The Structure of Electrons and Photons

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Abstract

In this paper I propose a model for a physical explanation of the structure of the electron and the photon. The model explains what the charge of an electron is and why it has a total angular momentum of $\sqrt{3}/2\ \hbar$. It suggests what the nature of inertial mass is and explains the spin value of $\hbar$ for the photon as well as the origins of its alternating electric and magnetic fields. It includes explanations for what static electric and magnetic fields are and why the stress energy tensors for these fields used in General Relativity have the form that they do. It also explains the Lorentz force and the Stern Gerlach force. It gives a physical interpretation of Planck's constant and proposes a physical mechanism for gravity which explains why it is so weak compared to the electric force. It also explains why the relativistic energy momentum formula has the form it does and also proposes a physical mechanism to explain the deBroglie wavelength of a particle.

Introduction

In a previous paper[1] I tried to explain some of the Constants of Nature by reinterpreting $1/\varepsilon_0$ and μ_0 as the Shear Modulus and mass density of free space respectively. This was because the speed of light c, is given as

$$c = \sqrt{\frac{1}{\mu_0 \varepsilon_0}} \qquad eq\ 1$$

This formula has the same structure as that which gives the speed of sound c_s in a medium with Shear modulus K and mass density ρ

$$c_s = \sqrt{\frac{K}{\rho}} \qquad eq\ 2$$

The units of $1/\varepsilon_0$ are $NC^{-2}m^2$ but in order for it to have the same units as Shear Modulus, i.e. Nm^{-2} the units of Charge would need to be in m^2 instead of Coulombs.

The units of μ_0 are NA^{-2} or Ns^2C^{-2}. If the units for Charge are changed from C to m^2 then the units for μ_0 become Kgm^{-3} which is density. The speed of light could therefore be interpreted as the speed of a transverse wave travelling through a medium with Shear Modulus $1/\varepsilon_0$ and mass density μ_0. This approach was a good start for demonstrating the existence of an aether but when taken further it gave some wrong predictions, one of which was the size of the electron. The size predicted was either much too large or a much larger Shear modulus was required.

In the previous paper I proposed that the aether is a tetrahedral structure composed of nodes connected by connecting rods that behave like springs under compression. The tetrahedral structure is effectively two interpenetrating Face Centered Cubic (FCC) Lattices with one cubic structure offset from the other by a quarter cell length in the x, y and z directions. This structure contains cells as shown in Fig 1. This cell is composed of ten nodes, six of which belong to one of the FCC lattices and four which belong to the other. The six nodes reside at the centre of the six faces of a unit cell from one of the FCC lattices while the four nodes reside at the corners of a unit cell from the other FCC lattice. A similar structure is created when the six nodes belong to the other lattice, but it is orientated at 180^0 to the one in Fig 1. These two structures are the basis for the electron and the positron. As the electron has six nodes from one lattice and the positron has six nodes from the other, I will refer to these going forward as the electron lattice and the positron lattice respectively.

