto departing electrons of the metal. In physical space, energy conservation is violated and the spectral area is no longer a constant. Energy-wise, you can be inside the metal or outside. There is a separation between physical space and electron wave-space according to the work function ϕ of the metal. Insofar as ϕ might be an electrical potential, we finally have the 4-vector, (ϕ, \mathbf{A}) , although it is not clear at this stage what to do with this 4-vector.

So one is physical space, the other is electron wave-space. Electrons reside at the metallic surface, either in the static case for free charges, or in conduction processes. This is the electron wave-space. The “physical space” is outside the metal. The electromagnetic frequency ν observed from outside the metal is different to that observed when residing on the metallic surface, k_s . A certain amount of energy, ϕ , has left or entered physical space such that the spectral area fails to be a constant by this amount of energy.

What happens to this un-accounted for energy? You have the frequency ν as observed outside the metal. This obeys the non-relativistic frequency transformation. Then you have the transformation into the electron wave-space, whereupon one has a different frequency, $k_s \leftrightarrow \nu_s$. What happens to the unaccounted for energy in physical space? Simply, additional photons $\hbar k_s$ are created or destroyed such that there is an overall conservation of energy. The internal frequency will be connected to the external frequency by the relation:

$$h\nu - h\nu_s = |\phi| \rightarrow h\nu - h\nu_s = \pm \phi$$

depending on the sign of ϕ . Compare this with the “fundamental equation of atomic physics”, the proposition that for a chemical process to occur, it is necessary that the orbital angular momentum quantum numbers for the process satisfy:

$$\Delta l = \pm 1.$$

This is the analogy:

$$h\Delta\nu = \pm \phi \rightarrow (h/\phi) \Delta\nu = \pm 1.$$

The quantum number, l , is called the azimuthal quantum number. For a given surface electron energy, ν_s , a photoelectric current will be produced when the metal is irradiated with energy:

$$h\nu = h\nu_s \pm \phi.$$

Similarly, electrons can move between two atoms in a molecule, (i.e. a molecule will exist), if $\Delta l = \pm 1$ between the two atoms. This is the condition for the existence of currents between atoms. For two atoms joined by an atomic bond, there is a continual flow of electrons between the atoms, from one to the other and back again. This constitutes an

“alternating current” moving one way and then the other, from one atom to the other and back. Since we are concerned with an azimuthal quantum number, we are dealing with the energy at the surface of the metal. Not axially, which describes the internal current, and not radially, which describes the exit of photons into “physical space”. We are only concerned here with surface currents.

When we leave the metal lattice and enter a molecule which is flipping

about in free space, not part of a metal lattice, we retain this “surface description”, except that now we are talking about the surface of an atom, not the surface of a metallic conductor. By analogy with the description for the metal lattice, we determine that there is a radiation from one atom to another and back again will occur according to the above descriptions, the two equations above which we claim are part and parcel of the same physics. We continue the “analogy of surfaces” with a little organic chemistry. Consider the s- and p-orbits of a carbon atom, $l = 0, l = 1$. For two carbon atoms, bonding, we have the required constraint, $\Delta l = \pm 1$. This is the condition for radiation to occur, equivalently electronic photons to move from one atom to the other and back again.

Now it is a surface interaction, according to our analogy, or whatever it is. One brings an s-orbit and a p-orbit together, given that they satisfy $\Delta l = \pm 1$, and there are two ways this can be achieved, as illustrated below.



Figure 41: σ - and π -bonding in organic chemistry, the single versus the double carbon bond

Ghosts and the metallic work function

Supposing an electron leaves a photon, with the formation of a dual ghost. Then if a ghost has the same energy as the departed electron, as per our discussions, don't we end up with $\frac{1}{2} m_e c^2$ more energy than what we started with?

$$\frac{1}{2} m_e c^2 \rightarrow m_e c^2 ?$$

Perhaps the energy is “borrowed” according to the uncertainty principle, with $\Delta E = \frac{1}{2} m_e c^2$ relatively large so that the time scale for the interaction Δt is relatively small, (very much shorter than the universal time scale, obviously). In the figure below, we start with the (rest) mass of a positronic photon, defining it as zero. It decays into a dual ghost and a massive positronic photon. The potential for this is $V = \Delta E$, see above, such that Δt is small. Now what do we know about fermions in nuclei (protons) and outside nuclei? We know, (Trevor Hambley, School of Chemistry, University of Sydney), that there is a huge energy difference between the protons in the nucleus and the orbiting electrons.

In the figure below, we start with the positronic photon, at zero energy. We

take its positron away, such that we have a large rise in energy, V , where the massive positron resides. What about the protonic configuration of the positronic photon? Its energy is hugely different from that of the orbiting fermions. Since electrons and positrons are of the same energy, (by duality), we might conclude that the protonic configuration is only a slight amount of energy above the zero energy, and a long way below the energy of the massive positronic configuration, as illustrated below.

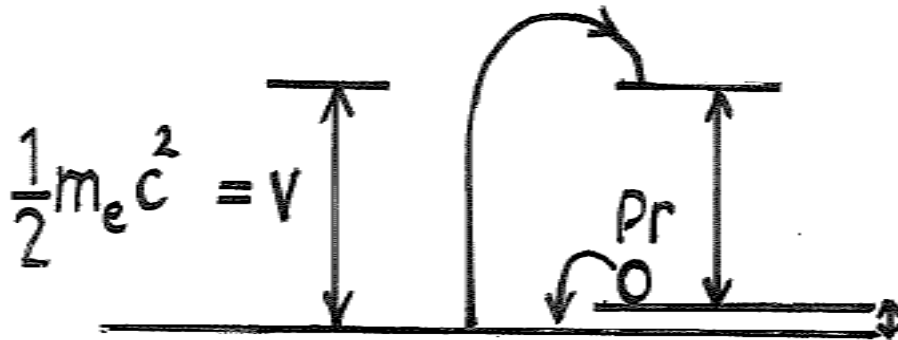


Figure 42: In order to make the energy of nuclear fermions totally outstrip that of orbiting electrons, it is necessary to define a potential such that the potential of the protonic configuration is only larger than that of a positronic photon by a miniscule amount

So we conclude that in the case of the protonic \leftrightarrow positronic photon, the energy potential separating these two states is extremely small, such that the time decay of a proton back into a positronic photon is extremely large, perhaps of the order of the lifetime of the universe.

But wait! This massive fermion, the massive positron, has zero kinetic energy, its energy $\frac{1}{2} m_e c^2$ is a potential energy. Kinetic energy is zero because in electron wave-space there is no velocity of the electron, hence no $KE = \frac{1}{2} mv^2$. When the fermion leaves its photonic wavepacket it does not acquire an energy separate from the ghost it leaves behind; its potential energy is this ghostly energy. You don't count the kinetic energy twice! The massive fermion has the potential to acquire the energy of the ghost on the wave.

With respect to Figure 42 above

Since we require that in order for a solar flux tube to dissipate, there is a dual movement of electronic and magnetic charge, we require that protons at the positive foot-point can "borrow" energy ΔE , ($\Delta E \times \Delta t \geq \hbar$). This very high energy state is such that it is a dual ghost, and will decay back into a photonic (non-dual) state in a very small Δt interval, (very small compared to the age of the universe, that is). The dual ghost is very unstable and not readily observed.

So the positronic photon loses its positron, the latter becoming massive. In the appropriate reference frame, the electron velocity is zero. But whilst the massive positron makes no contribution to the kinetic energy in this frame, ($v=0 \rightarrow \frac{1}{2}mv^2=0$), it nevertheless has the potential for kinetic energy, there is no way of getting around this. It can acquire a kinetic energy $\frac{1}{2}m_e c^2$, if it encounters a suitable dual ghost, accelerating to c the speed of light.

By contrast with the massive positronic state, the protonic state is only a miniscule amount greater than “ground zero” and a very long period of time is required, comparable to the age of the universe perhaps, before it will decay back to the photonic state. So it would appear that immediately after “Let there be light”, a certain number of positronic photons were converted to protons and they would stay in this orbit throughout the subsequent lifetime of the universe, these protons exist through indeed the life-cycles and deaths of stars and the creations of new stars, and their subsequent deaths etc. In such a manner after perhaps four generations of stars, we find a planet in the universe that will support life, and this planet has the minerals from countless fusion processes in the history of the universe. This is the earth, and its protons were there right from the beginning.

Consider the surface interactions, the helical path of electrons at the surface of a metallic conductor. This has a circular component (azimuthal) and an axial component of velocity. With regard to the circular component, there is no movement down through the central axial field, $v_B = 0$. Not $v_B = -E$, the zero Lorentz force photonic state. The surface interaction is a forced state, not a zero Lorentz force state. The surface interaction has the Higgs’ boson in it insofar as we take the limit of zero axial velocity, $v_B = 0$.

Consider the Lorentz magnetic force $\mathbf{F}_m = q\mathbf{v} \times \mathbf{B}$. We have made a 4-vector out of this with the scalar term, $\hbar\omega$. But why do we omit the term q in the 4-vector? Very simply because $\hbar\omega$ is the energy of a single photon, so we require $q = 1$, a single electronic or positronic photon.

