Introduction

Nature can only do simple things.

The processes described by Newtonian Mechanics and Maxwell's electromagnetic theory are simple enough and we can understand how nature works through the geometry of objects and fields to produce the result we mimic in our calculations.

Not so with Quantum Mechanics. To quote its most famous advocate who urged his audience: "....not to turn away because you don't understand it. You see, my physics students don't understand it either. That is because I don't understand it. Nobody does." (Feynman.)

This is where rational science abandons logic and asks the student to take a leap of faith. For those gifted with mathematical skills and with the right background knowledge, the study of wave equations and the Quantum Mechanical model of the hydrogen atom are easy enough to follow and reproduce in an exam. Beyond that, only summaries of the results of calculations are taught because it would be far too time consuming to even attempt to work through them in lectures. The wave equations can exist well enough on paper, or in computer programs, but how might nature enact them?

The most readily observable thing which shows quantised behaviour is the vibrating string. With this example in mind, the quantised energy levels of the atom were imitated by solving a wave equation. As the theory developed, the so called "quantum waves" which were described by the wave equation solutions grew in the imaginations of physicists until they seemed real. Max Born who was the genius behind one of the mathematical representations of the theory believed that they were no more than statistics. Every result required two observations, one before and one after the process which was being observed. Both observations were governed by the uncertainty principle. The first introduced a random element and the quantum mechanics provided a statistical analysis of the consequences.

To go further and assert that nature works though the mechanism of these probability calculations requires the philosophical interpretation that in between observations, the particle has no definite existence. This may be a simple leap of faith for those whose minds have been contaminated by Existentialist thinking, but not so for those of us grounded in the science of Newton and Maxwell.

The course that Physics took in its development was dictated by the historical accidents of the order in which things were discovered. Two essential ingredients to any rational understanding of the atom were missing: the discovery that magnetic flux is quantised and the ability to perform the itterative calculations which lead to Chaos theory.

Newton's equations describe the process of change in the instant of time. The force of gravity on an orbiting planet acts in the infinitesimal element of time dt to produce a change in velocity dv. During that time, the planet moves a distance $v\,dt$. That much we know. To find out more Newton had to invent the calculus and solve the differential equations to prove that over time, the planet moves in an elliptical orbit. Add a third body to the sun, planet system and the differential equations cannot be solved. The only alternative is do it the way nature does it calculating the changes in velocity and position in each infinitesimal element of time. We can cheat and use minutes or hours for our δt when dealing with planets, but performing a whole set of such calculations to form a whole orbit requires very fast and very accurate computing. When computer technology reached the required capability, Chaos theory emerged. We now know that complex systems produce pseudo random behaviour.

In the absence of this understanding, the random nature of radioactive decay seemed evidence enough that Newton's laws did not work at the atomic scale. Maxwell's electromagnetism also presented a problem in that it predicted that an accelerating electron radiated energy. Only when we take account of the quantised nature of magnetic flux do we realise the limitations of scale. What is true for a magnetic field of billions of quantum strands of magnetic flux is not necessarily true for one of only a few such strands. Indeed, the word strand becomes inappropriate and in the extreme example of a hydrogen atom in its ground state, a single quanta of magnetic flux wraps the electron orbit in a tight tunnel.

In the following paragraphs, we will simplify our discussion by assuming that the electron orbits the proton. A more accurate analysis is left for other sections.

Electromagnetic theory gives us a relationship between the energy stored in a loop of magnetic flux and the current which threads it. Spectroscopy gave the data which lead to the orbital model of the hydrogen atom and allowed us to calculate an accurate value for the orbital frequency. This gives us the current. Orbital mechanics and a knowledge of the charge on the electron and proton allow us to calculate the orbital kinetic energy of the electron and, low and behold, the energy in the quantum fluxoid is exactly half the kinetic energy of the electron. Reversing the logic, we discover from creating superconducting magnets from short lengths of fuse wire that magnetic flux is quantised and measure the size of the quanta of magnetic flux. Then combining orbital mechanics and electromagnetic theory and the fact that an orbit must be threaded by a whole number of quanta of flux, the allowed orbits pop out of the calculations.

To understand why orbiting electrons do not radiate energy and spiral towards the nucleus, we need to understand why electrons radiate energy. The first thing to understand is that in a radio transmitter, the action of generating the radio waves is one of an alternating current and the magnetic field produced by that current. The radio waves do not come from the electrons! The second thing to understand is that in a situation where electrons are subject to high acceleration such as in an X-ray tube, the process occurs because the electron was surrounded by a magnetic field. The change in direction requires a rotation of the magnetic field and that can only be accommodated if the movement of energy within the magnetic field is at less than the speed of light. This is not possible under extreme acceleration, so the outer part of the electron's magnetic field is shed becoming an X-ray photon.

Within the atom, the action of the electron's electric field in generating a magnetic field is restrained by the fact that its motion forms a current loop. Close to the electron, its action generates a magnetic field which moves with the electron. Further away, it generates the stable magnetic field which wraps its orbit. The kinetic energy of the electron is shared between the two and is subject to the principle of equipartitioning of energy.

In the years during which quantum theory was developed, a clear understanding of the nature of magnetic flux was impossible. Not only had its quantised nature not been discovered, but Einstein's theory of relativity had robed it of its substance and reduced it to an artefact of observation. Before we can understand the atom, we have to accept Lorentz's theory of electromagnetic mass. Magnetic flux is a real physical entity and it has the function of storing kinetic energy thus giving matter the property of inertial mass. For an isolated electron moving through empty space, the magnetic field surrounding it extends towards infinity. Just how far towards infinity depends on the presence of other magnetic flux. On earth, the answer is not very far in terms of the scale of our perception. Lorentz's theory gives a finite size to the electron. If we use this as a unit, then the magnetic field surrounding a free moving electron is probably limited to 100s or 1000s of electron radii. For an orbital electron, it is 1 electron radii and the sums are quite clear. That is the size required to store half its kinetic energy and that is almost exactly the size of the tunnel left by the flux of the orbital magnetic field.