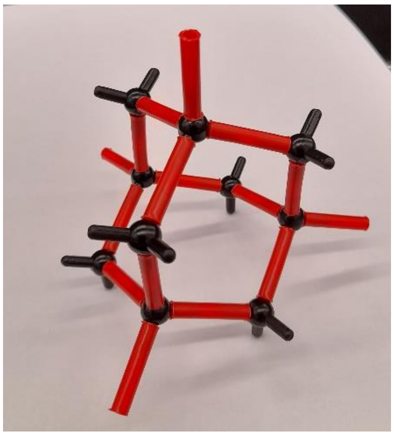

Fig 1

Electrons and positrons have the ability to do work by either attracting or repelling other particles and therefore they must have a source of energy. If the aether is a physical structure like I propose, then it must oscillate. The highest frequency of oscillation will be determined by the length of the connecting rods, and the lowest frequency will be determined by the size of the Universe. In my previous paper I proposed that these oscillations cause the electron and positron structures to oscillate. As it oscillates it causes waves to travel outwards through the connecting rods in a spherically symmetrically fashion. These waves constitute the electric charge of the electron and when these waves impact another electron, they will constructively interfere with the waves of that electron and increase the pressure on one side pushing it away. The six nodes in a positron reside in the positron lattice and are oscillating 180^0 out of phase with the electron lattice (that is known to be the case with a diamond, which has a tetrahedral lattice). When the waves from an electron impinge on a positron, they will destructively interfere with the waves being emitted by the positron causing a reduction in pressure on one side causing the electron and positron to move towards each other. The above is a very brief summary of my model of the electron and the positron and the nature of electric charge as proposed in my previous paper[1].

There are aspects of the previously proposed model that I was uncertain about such as

a) How the vibrating lattice actually drove the oscillation of the electron
b) The stability of the oscillating electron
c) How the electron moved through the lattice intact in any arbitrary direction
d) Why did the lattice vibrations select only certain cells to become electrons

In this paper I will address these points and modify some of my earlier positions. The first position I want to modify is that of interpreting charge as the squared amplitude of the nodal vibrations within the electron and change it to just the amplitude (nodal displacement) of the oscillation. The previous model was requiring an electron that was just too big to be realistic. The reasoning for the changed interpretation is as follows.

Electric Charge

The differential equation describing the motion of a spring mass system is as follows

$$m \frac{d^2x}{dt^2} + b \frac{dx}{dt} + kx = F(t) \qquad eq\ 3$$

A similar equation governs the behaviour of an LCR electrical circuit

$$L \frac{d^2q}{dt^2} + R \frac{dq}{dt} + \frac{q}{C} = V(t) \qquad eq\ 4$$

These equations are very well known, so no need to describe all the variables. Analogies are often made between the two describing the Inductance L, as behaving the same as Mass and the inverse Capacitance 1/C, behaving the same as the spring constant k. The other parallel which is the one most important to this paper is that the Charge q, is analogous to displacement x. If there is some fundamental link between the behaviour of Inductance and Capacitance at the macro level with the behaviour of the lattice then the units of charge should be meters, m.

When one applies this change, the units of $1/\varepsilon_0$ become Newtons and the units for μ_0 become Kg/m or Linear Density. I therefore interpret $1/\varepsilon_0$ as the force exerted by the connecting rods on the nodes to which they are attached and μ_0 as the Linear Density along a row of nodes. When a node moves some of the potential energy in the connecting rods is converted into kinetic energy of the nodes and I propose that this movement produces the observable properties of inertial mass and magnetic fields.

From Einstein's mass energy equivalence, we get that

$$E = mc^2 \qquad eq\ 5$$

$$\frac{E}{m} = c^2 \qquad eq\ 6$$

We can rewrite this in terms of energy density as follows by dividing both parameters by the Volume V

$$\frac{\frac{E}{V}}{\frac{m}{V}} = c^2 \qquad eq\ 7$$

We also have the expression relating Electric Field strength E_E and Magnetic field strength B

$$\frac{E_E}{B} = c \qquad eq\ 8$$

$$\frac{E_E^2}{B^2} = c^2 \qquad eq\ 9$$

If we multiply the top and bottom of the LHS by $\varepsilon_0/2$ then the top represents the energy density of an Electric field

$$\frac{\frac{1}{2}\varepsilon_0 E_E^2}{\frac{1}{2}\varepsilon_0 B^2} = c^2 \qquad eq\ 10$$

Since both equations 7 and 10 have an expression for the energy density in the numerator then we can equate the denominators as follows

$$\frac{1}{2}\varepsilon_0 \mathrm{B}^2 V = m \qquad eq\ 11$$

Equation 11 tells us that a volume containing a magnetic field has properties of mass. It is also well known that magnetic fields store angular momentum which is a property associated with mass. What eq. 5 does not tell you is why they are equivalent. I am proposing that the two sides of eq. 11 are equivalent because they are both caused by the structured movement of nodes in the aether. The only difference is the structure. We usually say that a mass has an emergent property called angular momentum but, in this model, mass is an emergent property of nodes with angular momentum, as is magnetism.