- (1) Supposing we vary $\mathbf{B} = \nabla \times \mathbf{A}$, such that the greater the curl, the slower the net velocity, in the case of non-one-dimensional field lines, \mathbf{B} . Electric charges move preferentially along magnetic field lines, \mathbf{B} . Where \mathbf{B} are helical, the electrons follow the helix and consequently make slower progress axially. So this brings us finally to Newton’ s first law of motion.
- (2) By contrast to electric charges moving preferentially along magnetic field lines, where there is movement across field lines \mathbf{B} , it is subject to the Lorentz force $\mathbf{F} = q\mathbf{v} \times \mathbf{B}$.

The two points listed above indicate together that fermions travel as constituents of “fermionic photons”, (non dual ghosts), in an helical

fashion. So let us start with the central (axial) field. Introduce fermions, (massive electrons), into the system. This is an axial interaction. Then pour in more fermions, azimuthally propagated ones, these surface fermions with a Lorentz force. This secondary fermionic interaction occurs at the surface. So as you put energy into the system, axially and azimuthally, no Lorentz force versus a Lorentz force, you acquire indeed a flux tube.

Now (1) above indicates that net (axial) transfer of electric charge occurs at speeds c and below, depending on how large the curl, $\nabla \times \mathbf{A}$, is. When the curl is zero the net transfer of charge occurs at c , the speed of light. This is regardless of what happens to the rest mass or the total mass. In the limit $v_{ax} \rightarrow 0$, (total azimuthal, field lines \mathbf{B} closed), we have the Higgs' boson. The mass in this limit becomes the total mass of the Higgs' boson. Its rest mass is also zero by the "squeeze theorem". The Higgs' boson becomes the only particle whose rest mass is equal to its total mass. The Higgs' boson co-exists with Newton' s first law of motion, the one cannot exist without the other.

Now what do we make of the Higgs' boson having the same rest mass and total mass? In short, the Higgs' boson is stationary in any frame of reference. This is the electron interaction. To accelerate an electron onto a photonic wavepacket or dual ghost, you get into the reference frame of the electron. If in that frame the electromagnetic energy $h\nu = m_e c^2$, then you can accelerate to the speed of light. So the existence of the Higgs' boson is all about getting in the reference frame of the electron; the electron is at rest and then you can see whether the acceleration can occur.

So when we construct the flux tube, in the manner described above, two of the photons in question have a Lorentz force, the ones at the surface. The two internal photons have zero Lorentz force. The internal photons and those of them which are radiated from the system, (dissipation), are existing in physical space. The Doppler shift in question is relativistic Doppler shift. By contrast, for the fermions existing on the surface of the metal, the appropriate Doppler shift is the non-relativistic Doppler shift. We are pouring energy into formation of a flux tube which will dissipate, $\mathbf{J} \cdot \mathbf{E} = |\mathbf{E} \times \mathbf{B}|$, with appropriate dimensional correction. Consider the circular component of the helical interaction at the surface. The centrifugal interaction at the surface results in appropriate photons in the vicinity of the surface exiting the flux tube and propagating into free space. That is what happens when radially directed photons make it through the gap between \mathbf{E} , \mathbf{B} at the surface.

Now the system dissipates at a rate given by $\mathbf{J}_E \cdot \mathbf{E}$ plus $\mathbf{J}_P \cdot \mathbf{B}$. Thus, the system dissipates at a rate given by the rate at which free charges can be loaded into flux tubes, $P = VI$, $I \leftrightarrow dQ/dt$. Only in the case of electromagnetic duality is there any dissipation, in accordance with our previous discussions. If we don' t have any positrons acting at the surface, then we have no internal dissipation $\mathbf{J}_E \cdot \mathbf{E}$ because there is no internal field, \mathbf{E} .

In conclusion, we see that there is something very special about the surface of a metallic conductor. We have seen that the photoelectric effect, $E = h\nu$, occurs from interactions between photons and electrons at the surface of the metal. The surface is where free charge resides statically and where surface currents exist electrodynamically. You are step by step creating a flux tube. The region of “electron wave-space” is defined as the surface of the metal.

So to add a surface current or an internal current is to add a quantity of charge per second from outside the system into electron wave-space. All of this charge will be dissipated into (externally directed) radiation, where duality exists, or there will be no dissipation where only the positronic, or the electronic, currents exist.

The nature of the Higgs’ and magnetic reconnection

It all amounts to the following. There is an “absolute zero” velocity inertial frame of reference with respect to the passage of light. This occurs when in the reference frame of the electron, i.e. when the electron is stationary, in that frame the electromagnetic energy matches the electron rest-energy:

$$h\nu = m_e c^2.$$

The mechanism for accelerating the fermion onto the dual ghost has something to do with this Higgs’ mass-energy.

The conclusion we draw is that in order to give a momentum-less massive fermion a momentum by accelerating it onto an electromagnetic wave packet, there needs to be a recoil to account for this creation of momentum. This is according to the conservation of momentum. The Higgs’, which has a certain rest mass but is always stationary, by definition, can account for the introduction of momentum into the system without going out of its “rest mode” by borrowing this momentum using its energy as a deposit, according to the energy-momentum 4-vector.

$$\text{Energy} = |\mathbf{momentum}|.$$

So the stationary fermion acquires a momentum Δp_x and the Higgs’ recoils with a momentum $-\Delta p_x$. Consider the Heisenberg uncertainty principle.

$$\Delta x \Delta p_x \geq \hbar.$$

Then:

$$-\Delta p \rightarrow \Delta p,$$

Therefore:

$$\Delta x \rightarrow -\Delta x.$$

It all amounts to the connection between the accelerating fermion and the re-coiling Higgs' boson, the displacement of one Δx is a reflection of the other, $-\Delta x$. We need to re-write the uncertainty principle in differentials:

$$dx dp_x \geq \hbar.$$

The massless fermion, existing at the surface of a metal or on the surface of an orbital is in the same space as the Higgs' .What space is this? This space is electron wave-space. We know the Higgs' boson exists at the surface of a metal because it is defined in terms of the limit of a totally azimuthal interaction, in that limit whereupon we know we are concerned with a dissipation, an interaction of axial and azimuthal fields. So for the Higgs' , we are concerned with the limit in which the helical fields actually close in upon themselves and helicity is lost. If we could achieve such a magnetic reconnection, we would have simultaneously have accounted for Solar Flares at the most fundamental level of theoretical enquiry.

This is clearly a surface interaction, the magnetic reconnection would occur at the surface of a flux tube. So it' s all about the appropriate frame of reference, such that this frame is called the absolute zero in velocity. Just as there is an absolute "lid" on velocity, c , so there is an absolute zero. So if you go into the reference frame of the electron, $v_e = 0$, if in this frame of electron wave-space $h\nu = m_e c^2$, then the Higgs' interaction can occur.

This is where we bring the previous "sinh⁻¹ interaction" into it once more. We define an absolute range of velocities in electron wave-space. In physical space, velocities can change by merely changing the reference frame of the observer. Not so in electron wave-space, where velocities are absolute. In electron wave-space, velocities are given by the sinh⁻¹ function, defined as zero, at the origin in the electron wave-space and rising up to the limiting $\pm c$ at the respective horizontal asymptotes. Velocity becomes a matter of where you are with respect to the Higgs' boson stationary frame. It becomes a matter of whether you have to put energy into the system or take it out of the system in order to accelerate an electron onto a photonic wavepacket (dual ghost). If the energies match such that the fermionic interaction can occur, it will instantly proceed. In such a circumstance the frame in which the electron is stationary will simultaneously record an electromagnetic frequency $\nu = mc^2/h$.

Newton' s laws and Faraday' s law

We see that Newtonian dynamics is an illusion; velocities are absolute, not relative. That' s what Newton' s first law is all about. According to

Newton's third law, we have conservation of momentum and energy, simultaneously. $\mathbf{F} \times t = \Delta m\mathbf{v}$ and $|\mathbf{F}| \times d = \Delta(\frac{1}{2}mv^2)$.

- (1) Consider the Higgs' boson. In the appropriate frame of reference, it is stationary. It is always stationary. In an interaction between itself and a massive fermion which is becoming massless as it encounters a dual ghost, it rebounds according to the reaction force in Newton's third law. Now the Higgs' has no momentum, since its speed is zero, but it can borrow momentum to match its energy according to extremisation of the energy-momentum 4-vector:

$$|\mathbf{p}| = \mathbf{E}.$$

- (2) In the same way, a fermionic photon can borrow energy to acquire the massive fermionic state which is a high energy state owing to the instability of the dual ghost.
- (3) Finally, a massive fermion has no kinetic energy or momentum in the Higgs' frame, (speed of fermion is zero), but has the ability to acquire, "borrow" if you like, a certain kinetic energy $\frac{1}{2} m_e c^2$, and equivalently a certain momentum associated with photonic propagation $p = \hbar k$.

So we select a pathway as defined by the passage of light, we vary the speed v of an electron along this pathway. The electron is accelerated or decelerated, energy taken away from the system or added to the system, the "electron wave-space". This occurs until the photon energy in the electron wave-space (frame of the electron) matches the electron rest mass. To get into this state, such that the photonic transformation becomes a possibility, the electron needs to be accelerated one way or the other (acceleration versus deceleration) according to Newton's second law, until the Higgs' interaction can occur.