The question of electron spin does not enter into our thinking. The Stern-Gerlach experiment reveals that single hydrogen atoms posses magnetic moment which is what we would expect from a current loop. We have no theory which predicts zero orbital angular momentum for the ground state, but there are other factors which need to be explained. Most prominent of these is the fact revealed by the Stern-Gerlach experiment:

that the hydrogen atoms are either attracted or repelled by the gradient of the magnetic field. This implies that they line up parallel or anti-parallel to the magnetic field. We might expect precession or alignment all in the same direction. But our expectation is built upon the experimental observations of magnetic fields of myriads of quantum strands of magnetic flux! Can we extrapolate down to small integer numbers of quanta which are far from strand-like.

Only when we use SI units and get a clear understanding of the nature of magnetic fields can we even get close to understanding the problem. Then we realise that there is a physical entity called magnetic flux which is described by the the vector field $\vec{B}$ and there is also a mathematical artefact equal to the sum of the actions of the moving electric flux of electrons and other elementary charged particles. This takes the form of the vector field $\vec{H} = \sum_i \vec{v}_i \wedge \vec{D}_i$. In the macroscopic world, current loops interact because each has an identifiable $\vec{H}$ field part of which threads the other current loop affecting the total $\vec{B}$ flux threading it. It is the mathematical artefact which cuts the current loop apparently inducing an emf. The emf is itself more of the nature of a mathematical artefact describing the net result of nature's action on each of the conduction band electrons. This action is the work which must be done to supply (or adsorbed by in reducing) the electron's contribution to the energy of extra (or fewer) quantum strands of flux now threading the current loop. Within the atom, there is no change in the number of quanta threading the orbit!

Detailed mathematical analysis is somewhat diabolical, but it shows that for a single electron in a circular orbit, the presence of a magnetic field parallel (or anti-parallel) to the axis of the orbit gives the classical coupling energy of $\pm \mu_B B$. The flux threading the orbit remains unchanged. The energy is still shared equally between potential energy and kinetic energy and the kinetic energy is still shared equally between the orbital and moving magnetic fields. The effect is to reduce (or increase) the radius and increase (or decrease) the frequency which in turn increases (or decreases) the current, but there is only a second order effect on the magnetic moment which remains virtually constant.

The evidence of the Stern-Gerlach experiment is that orbits flip to align parallel or anti-parallel with an imposed magnetic field. If the orbiting electron acts like a gyroscope then precession is to be expected, but any frictional torque resisting a gyroscope's precession will result in the imposed torque rotating the axis over time. Understanding that magnetic flux is quantised and that the orbiting electron is inside a flux tunnel leads us to question whether or not the orbiting electron behaves as a simple gyroscope.

In the standard model, great significance is given to Planck's constant h. In our theory, the angular momentum is also quantised and equal to $\frac{1}{\pi} n e \Phi_0$ and comparing the two theories $h = 2 e \Phi_0$. Our theory shows that the mysterious h of Quantum Mechanics is simply twice the product of the charge on the electron and the quanta of magnetic flux. Two constants of nature which we can measure by the methods of classical physics.

The question which then arises is why this same constant should relate the frequency and energy of a photon. Well, obviously, it is because photons are made of electric and magnetic flux. Is electric flux quantised? The answer to that depends on whether or not one believes protons and neutrons each consist of three quarks. If one does, then how can we explain charges of e, $\frac{2}{3} e$ and $\frac{1}{3} e$. There is a very simple answer: the quanta of electric flux is $\Psi_0 = \frac{1}{6} e$. The surface of a sphere may be divided equally into 2 hemispheres, 4 three sided regions or 6 four sided regions. The only problem is that we do not know what a photon looks like!

This is where we have to speculate, but one possibility is that a photon consists of 8 phases each consisting of a single loop of one quanta Φ_0 of magnetic flux permeated by a quanta Ψ_0 of electric flux terminating in displacement charge on the inner and outer surfaces of the magnetic flux. The only wave form for which the integrals of energy density give the correct energy content is $f(x - c\,t) = 1 - cos(x - ct)$ over the domain $(x - c\,t) = 0 \rightarrow 16\,\pi$. This function is also a solution to Maxwell's wave equation. Contrary to common belief, the usually quoted solution of a sine wave is not the only solution. The full solution is any smooth tailed twice differentiable function of $(x - c\,t)$.

At this point in our thinking, the question of wave particle duality arises naturally. We say that the photon is a

particle because it contains a defined quantity of energy and departs momentum when it is adsorbed, but these are simply properties of its electromagnetic field structure. In accepting the electromagnetic theory of mass, particles such as the electron have simply become electromagnetic field structures. The only real difference is the geometry of their electric fields. The spherical symmetry of the electron's electric field allows it to maintain a constant energy within its electric field.

These considerations have lead us to make the bold assertion that both our particle like solution and Maxwell's solution exist together. The quantisation of magnetic flux places a limitation on Maxwell's wave solution and it is only valid for (1) radio waves in which each half phase contains an abundant number of quantum of strands of magnetic flux and (2) as a perturbation of existing fields. This leads to the speculation that there is an interaction between the photon and the electromagnetic fields of atoms such that photons induce and exchange energy with electromagnetic waves.