When we replace the unit of charge i.e. the Coulomb with the meter it also changes the units of other quantities.

The Electric Field units become N/m. This is also called tension or compression. The Magnetic Field units become Ns/m^2 or Js/m^3 which is angular momentum per unit volume.

The Updated Model

In my previous model I proposed that the electron is a localised oscillation in the lattice structure driven by vibrations in the lattice. The best mathematical description of a localised oscillation is that of a soliton. Others have previously suggested a soliton model for the electron[2] and there is a vast volume of literature related to the study of solitons across many disciplines and the following is a Google AI summary of solitons and their many properties.

Solitons

A soliton is a highly stable, self-reinforcing, localized wave packet that maintains its exact shape and velocity as it travels. It achieves this by perfectly balancing a medium's nonlinear and dispersive effects. Remarkably, solitons even retain their identities after colliding with one another, behaving much like physical particles.

Key Areas of Study Featuring Solitons

Because the underlying mathematics of solitons—which are solutions to complex nonlinear partial differential equations (like the Korteweg–de Vries equation or the nonlinear Schrödinger equation)—are universal, they appear across a wide variety of scientific and technological disciplines:

- **Nonlinear Optics & Telecommunications:** Used to maintain high-intensity optical pulses through fiber optic cables without pulse distortion or dispersion over long distances. They are also used to generate optical frequency combs.
- **Fluid Dynamics:** The study of solitary waves originally began in hydrodynamics, where they describe unique phenomena like tidal bores and massive, long-lasting surface waves in shallow channels.
- **Plasma Physics & Astrophysics:** They model how ionic, electrostatic, and magnetic waves interact and propagate through partially ionized fluids and solar winds.
- **Quantum Mechanics & Particle Physics:** Solitons are used to model solitary behaviors in quantum fields, such as the behavior of quasiparticles and the trapping of quarks within protons.
- **Biophysics:** They are used to describe the transfer of energy along molecular chains, such as the Davydov soliton model, which explains how energy is transported along hydrogen-bonded protein structures in living organisms.
- **Condensed Matter Physics:** They feature heavily in the study of superconductors (such as magnetic vortices) and Bose-Einstein condensates (where they manifest as localized atom-density waves).

Soliton Molecules

A soliton molecule is a bound state of two or more individual solitons that travel together as a single, unified entity without separating. Just as atoms bind together to form molecules, individual solitary waves—which maintain their shape and energy over long distances—lock into specific, stable patterns in media in which they travel.

A discrete soliton molecule is a bound state of two or more localized wave packets (solitons) that travel together through a periodic, nonlinear medium without spreading. They form when the attractive and repulsive forces between the individual solitons perfectly balance each other.

Key Characteristics

- **Localized & Stable:** Like individual solitons, they do not disperse or lose their shape as they propagate.
- **Discreteness:** Unlike solitons in continuous environments (like a uniform optical fiber), discrete solitons occur in periodic lattices (e.g., atomic chains or optical waveguide arrays). This introduces "discreteness" effects, such as the Peierls-Nabarro potential, which restricts where the solitons can settle.

- **The "Molecular" Bond:** The individual wave packets act like atoms bound together in a molecule. They maintain a fixed spatial separation and a specific relative phase, moving as a single, composite entity.

Discrete soliton hopping

Discrete soliton hopping in a crystal lattice is a phenomenon where a self-localized, particle-like wave packet (soliton) overcomes the lattice's intrinsic energy barriers to abruptly jump from one potential well or lattice site to the next.