The Higgs' boson interaction:

$m_e c^2 = h\nu$. Because we have chosen the appropriate dimension along a passageway of light, a vector becomes a scalar;

$$\mathbf{E} \times \mathbf{B} \rightarrow |\mathbf{E} \times \mathbf{B}|.$$

We put it to the reader that the process of accounting for the various "borrowings" of energies in the three manners described above amounts to the realization of Newton's three laws of motion, and that to devise a fully consistent scheme that takes account of energy transfers into electron wave-space in various circumstances and makes sure they all match up. In effect Newton's three laws become an accountancy measure for the uncertainty principle. Presumably further investigation might start with a categorization of the above such that:

$$(1) + (2) \Leftrightarrow (3),$$

and see where we go from there.

Consider Power = $|\mathbf{E} \times \mathbf{B}| = \text{Force} \times \text{velocity } \text{Js}^{-1}$. In the case of a rotational interaction, we have Power = $\tau \cdot \omega$, where τ = torque, and:

$$\hbar\omega = |\mathbf{v} \times \mathbf{B}|.$$

Now it is important to be able to move freely between linear and angular momentum, as we vary between displacement and angular displacement, force and torque. For linear displacements:

$$d\mathbf{p}/dt = \mathbf{F},$$

whilst for angular displacements:

$$d\mathbf{l}/dt = \boldsymbol{\tau},$$

where we are generalising now to angular momentum, \mathbf{l} , and torque, $\boldsymbol{\tau}$.

Faraday' s law

Let' s investigate the Lorentz force. It has magnitude vB , and direction given by the vector $\mathbf{v} \times \mathbf{B}$. Equating this then with the centripetal acceleration:

$$mv^2 / R = vB,$$

$$Rmv / R^2 = B,$$

$$l = R^2 B.$$

Consider now the $(\hbar\omega, \mathbf{v} \times \mathbf{B})$ 4-vector. We are in a position to derive it from first principles, that is, its extremisation. The angular momentum is given by a fermion in a closed circular path \mathbf{B} , and there is a magnetic flux \mathbf{B} through this such that:

$$l = AB,$$

where A is the area of the fermionic pathway and B is the flux through it.

We' re obviously looking for Faraday' s law:

$$\text{EMF} = -d\Phi_B/dt, \text{ and } \Phi_B = AB.$$

We then make the above critical transformations:

$$|\mathbf{momentum}| \leftrightarrow \text{energy } hv, \text{ simultaneously:}$$

$$|\mathbf{angular momentum}| \leftrightarrow \text{energy } \hbar\omega.$$

Then making the latter transformation:

$$l \rightarrow \hbar\omega,$$

by analogy with $|\mathbf{p}| \rightarrow \hbar v$, we find that $(\hbar\omega, \mathbf{v} \times \mathbf{B})$ and not $(l, \mathbf{v} \times \mathbf{B})$ is a 4-vector. We have satisfied the 4-vector requirements if it has eventuated that:

$$\text{EMF} = -d\Phi_B/dt.$$

Supposing the electromotive force $\varepsilon = dl/dt$. The requirements have been satisfied and we have proved Faraday's law from first principles. This leads on of course to the fourth Maxwell equation:

$$\nabla \times \mathbf{E} = -\partial\mathbf{B}/\partial t.$$

Duality and classical electromagnetism

Why does classical electromagnetism lack duality? Simply because classical experimental experimentalists, e.g. Faraday, did not have the technology to observe fermions at high energy. Positrons occur in free space only at very high energies. Classical physicists did not have equipment such as bubble chambers and particle accelerators to observe these high energy fermions. So classical physicists only observed the electrical charge part of the duality, the electrons, and not the magnetic charge part of it, the positrons. Classical electromagnetism completely lacks duality, magnetic charges or positrons do not come into it.

The critical experiment for quantum mechanics and ultimately quantum electrodynamics was the photoelectric effect, and Einstein's interpretation of it. This led directly to the de Broglie expression, and ultimately the Schrodinger equation and quantum mechanics. But at low energies we do not have the emission of positrons when we shine light on a metallic conductor. If we did, Einstein might have got his unified field theory, the dual theory of electrodynamics, by-passing quantum mechanics completely.

However, this is not what occurred. Instead, it has been Dirac and Feynman who have fashioned quantum electrodynamics by applying Einstein's special relativity to quantum theory. This is called relativistic quantum mechanics. The most immediate and fundamental result of Dirac's theory is the appearance of the anti-particle to the electron, the positron, with a negative energy. It is ironic that the work of Dirac and Feynman was based on special relativity, another of Einstein's three ground-breaking papers of 1905, another being the photoelectric effect which we have already discussed. But Dirac used the Dirac equation, not the relativistic Schrodinger equation. It is therefore plausible that quantum mechanics has nothing to do with electrodynamics and quantum electrodynamics, being at its own separate vertex of the duality triangle. Similarly, classical electromagnetism is a long way from quantum electrodynamics. Classical electrodynamics is

waves, and nothing but waves. QED and QTE, by contrast, turn waves into quanta, in the same manner that Einstein turned classical waves into quantized units, with his photoelectric effect. Quantum mechanics, then, is another thing altogether. As we have discussed, QM occurs in consequence of a requirement that the two electromagnetic dualities occur together, not separately, with the consequence that Maxwell's equations have to be ditched because one will not get a solution out of them with both electric and magnetic charges, and one must invent a new equation, the Schrodinger equation, to determine what occurs when electrons interact with positrons, (in a protonic configuration).

The weak force is the passage of entropy, and the strong force is the passage of enthalpy; the unification of particle physics and thermodynamics

We have at the surface of an atomic orbital an electron propagating. Where is the corresponding positron? It is locked into a protonic orbit and is situated in the nucleus. This is the nature of the kind of duality we observe in quantum mechanics; the duality of QTE/QED is of a different nature, as we have discussed, and lies at a different vertex of the duality triangle. The dual Maxwellian equations work the same way whether we are considering positrons or electrons. But not both simultaneously, otherwise we are in the domain of quantum mechanics.

Analogy

The fermions which curl at the surface of a conductor set up internal axial fields making for the passage of electrical current, setting up a potential for internal dissipation, **J.E**, resulting in the release of photons, electronic or positronic, into free space, (Edison's light bulb).

We can make a weak force out of this situation. Consider the propagation of the surface electrons of the electrical conductor. It is an helical motion. One component of its motion is the constant axial movement. Then we have the circular azimuthal component. As in the case of atoms, there is a centripetal acceleration, requiring the emission of photons. In the case of atoms, this will occur after such a period of time that the theoretical quantity of radiation energy over this time period is matched by the propagation of electromagnetic energy associated with the weak interaction. It is different however in the case of the electromagnetic flux tube, however, where the energy is radiated simultaneously with the fermionic acceleration. There is not a timetable for the radiation determined by the uncertainty principle,

$$\Delta E \times \Delta t \geq \hbar,$$

whereupon the smaller the smaller the “borrowed” energy, ΔE , the larger the time frame Δt for the interaction, as we have already discussed with reference to the decay of a proton to a positronic photon.

So starting with QED, QTE, and through duality we wind up at the weak interaction. There is no way this could be achieved through classical electromagnetism alone. Consider the familiar lobed p-orbit. At all points of the orbit of the fermion at the surface, the speed, c , is a constant. With regard to the nucleus, all points of the orbit have a centripetal acceleration, except perhaps where the electron enters the nucleus where the centripetal acceleration v^2/R appears to be undefined, (“ $R = 0$ ”). The only way v^2/R will be defined here, (non-infinite), will be of the radial speed at this point is also zero. Then the centripetal acceleration could perhaps be some constant value as the nucleus is traversed by this electron.

Consider an electron at some point on the orbital, but not in the central position. It is travelling at the speed of light, c , but we are not concerned with its total speed. We are only concerned with the azimuthal component of the velocity, the component of the velocity such that a centripetal acceleration is acquired. This acceleration ultimately will require a release of energy through the weak interaction. This release of energy is akin to the dissipation, $\mathbf{J}\cdot\mathbf{E}$, associated with flux tubes although for flux tubes it occurs instantaneously, not after a (potentially very long) period of time.

Now electromagnetic flux tubes radiate photons of energy but also phonons of heat, which are uncharged. These are called “ghosts”, having parted with their propagating fermions. We’ ll discuss these in due course. For the moment, we’ ll stick to photons, (unghostly).

From classical physics, we associate a dissipation (of heat) such that:

$$\text{Dissipation} = \mathbf{J}\cdot\mathbf{E} = \text{Force} \times \text{velocity}.$$

We associate the force above with the electric field, \mathbf{E} , (that is what an electric field is), and similarly the velocity with the current density, \mathbf{J} . For the axial passage of an internal photon, the axial current density will be in proportion to the axial component of velocity. Similarly for radial movements. Azimuthal movement do not occur in the interior of electromagnetic flux tubes, only at the surface. Similarly, radial movements occur only internally, not at the surface.

In previous discussions in this paper, we have already formed an hypothesis such that the internal field \mathbf{E} of the flux tube supplies a force whereby heat will be liberated, as per classical physics. In due course we shall conclude that ghostly photons (phonons of heat) and fermionic photons (light) are the same thing, but without the fermions deleted in the latter.

Because of Electroweak Unification, we know that there is a weak force associated with the passage of a current in a terrestrial electromagnetic circuit. We conclude that the circular component of the velocity of the surface fermions requires a dissipation $\mathbf{J}\cdot\mathbf{E} \propto |\mathbf{E} \times \mathbf{B}|$ to account for the centripetal acceleration.

Why is it that $\mathbf{J} \leftrightarrow \mathbf{v}$ and not $\mathbf{J} \leftrightarrow \rho = \text{charge density}$? This is a result of our consideration that there are only 4 photons involve, \pm at the surface and \pm internally, such that the only factor that comes into the current, axial or radial, is the axial or radial velocity of the one quantum in question.

We have discussed the centripetal acceleration around the surface of the p-lobe atomic orbital. Perhaps the centripetal acceleration is maximized at the furthest path length around the orbit from central point, (the point where the centripetal acceleration $v^2 / R = c^2 / R$), for at this point the orbital speed c is entirely centripetal. Perhaps! The distance, R , comes into it too, but perhaps speed v^2 wins out over R because it is squared. We hypothesise that the centripetal acceleration is maximized at the (two) extremities of the orbit, and minimized as the electron approaches the nucleus.

Because of this, the weak force is a nuclear force although it is expressed in electromagnetic circuits where the only atomic interaction is that of lattice points in the metallic conductor. Crucially, where there are no lattice points, such as in the interior of a 3D field line, \mathbf{B} , whose surface is defined by $\mathbf{B} = \nabla \times \mathbf{A}$, analogous to $\mathbf{J} = \nabla \times \mathbf{B}$, then there is no dissipation. So where the electroweak force operates, there must be an atomic interaction. Electroweak cannot operate in a region where there are no atoms. This is all good because the weak force is by definition a force associated with atomic decay. Without atoms, even in electromagnetic flux tubes, the weak force cannot operate. The 3D magnetic configuration, where the field \mathbf{B} exists over a region of space, not as a single line at a surface, is such an atom-less entity where the weak force does not operate.

All is well as the $\mathbf{J.E}$ interaction is identically an interaction of an internal current-carrying photon with an internal lattice point such that the photon is deflected and radiates out of the system. Where we have no dissipation, we have no deflection of the internal photons. This is only true for zero resistance, for a given current, such that:

$$\text{Power } P = I^2 R.$$

As R increases from zero an increasing proportion of internal photons are deflected, such that:

$$\mathbf{E} \times \mathbf{B} \propto \text{density of lattice points.}$$

So where we have resistance, we impede the passage of electric current, I , through the conductor axially such that some of the photons are deflected at lattice points and these components of internal current are radiated externally, such that internal photons acquire radial velocities and photons are liberated from the metal.

From this it is a short step to arrive at the fundamental result of QTE, such that:

$E^2 \propto Fl / \lambda$ as $E \rightarrow \infty$, and

$v \rightarrow c$ as $E \rightarrow 0$.

For zero resistance we equate the axial field, $E_{ax} = 0$. Then no internal photons are deflected, such that:

$v_{ax} = c$.

(QTE s.t. $E \rightarrow 0$, $v \rightarrow c$).

So as E_{ax} increases internally, dissipation increases internally, and photons are emitted radially from the interior of the metal.

Electroweak unification

That's okay for p-orbits. The centripetal acceleration is maximized at the extremities and minimized at the central position, (in the nucleus). What about s-orbits? For a constant speed, c , around the orbit, the centripetal acceleration is a constant. Further, the orbit does not pass through the nucleus. Therefore the weak interaction does not occur for an s-orbit, because there is no interaction with the nucleus. In some manner, therefore, variable centripetal accelerations around the orbit are associated with movement through the nucleus and existence of the weak force. s-orbits cannot undergo the weak interaction by themselves. The only way an s-orbit can undergo a weak interaction is in association with another (non-spherical) orbit, for example a p-orbit. Fortunately this is possible because the rule for interactions between atomic orbitals is $\Delta l = \pm 1$, such that an s-p interaction is atomically possible and will account for a centripetal acceleration around the s-orbit whereupon there is the possibility of a nuclear interaction such that the weak force can occur and acceleration of electric charge is accounted for in the Maxwellian fashion, through the p-orbit.

That takes care of s,p orbits. What about d, f orbits. It works according to the same rule for these, $\Delta l = \pm 1$, such that f-orbits only bond with d-orbits, but d-orbits can bond with p-orbits or f-orbits. (s-orbits such that $l=0$, p-orbits such that $l=1$, d-orbits such that $l=2$ and finally f-orbits such that $l=3$). Similarly, p-orbits can bond with s-orbits or d-orbits, (again, $\Delta l = \pm 1$).

Ions in isolation

So what about salts dissolved in water, where e.g. Na^+ , Ca^{2+} , Cl^- , F^- exist in isolation? The anions are not a problem as these are p-block elements and the added electrons go into p-orbits, which can undergo the weak interaction if necessary, since their paths go through the nucleus. What about the cations? These are s-block but cannot exist in isolation, (without ionization), as the outer (valence) orbits are s-orbits. In isolation, the only way these s-block atoms can exist is to lose their valence s-electrons, so that we do not

have $l=0$ electrons outside the atom, which wouldn't be able to exist, in the absence of a weak interaction.

What about electrons in inner orbitals, (non-valence electrons)? Some of these are in s-orbits. So they would be accelerating. So they should radiate. But they cannot, as their paths do not go through the nucleus, hence the weak force cannot operate. We'll address this matter in due course. Indeed, we conclude that inner orbitals cannot carry electric charge at all, even if they are non-spherical. (That is, even if they are p-, d- or f-orbits). Only valence electrons can carry electric charge.

So the internal photonic pathways are habituated by ghosts. We know that ghosts do not carry electric charge. So while there is a centripetal acceleration in all orbits, for internal orbits we do not have an acceleration of electric charge. So there is no potential radiation, and no weak force. What happens to what would have been internal electrons propagating on internal photonic pathways which have vacated these internal pathways to leave internal ghosts? Where have they gone?

Supposing these internal orbital electrons annihilate with their respective positrons (in protonic orbits in the nucleus).

$$e^+ + e^- \rightarrow \gamma_1 + \gamma_2 ,$$

(the fermionic pair becomes a ghostly pair).

Now the rest masses of the electron and the positron, e^- and e^+ , are equal in magnitude and opposite in sign. So these vanish, leaving only the respective kinetic energies.

$\gamma_1 \leftrightarrow$ KE(1), positronic, and

$\gamma_2 \leftrightarrow$ KE(2), electronic.

That is, the energies of the respective ghosts, (one in the nucleus, one in the electronic orbital), are the same as the kinetic energies of the e^+ , e^- prior to the annihilation, (we know that ghosts have no electric charge but have the same energy as the respective fermions). Consider the Schrodinger equation:

$$(\nabla^2 + V) \psi = E \psi .$$

E is the kinetic energy, not inclusive of the rest mass-energy. The rest mass does not come into it. One needs to have the fermionic pair to start with, then put them in an orbital of a given energy which is independent of the fermionic pair we had to start with. For the electron, the total energy is the orbital energy E plus the rest mass energy. Similarly for the positron locked in its protonic orbit, its total energy is the (protonic) orbital energy plus the rest mass of the positron, the latter being the negative of the mass-energy of the electron.

Quantum Chromodynamics

That is what QCD, (the existence of the strong force), is, the negation of the repulsion between nucleons in the nucleus. It does not matter what sort of an atom you are talking about, only one nuclear positron is unghostly, and only one orbital electron is unghostly. The other fermionic pairs annihilate leaving only ghosts in their respective orbitals, (external and nuclear).

So upon consideration of the weak nuclear force, we have annihilation of fermions in the nucleus with the external orbital fermions, leaving only ghosts. And this now accounts for the strong nuclear force, whereupon only one non-ghostly fermion operates in the nucleus, so there is no Coulombic repulsion between nucleons. Only one of the protons has a Coulombic charge. Now as we add protons to the nucleus, these become “ghostified” , and the orbitals are the same as for hydrogen, with the exception that they expand outwards spatially, with a corresponding increase in energy. See “Chemical Physics” , (Farmer, 1997). The ghosts fill the inner orbitals, and since these carry no electric charge, they do not affect the atomic orbital energies. The energies of the atomic orbitals are however affected by the enthalpy changes in the nucleus as we add (ghostly) protons to the nucleus. Indeed we shall see that the strong and weak nuclear forces are expressions of the enthalpy changes inside the nucleus and entropic considerations outside the nucleus, such that the theory of quantum fields will be completely unified with physical and chemical thermodynamics.

Valence electrons

So for a given atom, only one orbiting electron is “de-ghostified” , and this is a valence electron. If there were more than one unghostly orbiting fermion, the Schrodinger equation would be, and indeed has been, impossible to solve, because the potential is no longer a point positive charge in the nucleus, the potential now involves negative charges externally to the nucleus.

This must have something to do with the fact that in atomic bonding → molecular situations, each atom likes to have its valence shell filled, but note this is not universal. Compounds like to have the valence shells of the respective atoms filled, because of quantum field theory as we have discussed, where it is possible, but this is not always possible, presumably owing to spatial considerations where the respective orbital dimensions are such that orbits get in one another’ s way and the valence shell of the central atom cannot be filled.