The Mechanics of Hopping

- **The Lattice and Nonlinearity:** In continuous, uniform media, a soliton propagates without changing its shape because nonlinearity perfectly balances dispersion. In a crystal lattice, the periodic potential imposes "discreteness," allowing the soliton to self-trap directly into specific lattice sites.
- **The Peierls-Nabarro (PN) Barrier:** Because the lattice is not perfectly smooth, a periodic energy barrier—the PN barrier—is created. This barrier typically acts to "pin" discrete solitons in place, making them less mobile than those in a continuum.
- **The Hopping Process:** When a discrete soliton is given sufficient momentum (from external driving forces, thermal fluctuations, or a nonlinear kick), it gains enough energy to overcome the PN barrier. The soliton then breaks from its current localized site, "hops," and quickly self-localizes into the adjacent site.
- **Where It Occurs**

  Understanding soliton hopping helps describe energy transport and nonequilibrium processes in a variety of discrete nonlinear systems:
- **Photonic Lattices:** Used widely in nonlinear optics, where discrete light pulses "hop" between coupled arrays of nonlinear waveguides to achieve optical switching and routing.
- **Molecular Chains and Biopolymers:** Used to model the transfer of energy, such as the transport of protons along hydrogen bonds or through biological macromolecules like DNA.
- **Condensed Matter Systems:** Describes the dynamics of excitations like kinks and polarons moving through periodic crystal structures, or Wigner crystals in trapped ion systems.

The Nonlinear Schrödinger Equation (NLSE)

The Nonlinear Schrödinger Equation (NLSE) is a universal partial differential equation used in classical physics and mathematics to describe how wave packets evolve in dispersive and weakly nonlinear media. Unlike the standard quantum mechanical equation, it does not calculate probability amplitudes, but rather models classical fields, optical pulses, and fluid waves.

Core Phenomena: Solitons

The most fascinating feature of the NLSE is its ability to produce **solitons**. When the spreading effect of dispersion perfectly balances the compressing effect of the nonlinearity, the wave packet stabilizes. This allows the wave—often called a solitary wave—to travel long distances across a medium without changing its shape or intensity.

Primary Applications

- **Nonlinear Optics:** The NLSE is the foundational equation for understanding how intense laser pulses travel through glass optical fibers, forming the basis of global telecommunication networks. It is used to analyze phenomena such as self-phase modulation and four-wave mixing.
- **Fluid Dynamics:** It models slowly varying, small-amplitude gravity waves on the surface of deep water (ocean waves).
- **Bose-Einstein Condensates (BEC):** In ultra-cold atomic physics, a modified version of the NLSE known as the Gross-Pitaevskii equation is used to predict the behavior and stability of matter-wave condensates.
- **Plasma Physics:** It describes the evolution and self-trapping of modulated envelope waves in high-density plasmas.

Because of its exact integrability via the Inverse Scattering Transform, the NLSE serves as one of the most important solvable nonlinear partial differential equations in applied mathematics and theoretical physics.

The Discrete Nonlinear Schrödinger (DNLS) equation

The Discrete Nonlinear Schrödinger (DNLS) equation is a fundamental mathematical model used to describe wave propagation and energy localization in discrete, nonlinear environments. It translates the continuous Nonlinear Schrödinger (NLS) equation into a lattice structure, mapping physical dynamics across discrete points or sites.

The Core Mechanism

Unlike continuous systems, where a wave packet simply spreads out due to dispersion, a discrete lattice adds two competing forces:

- **Linear Hopping:** Energy or particles can "tunnel" or hop from one site to its neighboring sites, promoting spatial spreading.
- **On-site Nonlinearity:** The reaction of the medium depends on the intensity of the wave, creating a self-focusing or self-trapping effect that pulls the wave together.

When these two forces perfectly balance, the equation gives rise to highly localized, stable wave packets.