The Higgs’ boson

The operation of the Higgs’ boson occurs in such a manner that in the appropriate frame of reference, an electron will be accelerated from rest onto the appropriate photonic wavepacket. In this situation the electron loses its rest mass. With this process in reverse, the electron leaving its photonic

wavepacket acquires a rest mass, its speed being reduced from c to zero, such that the Higgs' boson has given the electron a (rest) mass. That is, the Higgs' boson gives particles masses, in accordance with the discoveries of modern particle physics.

So where the Higgs' boson has operated, we wind up with say two ghosts and two massive fermions at rest. If these massive fermions are at rest, then according to Dirac, their rest mass-energies of these cancel;

$$\text{energy}(e^+) = - \text{energy}(e^-),$$

such that it is as if these fermions never existed.

$$h\nu_1 \leftarrow e^- \text{ (orbital electrons)}$$

$$e^+ \rightarrow h\nu_2 \text{ (nuclei)}.$$

That is, to accelerate e^- onto electronic orbitals, we must supply a kinetic energy $h\nu_1$, and to accelerate e^+ onto nuclei, we must supply a kinetic energy $h\nu_2$. The rest masses don't come into it, as we have previously concluded.

Now if zero kinetic energy is required to accelerate e^+ / e^- onto a photonic wavepacket, that means that in the frame where the photon energy $h\nu = m_e c^2$ the fermion is at rest. Hence, according to the de Broglie expression, $p = h/\lambda$, we have an infinite massive fermionic wavelength. Then, for speed c , the frequency $\nu = 0$, such that kinetic energy $KE = h\nu = 0$. We are talking about electron wavelength here, applicable for massive fermions. This is as opposed to electromagnetic wavelengths. The two kinds of wavelength are the same prior to the activity of the Higgs' boson, when the fermion is massless and propagating on its electromagnetic wavepacket.

This is identically what we have already seen in our interpretation of the QTE result:

$$Fl / \lambda \rightarrow E^2,$$

as $E \rightarrow 0$. (The other part of this result, $\nu \rightarrow c$ as $E \rightarrow 0$, we have already discussed above with reference to the weak nuclear force).

Interpretation for the compound, methane = CH₄

Now anyone who knows anything about chemistry will know that methane consists of a central carbon atom, C, surrounded tetrahedrally by four hydrogen atoms. Between C and each H atom, there is a bond consisting of two electrons, one from the hydrogen atom and one from the central carbon atom. The valence shells of C, H are all filled, in accordance with the above discussions, this is desirable. Now the only way this can happen is for all of the four valence electrons for carbon to be ghostly and for the single

unghostly atom in each bond to be supplied by the hydrogen. So each hydrogen has one (unghostly) proton in its nucleus, whilst all the (four) valence electrons of carbon are ghostified. We arrive at this result simply by considerations of symmetry. For carbon, with no unghostly protons in its valence shell, the energy levels arise in a similar manner to how the nuclear energy levels occur for the p- and d-protons, where there is no central potential, (no charged nucleus in the case of carbon).

Rutherford' s gold dilemma

Supposing there is only one interacting (non-ghostly) proton in the nucleus. We fire an alpha particle at an atom, for example in a piece of gold foil. Since an alpha particle is far heavier than a proton, we expect that if an atom is just a mixture of protons and electrons as in Thomson' s "Plum pudding model" , then an alpha particle proceeding into an atom would hardly be deflected as it passed through, even if it struck a direct hit with a proton. But Rutherford and his experimentalists in the Cavendish laboratory performed the experiment and observed that deflections were not insignificant, indeed some of the alpha particles

"bounced" completely backwards. The only way Rutherford could rationalize this result was to hypothesize that all of the atomic positive charge was concentrated in the center of an atom, the "nucleus" , and so when an alpha particle encountered the nucleus it was interacting with a very heavy quantum of positive charge, (the atomic number of gold is very high, 79 in fact, then it is interacting with a mass of positive charge of 79 protons, and the interaction could be significant.

However we have modified Rutherford' s conclusions insofar as the alpha particle is interacting with such a nucleus, however only one of the nucleons, presumably one in the central position, is charged. The rest are ghosts. An alpha particle would not be deflected upon striking any of the ghosts. Ghostly protons however have the same mass-energy as charged protons, it is just that they do not carry electric charge. An alpha particle is not going to be deflected if it hits one of these ghosts. However the ghostly protons interact with the one charged proton in the nucleus, in some manner, holding it securely in position, giving this one proton an effective mass equal to the "classical" , (non QTE), mass of the gold nucleus. Even though it has only a solitary charge, it behaves as if it were very heavy. Therefore an alpha particle can be significantly deflected.

Valency and symmetry

Consider a chemical compound consisting of a central atom surrounded by atoms of another element. In accordance with the above discussions there are two possibilities. The central atom has one non-ghostly proton in its nucleus or none. So too for the surrounding atoms. The bonding must occur in such a manner that these rules are obeyed, and chemical valency is a consequence of this. Where the central atom is entirely ghostly, the weak interaction occurs entirely in the external (surrounding) atoms.

The following discussion is taken from “Chemical Physics” , Farmer, 1997. Consider a nucleus interacting with the s-orbital valence shell of another atom. Prior to the interaction, the s-orbit has to be ghostly as it does not pass through the nucleus and there is no interaction with any other atoms. Let us then expand the s-orbit such that it encounters the nucleus. As it continues to expand, it kind of “bounces off” the nucleus of the other atom and becomes a p-orbital of the secondary orbital, pointing in the other direction. In this manner we have an s-p interaction, whereupon the nature of the chemical bonding is determined by the atomic expression, $\Delta l = \pm 1$. The final result is that each atom has its own s-, p-orbits of the same dimension. That is, for each atom, the s-orbit has expanded or the p-orbit has contracted, such that for each atom the p- and s-orbits are of the same dimension, the p-orbit fits neatly inside the s-orbit.

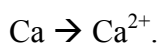
Consider a di-atomic molecule, e.g. H₂ . It is not possible to always have one atom in a p-orbital configuration and the other in an s-orbital configuration, for this would violate the molecular symmetry of the two H atoms.

Therefore each atom becomes a hybrid of two orbitals, s and p. $\Delta l = \pm 1$ is still applicable, but for the constituent atoms, at a given point of time, either the one atom is in s-configuration and the other in p-configuration, or visa-versa. This only works because in the molecular situation, s- and p-orbits have the same dimension. In chemistry there are three kinds of such

“hybridization” between s- and p-orbits. These are called sp hybridization, sp² hybridization and sp³ hybridization. They are particularly important in organic chemistry, where for example a carbon atom in the central position is surrounded by four hydrogens in a tetrahedral geometry.

Salts again

Consider for example Na, Ca, ionized in water. The outer s-orbitals cannot carry electric charge as there is no interaction with the nucleus of this or any other atom in the water. Charge cannot be accelerated as there is no mechanism for the radiation the centripetal acceleration requires. The only suitable solution is to make ghosts of these outer (s-) electrons:



We’ ll see what we can make of this at a later stage of proceedings. In organic chemistry the s-orbits which would not have been able to exist in isolation in the hydrogen atom are now hybridized such that they are a mixture of s- and p-orbits and the nuclear interaction can therefore occur. It is a different situation for salts, where no hybridization occurs. The only way to prevent external non-ghostly s-orbits is through hybridization. One can look at it two ways. Either one considers the one atom to have an external non-ghostly s-orbit and its bonded partner to have a non-ghostly p-orbit, such that the weak interaction for the s-orbit occurs in the nucleus of the p-orbit, or equivalently one simply requires that for each atom the orbitals are

hybridized such that the radiation we expect from the s-orbit of each of the bonded atoms is paid for by the weak interaction occurring in their p-orbit nuclei.

There are two principle kinds of bonding under consideration here, ionic and covalent. For salts, this is ionic. For organic compounds, this is covalent. For the latter, for example in the case of methane, the central carbon nucleus is devoid of any non-ghostly protons, hence carries no electric charge. Yet in the absence of a central electric charge, hence no central potential, we still have the external (from the ghostly nucleus) atomic structure although there are only ghosts in the position of the nucleus. This is in accordance with the Bohr model whereupon one counts to number of wavelengths around a circular (s-) orbit, with no reference to what is inside at the center of this orbit. Indeed it does not matter if there is nothing at the center of the orbit. We shall see in due course that Bohr orbits are uniquely ghostly orbits. Similarly, in the nuclear situation, positronic orbits in protons occur without any central charge or potential, whereas for non-ghostly valence shells the orbits are a consequence of a central potential. This is where we start, at hydrogen, whereupon a non-ghostly electron is able to exist in any of the possible hydrogen orbits, in consequence of the central non-ghostly proton. However, if we add protons to the nucleus, (and electrons externally), these energy levels change, (expand), such that the new energies are determined by the thermodynamic interactions of the nucleus, and have nothing to do with any multiple non-ghostly orbiting atomic fermions. This has led generations of chemists around in circles, trying to solve the Shrodinger equation for multiple non-ghostly orbiting electrons, which simply do not exist. This is the difference between ionic and covalent bonding.

So we conclude that the Bohr model is a model of ghosts. s-orbits by their nature have to be ghostly except where interactions occur with other atoms, hence other orbitals. p-, d- and f-orbits can be ghostly or otherwise, indeed even in the case of a solitary atom where no bonding has occurred with any other atom. So in aqueous solution, for example, Na, Ca have to find e.g. a chlorine atom, Cl, to offload their electrons onto. This is not a problem, as the valence shell of Cl is a p-orbit, hence can incorporate a non-ghostly additional electron.