Key Phenomena and Applications

The discrete nature of the DNLS equation yields a much richer array of behaviors than its continuous counterpart. It is widely applied across multiple branches of physics and chemistry:

- **Nonlinear Optics:** Models light pulse propagation in coupled waveguide arrays and photorefractive crystals, allowing for the formation of spatial and temporal discrete solitons.
- **Bose-Einstein Condensates (BECs):** Describes ultra-cold atoms trapped in a periodic "optical lattice," where atoms interact nonlinearly and exhibit macroscopic self-trapping.
- **Molecular Biology and Materials:** Originally proposed to model the transport of vibrational energy in proteins and molecular crystals.
- **Thermodynamics & Breathers:** Because energy is constrained by the lattice, it often forms highly localized, long-lived, oscillating states called "discrete breathers" (or intrinsic localized modes).

Discrete Breather Solitons

Discrete breather solitons are spatially localized, time-periodic vibrational energy packets that remain stable in nonlinear, discrete physical systems (such as crystal lattices) without spreading out. They occur when the tendency of a wave packet to disperse is perfectly balanced by the system's inherent nonlinearity.

How They Relate to Relativity

When exploring relativistic effects like time dilation and length contraction, discrete breather solitons serve as fascinating theoretical tools and conceptual analogs in nonlinear physics and quantum field theory: [1]

- **Lorentz Invariance & Soliton Models:** In advanced theoretical models (such as the breather-soliton model of elementary particles), subatomic particles are not treated as traditional point masses, but rather as vibrating, localized solitons. The mathematical structure of these localized fields natively produces the Lorentz transformations.
- **Time Dilation as a Frequency Shift:** In special relativity, time dilation dictates that moving clocks appear to tick slower from a stationary observer's frame. Because breather solitons are fundamentally *time-periodic*, their intrinsic oscillation frequency drops when the breather moves at relativistic velocities. The moving soliton "ticks" slower relative to a stationary observer, mirroring relativistic time dilation.
- **Length Contraction as Spatial Localization:** Relativistic length contraction dictates that moving objects appear physically shorter along the direction of motion. For a moving breather soliton, the internal energy profile compresses and narrows in the direction of its trajectory. This spatial confinement mathematically matches the Lorentz contraction observed in physical objects.

Ultimately, the interplay of discreteness and nonlinearity provides a mechanical, wave-based framework for understanding how fundamental energy lumps translate through spacetime, linking the continuous mathematics of Einstein's relativity with discrete classical Hamiltonian lattices.

The Electron

It appears obvious to me that the above AI summary demonstrates that the electron is very likely a discrete breather soliton molecule. The structure in fig 1 is made up of four overlapping zig zag hexagonal structures similar to those found in polymer chains and protien molecules as was mentioned in the summary above. I propose that an individual soliton propagates around each of these hexagonal rings and that the four solitons bind together into a discrete breather soliton molecule which is confined to a single lattice cell. In the realm of solid-state physics and materials science, the microscopic size and rapid thermal fluctuations of atoms make directly observing or resolving these bound multi-soliton structures in physical crystal lattices highly complex but outside of actual crystal structures, bound states of solitons and breather molecules have been successfully generated and imaged in detail within optical platforms.

These four hexagons contain six nodes from the electron lattice and four from the positron lattice as mentioned above. The six nodes reside at the center of the faces of a FCC cell of the electron lattice. I also propose that the four nodes from the positron lattice remain relatively stationary (like nodes on a standing wave) as the solitons propagate around the rings. The six nodes at the center of the faces will therefore be set orbiting around their equilibrium positions and I proposed that they do so as in fig 2. The positron nodes are omitted for clarity but I suspect they play very little role anyway.

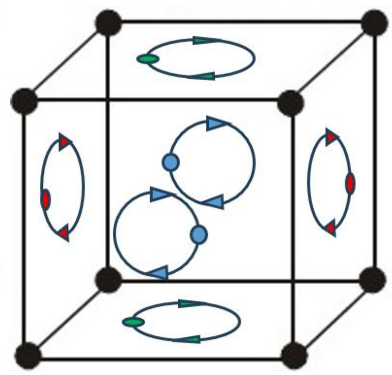

Fig 2

Without a simulation, I can't be certain what the orbits actually are but the configuration in fig 2 helps explain many of the properties of the electron. The planes of the orbits are parallel to the face that the node is on, and opposite faces both orbit in the same direction. This stationary soliton molecule is self-sustaining, as are all solitons, and therefore does not need to be continuously supplied with energy from the lattice as was the case in my previous model. The discrete soliton molecule (electron) on acquiring more energy can discrete hop to a neighbouring cell as described above in the AI summary. The more energy it acquires the more hops it makes in a given time and therefore the greater the velocity of the electron.