Protons

We have hypothesized that protons consist of positrons locked in p- and d-shaped orbits, with an external circular “ghostly” orbit such that the nucleons (protons) have a spherical shape, in accordance with our expectations. f-orbits are not possible because their complicated geometry is not consistent with an external circular orbit. The protonic orbits are a combination of “ghostly” orbits and orbits that have the potential to be unghostly. Interestingly, there is in chemistry, (as opposed to nuclear physics), a d-orbital that is similarly a combination of a necessarily ghostly (circular) orbit and an orbit that has the potential to be unghostly. If you take the four-lobed d-orbital and rotate about one of the axes, you acquire a different looking d-orbital which looks like a p-orbital with an axial ring at

the “equator” . In the atomic case, (as opposed to the nuclear), the necessarily ghostly and potentially unghostly orbits do not touch, whereas in the nuclear case the external s-orbit is in contact with the central p-, d- parts of the orbit.

The f-orbital in chemistry is analogous, excepting that it has two equatorial rings about the central p-shaped orbit. So where there are combinations of necessarily ghostly orbits and potentially unghostly orbits in an atom or in its nucleus, there are two such orbits in the nuclear case (positronic pathway) and there are similarly two such orbits in the atomic case, (electronic pathway). Of course, we seek a reason for this, it “cannot be a fluke” , in the words of Einstein with regard to his General Theory of Relativity, whereupon the solution to the equivalence of gravitational and inertial mass is that in a gravitational field, we have a curved space-time.

So let’ s take a positron in a p-protonic orbit. By a simple rotation of 90 degrees about one of the axes of symmetry, the axis that passes through the centre of the “p- “ orbit, not through its lobes, one acquires something that looks like the above discussed d-orbit, the one that has an equatorial ring. In this process, with a rotation of 90 degrees, we go from a positronic pathway to an electronic pathway:

$$e^+ \rightarrow e^-.$$

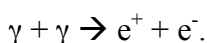
Thus, the fundamental difference between electrons and positrons, (matter and anti-matter), is that the one is out of phase with the other, that is, they have a phase shift of 90 degrees. Consider Maxwell’ s electromagnetic radiation. The solution to the wave equation is $\exp(i\theta) = \cos \theta + i \sin \theta$. There are two components of this solution, the electronic and the positronic photon, and we know that a sine wave is out of phase with a cosine wave (by 90 degrees). Electrons and positrons are exactly the same thing, except with a phase difference between them. This is why we require the electromagnetic duality. And its consequence is that we also have dualities in “String Theory” , which leads onto “M-Theory” , which has a five-fold duality which physicists and mathematicians have concluded is the basis for the much sought after theory of “Quantum Gravitation” . M-theory is therefore “11-dimensional Supergravity” , in some manner which is yet to be determined.

Next, consider the protonic d-orbit. We have the central four-lobed orbit with a ghostly s-orbit touching the extremities of the four lobes. In the usual manner, rotate about one of the d-axes, an axis passing through two of the lobes, not between lobes, such that we acquire a p-type orbit with an axial ring and with the original protonic ghost that provides the spherical nature of the proton. It is now up to the reader to convince her or himself that we can rotate this original ghostly orbit about one of the axes, by 90 degrees, such that we get an f-orbit, consisting of the familiar p-shaped orbital with two equatorial rings.

Back to ionic interactions

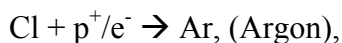
Consider again Ca^{2+} , which wants to lose both of its valence electrons, to be ghostly in isolation, (in solution), such that the weak force can operate. But we are not allowed an atomic charge of +2 because we are only permitted one non-ghostly proton in the nucleus. Let's start by removing just one of the valence electrons. This new entity, " Ca^+ ", has just the one non-ghostly proton, as always. Let's now remove a second electron. The second electron goes onto for example $\text{Cl} \rightarrow \text{Cl}^-$, as for the first electron that we removed. But how do we acquire two electronic charges with only one unghostly proton in the nucleus?

At every stage of proceedings it is always a possibility to create new unghostly e^+/e^- pairs out of internal ghosts:



In this manner we can supply new unghostly protons, where they are required.

So let us remove a second electron, from " Ca^+ ". It is now hypothetically a Ca^{2+} ion. We take the electron from one of the ghostly pairs in the vicinity of the valence shell, leaving an unghostly positron, in the nucleus. We now have two unghostly protons in the nucleus, which in accordance with the above discussions is forbidden. The target of the secondary forbidden unghostly proton in the Ca nucleus is a Cl atom. Consider Chlorine, Cl. We have taken an unghostly electron and put it onto Cl. We have a forbidden secondary unghostly proton in the Ca nucleus, whose target through the weak interaction is the Cl atom. When the unghostly proton is eventually transferred to the Cl atom, through the weak interaction, the original unghostly electron and proton of Chlorine are "ghostified", such that a secondary chlorine atom acquires a new unghostly electron, from Calcium, and ultimately will acquire a new unghostly proton, by weak decay, from Calcium. Ultimately, we have the transformation:

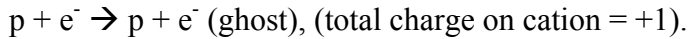


and this in some manner accounts for the unreactivity of the Noble gases, whereupon Cl occurs to the left of Argon in the periodic table, and conversely Ca occurs on the other side, to the "right" of Argon.

Then prior to the weak "decay", we have ions in solution, the charge on one chlorine being the secondary unghostly electron that has departed from Ca, and an effective charge of +2 on the calcium, whereupon this additional nuclear unghostly proton is forbidden from interacting with the electrons of Ca until such a time that the weak decay occurs. When the weak interaction occurs, the extra energy that would have been expected in accordance with our situation of having two positive charges in the nucleus interacting with its orbiting electronic charge is (eventually) radiated.

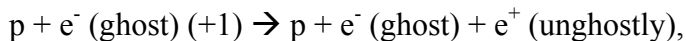
Now the second non-ghostly proton in the nucleus is there only on borrowed energy, $\Delta E \times \Delta t \geq \hbar$, such that we have a weak nuclear interaction, potential $V = \Delta E$, which is very small, such that Δt , the time frame over which the interaction occurs, is very large, by the uncertainty principle. This second unghostly proton will ultimately be ejected or its charge will at least, via the weak nuclear decay.

Let's have another look at this situation. Firstly, we take an unghostly electron from our atom, leaving a cation, +1, and a ghostly electron.



Then, we create a fermionic pair out of a couple of ghosts in some atomic orbital, $\gamma + \gamma \rightarrow e^+ + e^-$.

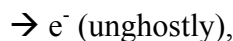
We take one of these fermions, e^- , off and put it onto another Chlorine $\rightarrow Cl^-$. The cation now has an effective charge of +2, as we require.



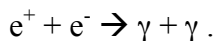
(total effective charge on cation = +2).

Now we have a potential positron, e^+ , from our cationic nucleus. $p \rightarrow e^+$. So we have two unghostly positrons to deal with. Now with a 90 degree rotation, we can put one of the positrons onto e^- (ghost), which is a dual ghost. We have then just the one unghostly nuclear proton.

So we have an unghostly electron, e^+ + 90 degree rotation + e^- (ghost)



and this fermion will ultimately be radiated in the weak decay. We already had weak decay with a positive messenger particle. Now, with a rotation of 90 degrees, this becomes the anti-particle, the negatively charged messenger particle. We know the weak interaction has positively and negatively charged messenger particles and neutral messenger particles. We can acquire the latter by the now familiar transformation:



Hence we construct ghostly (neutral) messenger particles also for the weak interaction.

Where does radiation come into electroweak?

The extra proton in the nucleus, in the instance of positive messenger particles, does not interfere electronically with proceedings because it is constricted to do this only in a time frame Δt large, and until that time things just continue on electromagnetically as if that extra non-ghostly proton in the nucleus were not there. It is "put away to be used later". Perhaps the

time frame for weak nuclear decay is the same as the time frame for decay of protons to (unconstructed) positronic photons, thought to be perhaps in the time frame of the existence of the universe. As we have discussed previously, the proton will ultimately decay into a positive particle, this being a positronic photon, (see previous figure). This is the particular kind of nuclear decay we are looking for, but what is its half-life ? That is, the time frame over which the accelerating electron would need to decay to provide the theoretical electromagnetic radiation, that is what we are looking for.

Highly radioactive substances are quickly lost to decay, while those that (hypothetically) radiate weakly endure longer. Half-lives of known radionuclides vary widely, from 10^9 years for very nearly stable nuclides to 10^{-6} seconds for highly unstable nuclides.

Chemical shielding

Chemists have devised ways of accounting for the behavior of nuclei and orbiting electrons in terms of multiple non-ghostly nucleons and multiple non-ghostly orbiting electrons. The nuclei are not a problem, it makes no difference qualitatively whether the nucleus has a single positive charge or multiple positive charges in terms of the solutions to the Schrodinger equation. However when one adds additional orbiting non-ghostly electrons, the potential becomes a function of the orbiting electrons too, and it becomes impossible to solve the Schrodinger equation exactly, it can only be done by approximation. An approximate qualitative solution is described in terms of chemical shielding. The effect of hypothetical internal non-ghostly electrons on the valence electrons is such that the effect of the nuclear potential is modified by the inner electrons which are situated between the nucleus and the valence electrons. The fact that this description works, qualitatively, although the hypothetical multiple non-ghostly protons in the nucleus are nonsense, and so are multiple orbiting non-ghostly electrons, must have something to do with the time frame for chemical decay of various chemical substances. That is, we need to understand the weak nuclear force and radioactive decay before we are in a position to come to grips with the fact that chemists appear to have a qualitative explanation for atomic interactions when in fact the non-existence of exact solutions for multiple electrons appears to indicate that there is something incorrect about the manner that chemists have gone about things.