Electron Charge and Magnetic Moment

Earlier I stated that the lattice is vibrating at a multitude of frequencies so we can view the lattice as a sea of phonons travelling isotropically in all directions. Solitons can scatter phonons, but they absorb them first and then re-emit them. Low frequency phonons usually just pass through a soliton with just a phase shift, but high frequency phonons are scattered. As the background sea of phonons is isotropic, the electron will scatter them in a spherically symmetrical pattern. Phonons that are scattered that have their oscillations plane polarised constitute the electric charge of the electron while phonons that are scattered circularly polarised constitute the magnetic field of the electron. As the phonons are scattered isotropically there is no net force on an isolated particle but if something interferes asymmetrically with the particles ability to scatter phonons then it will feel a net force. The flux of phonons around an electron is no longer isotropic so when another electron enters this flux it will feel a force. Phonons scattered off an electron will be in phase with the electron and therefore will constructively interfere with another electron causing it scatter phonons more effectively on the near side and therefore causing it to be repelled. If it encounters a positron, it will destructively interfere with it causing it to scatter phonons less effectively on the near side and therefore to be attracted.

Earlier I proposed that the charge of the electron should be measured in meters as it relates to the displacement of the nodes in the electron structure. If we say that the lattice cell that contains an electron has a unit cell length of l_0 then each of the six nodes will be displaced by approximately πl_0 they rotate. The charge of the electron is therefore 6 πl_0 which means l_0 is approximately 8.4 x10^{-21}m.

Magnetic Field

In a permanent magnet a collection of electrons have their spins aligned permanently. If we choose one of the axes of the electron model in fig 2 then all of the electrons would have their nodes rotating around this axis e.g. the x axis, all rotating in let's say the clockwise direction. The spin around the y and z axes can be either clockwise or anticlockwise. All these electrons with their x axis spin aligned will cause the nodes in the electron lattice in the space within and around the magnet to also rotate in a clockwise direction around the x axis. They do this by scattering phonons and introducing a clockwise rotation into them. These rotating phonons constitute the magnetic field of the electron. The electron lattice nodes just circle clockwise around their equilibrium position, but the positron lattice nodes will circulate anticlockwise around the x axis. On average half of the electrons will have their y and z axes spin in the clockwise direction and half in the anticlockwise direction so there is no y or z axis spin transferred to the lattice nodes. A static magnetic field is therefore just a volume of aether where all the electron lattice nodes are moving synchronously in parallel circular orbits about their equilibrium position and all the positron lattice nodes are moving synchronously in parallel circular orbits about their equilibrium position in the opposite direction. The direction of the magnetic field is along the axis of rotation of the circular orbits. As the nodes orbit, they will tend to push the lattice apart at right angles to the axis of rotation which will also cause the lattice to contract along the axis of rotation.

In General Relativity the Stress energy Tensor for a Magnetic field B, aligned along the x axis is given as

$$T^{\mu\nu} = \begin{pmatrix} \frac{1}{2}\frac{B}{\mu_0}^2 & 0 & 0 & 0 \\ 0 & -\frac{1}{2}\frac{B}{\mu_0}^2 & 0 & 0 \\ 0 & 0 & \frac{1}{2}\frac{B}{\mu_0}^2 & 0 \\ 0 & 0 & 0 & \frac{1}{2}\frac{B}{\mu_0}^2 \end{pmatrix}$$

The first term in the matrix T^{00} is just the total energy of the field. The negative sign of the T^{11} component indicates an **attractive tension** pulling along the field lines. The positive values of T^{22} and T^{33} represent **pressures** pushing outward in the directions perpendicular to the magnetic field.