Spin and angular momentum

Spin is just a kind of angular momentum. So spins can simply be added to angular momenta. So for say electrons, spin $s = \pm \frac{1}{2}$, as we go from one configuration to the other we have a change in orbital angular momentum $\Delta l = l_1 - l_2$

$$= s_1 - s_2$$

$$= \pm \left(\frac{1}{2} - \left(-\frac{1}{2}\right) \right) = \pm 1.$$

Then $\Delta l = \pm 1 \leftrightarrow \Delta\phi = \pi / 2$ (= 90 degrees),

such that the rule for molecular interactions between atoms in all its simplicity has something to do with the two possible spin configurations. We have already in this paper made an equivalence between $\Delta l = \pm 1$ and a similar equation involving certain physical variables, we have now done this a second time in terms of the fundamental result that electrons and positrons in a given fermionic pair differ only in a phase shift of 90 degrees.

This accounts for the fact that photons have possible spins 0, ± 1 , whereas electrons / positrons have spins $\pm 1/2$. In a nucleus, each positron e^+ interacts with its external partner, an electron e^- , in a ghostly fashion or otherwise, and not with any other electrons unless these electrons share the same phase difference as the original positron, (which is highly unlikely). At the point of fermionic creation, $\gamma + \gamma \rightarrow e^+ + e^-$, the respective fermions are 90 degrees out of phase with one another, but this has nothing to do with the absolute phases of other fermionic pairs. For a given pair;

Consider the weak interaction, whereby a ghostly s-orbit must be transformed to a possibly unghostly p-orbit in order that the weak interaction can occur and centripetal accelerations around atoms can be accounted for. Therefore one might say that the weak force is an absence of ghosts. Conversely, we are by now completely aware that the strong force is an absence of fermions, (presence of dual ghosts). This is the difference between the strong and weak nuclear forces. The weak force vanishes when fermions \rightarrow ghosts. The nucleus is held together by an absence of fermions. What can we therefore deduce about the strong force?

fermionic (massive or otherwise) $e^+ + e^- \leftrightarrow \gamma + \gamma$, such that:

fermions + dual ghosts \leftrightarrow strong = absence $\Rightarrow \Leftarrow$ weak = absence.

That is, the weak force drives the equilibrium in one direction, while the strong force drives the equilibrium in the other direction. The position of the equilibrium, $e^+ + e^- \leftrightarrow \gamma + \gamma$, is determined by the relative strengths of the weak and strong nuclear forces. This is what a chemical reaction is, with its equilibrium constant K_{eq} , it is an interaction between the weak and strong nuclear forces.

Consider “fermions + dual ghosts \leftrightarrow ” , (massive fermions) , above. When massive fermions self-annihilate, the dual ghost energy is altered such that the equilibrium to the right, above, is altered:

\rightarrow LHS = RHS

That is, a quantity of heat is a quantity of electric charge when fermionic annihilation occurs $\rightarrow dH \leftrightarrow dQ / T$, where dH is a quantity of heat (energy) while dQ is a quantity of electric charge.

Thermochemistry

Consider Boltzmann's kinetic theory of gases. If you put some gas molecules in a small box in the corner of a larger box, then remove the constriction defined by the smaller box, then the gas will expand to fill the room. The expansion process is termed an increase in entropy. The reverse will not happen, any time soon at least. If you put the gas molecules in the larger box, they will not spontaneously assemble themselves back into the boundary in the corner defined by the small box. If they did do this, it would be a spontaneous decrease in entropy, which is forbidden by the second law of thermodynamics. There is however a process known as the "Kac Ring", which says that ultimately repetitions will occur and the gas will eventually spontaneously go back to its low entropy (highly ordered) configuration, although this would be on a very large time scale, perhaps akin to the age of the universe, it has been suggested. This reminds us of the time scale for the decay of a proton into an unconstructed positronic photon, which we have also hypothesized to be on a time scale of the order of the lifetime of the universe. It is highly likely there is some connection here.

So let's take an "entropy box", with a hole in it for particles to get through. Outside the box, we have a nucleus that can undergo a weak decay. We direct the messenger particles of the decay through the hole in the box. Then as the box gets filled with messenger particles of the weak interaction, the system "spontaneously" becomes more orderly, the change in entropy ΔS negative. We now have a "potential for disorder", which can drive thermodynamic processes. Similarly, if one has two heat-carrying bodies, one at a higher temperature than another, there is a thermodynamic potential whereupon heat will spontaneously flow from the hot body to the cold body, but not in reverse, unless there is an accompanying process of entropy increase such that the total entropy for the two processes increases. The flow of heat from hot to cold can similarly drive thermodynamic processes.

So in the thermodynamics of chemistry, there are three processes that together determine whether a chemical reaction will occur, the flow of heat (enthalpy) from one place to another, the spontaneous expansion of a gas, and finally an increase in the degrees of freedom of a molecule. These three are all kinds of entropy exchange. In chemistry we are principally concerned with the flow of heat energy from one molecule to another, and with the increase in molecular degrees of freedom. We are not generally concerned with the kinetic entropy, (above), although we are about to get concerned with it. Chemists use a thermodynamic quantity known as the Gibbs' free energy, $\Delta G = \Delta H - T\Delta S$, where ΔH is a quantity of heat, T is the temperature, and ΔS is associated with molecular degrees of freedom. This is likely to cause confusion, because in fact both of the terms on the right hand side are types of entropy. What chemists mean is that the chemical process is determined by $S = \text{degrees of freedom entropy}$, and the other kind of entropy, associated with flow of heat is $\Delta "S" = \Delta Q / T$, where ΔQ is a quantity of heat. The chemical process will then spontaneously occur if the change in G , the Gibbs' free energy for the process is negative.

Now the spontaneity of a chemical reaction is determined by the equilibrium constant, K_{eq} , which is a function of ΔG , the change in the Gibbs' free energy. The latter, as we have mentioned, is a function of the enthalpy (heat) and the entropic degrees of freedom. This determines the concentrations of the various molecules in the system at equilibrium. However we have described above a similar kind of equilibrium involving the weak and strong nuclear forces, for the process $e^+ + e^- \Leftrightarrow \gamma + \gamma$, whereupon the weak force drives the process in one direction and the strong force in the other direction. The position of equilibrium is determined by the relative strengths of the weak and strong nuclear forces for the process.

We obviously seek to unify these two processes, whereupon chemical thermodynamics (thermochemistry) is identically an expression of the weak and strong nuclear forces. We have described above the process whereby kinetic disorder (entropy), S , is an expression of the weak nuclear force, and enthalpy (heat), H , is an expression of the strong nuclear force.

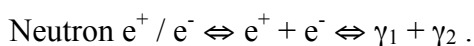
Transfer of enthalpy = the strong nuclear force

Consider a transfer of heat such that a massive positron or a massless positron on a certain energetic photonic pathway γ (not protonic but will be) moves into the nucleus. It interacts with a neutron, removing its electron to create a proton.

Now as soon as we introduce $\gamma + e^+$ inside the valence shell on its way to the nucleus we leave $\gamma + e^-$ at the surface. The existing non-ghostly nuclear fermion and its orbiting electronic partner disappear into a ghostly existence.

The massive electron stripped from the neutron and the incoming massive positron, (having left its photonic pathway γ), self-annihilate, creating two ghosts, $\gamma_1 + \gamma_2$. The newly created non-ghostly electron left behind at the surface takes its place in its atomic configuration outside the nucleus, such that the energy of the orbit = γ . The net effect is one less neutron in the nucleus. The incoming positron, γ_1 , will be able to interact with the nucleus if its energy γ_1 is that of a p- or d-positronic orbit in a proton.

We know a neutron is a proton and an electron united in some fashion. We devise the following "equilibrium" :



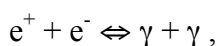
Consider the kinetic energy $\frac{1}{2} mv^2$. Where the total masses of electron-positron at speed v are equal, (but opposite in sign as they always are), self-annihilation of these massive fermions can occur, creating the ghosts we observe on RHS of the above equilibrium. We then conclude that the movement of a neutron externally is equivalent to the movement of a dual ghost externally. A neutron then is nothing other than a pair of dual ghosts, moving in unison, (they have the same speed, they are united in some fashion). We' ll eventually conclude that a phonon of heat is a dual ghost.

Now a phonon of heat, hypothetically a dual ghost or a pair of them, carries ghosts, i.e. mass-energy, (but not electric charge). When we compare different forms of entropy for the system such as degrees of freedom, (-klog w), or heat entropy $\Delta Q / T$, we do a similar thing to our comparisons of kinetic entropy (Boltzmann, weak interaction) with other forms of entropy.

Take a hydrogen atom. Introducing new protons, in the manner above, we build up the hydrogen energy levels by incorporating ghosts at ever increasing energies. They have the same energy as the uni-electronic hydrogen with its single electron in the various orbits, but they have no electric charge, so their presence is not (directly) felt by the orbiting unghostly valence electron, and the energy levels are not altered by the presence of the internal ghosts. The energy levels do expand however, as we add protons. See Farmer, “Chemical Physics”, 1997. But it has nothing to do directly with the additional orbital electrons, it is more to do with thermodynamic considerations of nucleons.

Supposing we consider an additional proton incorporated into the nucleus as being equivalent to our nuclear decay, where we take messenger particles from nuclei in one location and beam them through an opening in an “entropy container”. In a similar fashion we beam a positronic photon inside the boundaries of the nucleus, however these may be constituted, such that the total order (negative disorder) of the nucleus increases. This orderliness can drive various nuclear and therefore chemical processes.

Relatively speaking, in this process of adding protons the strong force becomes relatively weaker, as a larger quantity of positive charge in the nucleus has its positive charge nullified. The fermionic-ghost equilibrium is driven in a particular direction by the increased orderliness of the nucleus. Consider:



in the vicinity of the valence shell as we add protons to the nucleus and electrons externally. The above equilibrium goes from totally to the left to totally to the right as the entropy front moves through the various external orbital energy levels. We call it the “entropy front” because it is associated with the increasing nuclear entropy associated with the additional protons. They get through the boundary of the nucleus as positronic photons but can interact inside if they have the correct energy.

What about the neutrons we are continually removing to increase the atomic number of the atom? Perhaps matter originates in the Big Bang as protons (hydrogen nuclei) with all manner of number of neutrons (quanta of heat, things are very hot inside the Big Bang), and the nuclei with increasingly larger numbers of neutrons have the potential to ultimately acquire similar numbers of protons.

Now we might anticipate that two ghostly photons $\gamma_1 + \gamma_2$ can only self-

annihilate to create a fermionic pair $e^+ + e^-$ if they have sufficient energy to account for the mass-energies of the two fermions. However we expect the energies of the two fermions to have opposite sign, in accordance with the result of Dirac. When these are equal and opposite we have the fermionic annihilation whereupon the above equilibrium is driven completely to the right.

Now the process of adding a proton and removing a neutron is equivalent to having an electronic messenger particle exiting from the atom in an external direction. (The oppositely moving protons cancel). This is a charged messenger particle of the weak force. The electron or messenger particle is a moving electron (entropic) front at the atomic surface as we add fermions; it is as if the unghostly electron at the surface (valence) is moving outwards at a certain speed. This governs the movement of electric charge (unghostly) from one orbit into another orbit of a different energy. Then by a process we have already devised or the reverse of it we can similarly account for positively charged messenger particles of the weak force.

Supposing we select the appropriate frame whereby $E = hv = m_e c^2$. We take an electron or positron off to create a dual ghost and a massive stationary fermion. The (dual) ghost energy = $(\frac{1}{2} m_e c^2) \times 2 = m_e c^2$. The kinetic energy of the massive fermion is zero, as its speed is zero. So the total energy is still $m_e c^2$. But this massive electron / positron still has the potential to accelerate to c , although its total energy \Leftrightarrow rest mass energy will not change in this process. When it is incorporated onto the photonic wavepacket it has lost its rest mass, but its new total mass is the same as its rest mass was before making the transformation.

Now $\gamma + \gamma \Rightarrow e^+ + e^-$ is forbidden unless energy $(\gamma + \gamma)$ sufficient? Let' s investigate this a bit further. If electrons have positive energies, then positrons have negative energies, don' t they? (Dirac). Supposing we observe an electron (positron) travelling at a speed v_e , and a photon moving in the same direction with a frequency ν_{em} . If we have to accelerate the electron / positron in order that in the electron frame $h\nu = m_e c^2$, then we say we have a negative energy. If we must reduce its speed to achieve this, we say it has a positive energy. Where an electron and positron move in unison, such as in a neutron, the total (kinetic) energy is zero as v^2 is the same for both, whereas their mass-energies are the opposite of one another. Where $h\nu = m_e c^2$ in the electron reference frame we have the zero energy. In the original frame (not the fermion frame), we observe the fermion get aboard the (ghostly) photon, but the electromagnetic frequency we observe does not appear to correlate with the existence of a massless fermion. Note that we are dealing exclusively with kinetic energies here, $\frac{1}{2} mv^2$, or photons, $(\gamma + \gamma)$, of energy. We are not interested in the mass-energy associated with a stationary fermion, its "rest mass energy", we are only concerned with the energy of its orbit.

So where $h\nu = m_e c^2$ in the frame of the electron, we have the zero energy. That is, energy $(e^+) = -$ energy (e^-) . We conclude that positronic / electronic

photonic fermionic pairs can appear out of empty space, in the absence of any (ghostly) photons, $\gamma + \gamma = 0$.

Now photons can carry positive or negative energies, (electronic or positronic), in accordance with our above discussions. This corresponds to the Poynting vector $\mathbf{E} \times \mathbf{B}$, the rate of transfer of energy in the wave, positive or negative. In accordance with our previous discovery that electrons and positrons are the same thing, only 90 degrees out of phase with each other.

We might consider therefore that if we take an electromagnetic wave and rotate it by 90 degrees such that $\mathbf{E} \rightarrow \mathbf{B}$, $\mathbf{B} \rightarrow \mathbf{E}$, (who knows at this stage what happens to the relative phases?), then $\mathbf{E} \times \mathbf{B}$ reverses in sign. The wave now carries a positron and not an electron. The energy flows in the other direction because we have reversed the mass-energy of our fermion.

We observe that for an electromagnetic wave, rotation by 90 degrees changes the symmetry of the weak force, unlike 90 degree rotations in regular 3D. And unlike the strong nuclear force. This is the nature of the symmetry of the weak force.

See “Symmetries in Particle Physics” , Quantum Fields and Fundamental Forces, Imperial College, London, 1999, and
“Tachyons and Broken Symmetry” , Masters’ thesis, QFFF, 2000.

This is why the weak force is classified separately from the strong force, because of this broken symmetry. Now because we are concerned with Electroweak, we are concerned with positive charge moving in one direction and / or negative charge moving in the opposite direction. In this instance there is a net transfer of electric charge and energy. Otherwise, we are concerned with “photons in free space” , whereby we have an equal mix of positive and negative, so no transfer of electric charge, but we do have a net transfer of energy $\mathbf{E} \times \mathbf{B}$.

Consider for a final time:

$$e^+ + e^- \Leftrightarrow \gamma + \gamma = 0,$$

such that mass-energy (e^+) = - mass-energy (e^-). This is a neutron, created out of nothing. Because the total energy is constrained to be nothing, the e^+ / e^- cannot get away from one another. In Quantum Field Theory, this is called positronium. The positron is not locked in any kind of protonic orbit. Such an entity can travel at any speed except perhaps c itself, for the electron and positron interact with each other independently of the speed of the observer. We observe this is true in radioactivity, neutrons do have variable speeds, indeed only relatively slow moving neutrons can interact with an unstable nucleus to cause radioactive decay. But there is no mass-energy in positronium.

Now a neutron is stable against decay because it has no net energy. It is happy to bounce around in a nucleus indefinitely. Or whatever it does inside there. Only if we add energy, either $\gamma + \gamma$ positive or $\gamma + \gamma$ negative, whereupon this positronium decays to rectilinear propagation of electrons and positrons (potentially protonic orbits, if the γ energy is appropriate), will the transformation from positronium to fermions occur.

$$n(\text{positronium}) \pm \text{energy} \Leftrightarrow p^+ + e^-.$$

Positronium

We have discussed above a mechanism by which electron and positron can travel simultaneously at a speed v , such that:

$$\begin{aligned} \text{KE} &= \frac{1}{2} v^2 (m_e + m_p) \\ &= 0, \end{aligned}$$

(since the energies are negative of one another. The rest mass of the electron and positron doesn't come into it. These massive stationary fermions are introduced from elsewhere. Then these (potential) neutrons can travel at $0 < v < c$. In the principal reference frame the fermions are massive but stationary, such that there is no kinetic energy KE in $\gamma + \gamma = 0$. But we can alter the speed of the observer such that speed of "neutron" > 0 . "v" is the speed of the center of mass of the positronium. The constituent electron and positron are tumbling around each other like clothes in a drier. But the center of mass of the positron and electron together move as if they were attached to each other in some manner and undergoing a strictly rectilinear motion. The central argument is that when $\gamma + \gamma = 0$, in the principal reference frame the positron and electron are stuck hopelessly together with no kinetic energy, (the rest mass of electron and positron does not come into it, they are introduced from elsewhere). Finally, by introducing appropriate energies $\gamma + \gamma$, this positronium can be converted to proton + electron.

Evidentially, the positronic photon we beamed at a nucleus and fine-tuned to the protonic energy, creating an electronic messenger particle for the electroweak force, exiting the system, is identically the quantum of energy we add to positronium (energy = 0) to convert to proton plus electron, and this quantum of energy is none other than the mass-energy of the Higgs' boson which counters the electronic acceleration from zero velocity / momentum to momentum $p = \hbar k$.

$$E = p^2 / 2m = \hbar^2 k^2 / 2m.$$

James Russell Farmer, 28 January, 2015.