Electric Field

When a parallel plate capacitor is charged, electrons are moved through a conducting wire from one plate to the other. The electric charge from all the excess electrons on one plate will be scattering plane polarised phonons into the space between the plates. If the plates are perpendicular to the x axis then all the nodes in the lattice between the plates will oscillate in plane polarised fashion perpendicular to the x axis. As with the magnetic field this will cause the lattice to be compressed along the x axis and expand in the y and z directions.

In General Relativity the Stress energy Tensor for an Electric field E, aligned along the x axis is given as

$$T^{\mu\nu} = \begin{pmatrix} \frac{1}{2}\varepsilon_0 E^2 & 0 & 0 & 0 \\ 0 & -\frac{1}{2}\varepsilon_0 E^2 & 0 & 0 \\ 0 & 0 & \frac{1}{2}\varepsilon_0 E^2 & 0 \\ 0 & 0 & 0 & \frac{1}{2}\varepsilon_0 E^2 \end{pmatrix}$$

The first term in the matrix T^{00} is just the total energy of the field. The negative sign of the T^{11} component indicates an **attractive tension** pulling along the field lines. The positive values of T^{22} and T^{33} represent **pressures** pushing outward in the directions perpendicular to the electric field.

General Relativity explains gravity as the curvature of Spacetime and that all forms of energy, i.e. mass, electric and magnetic fields etc can curve spacetime. This simple model explains how electric and magnetic fields compress and expand space in orthogonal directions thereby introducing curvature.

Electron Spin

Quantum Mechanics tells us that the total intrinsic angular momentum of an electron is √3ħ/2 but when measured along any axis it is just ħ/2. If we look at the electron in fig 3 then the momentum vector for each axis is as shown. The vector sum of these three vectors points along a diagonal of the cube from the centre to a corner. If each of the three vectors has a magnitude of ħ/2 then by simple geometry the length of the resultant is √3ħ/2. We usually measure the electron's angular momentum by observing its interaction with an external magnetic field. As all inertial frames should produce the same results, we can select an inertial frame that is stationary with respect to the lattice and has its axes aligned with the FCC electron lattice. In this frame an external magnetic field can only be aligned parallel to one of the axes and therefore the component of the electron's total angular momentum that interacts with the external magnetic field can only be ± ħ/2, regardless of which of the three measurement axes is used. The spin characteristics of the electron can therefore be easily explained by its cubic shape and the cubic lattice in which it resides.

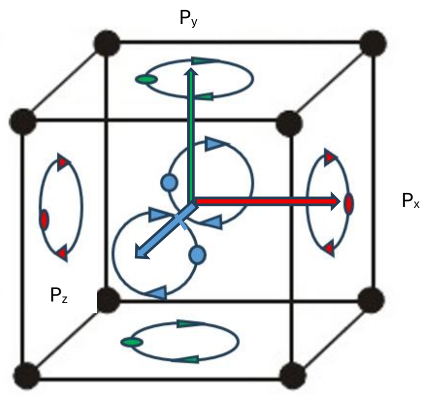

Fig 3

This explanation also gives us a physical interpretation of Planck's Constant. ħ/2 is the angular momentum of a pair of nodes on opposite sides of the electron structure.

Electron Inertial Mass

In the previous section I showed that the angular momentum of each pair of nodes in the electron structure is ħ/2. If we knew what frequency they were rotating at then we could calculate the total energy. We know that when an electron and a positron annihilate, they produce two photons with the Compton frequency (f_c) and I think that it is reasonable to assume that the nodes in the electron rotate at or close to the angular frequency of $2\pi f_c$. The energy of the electron is the total energy of the three pairs of rotating nodes which is 3 x ħ/2 x

$2\pi f_c$ which reduces to 3/2 hf_c. The energy of the photon produced during annihilation is just hf_c so perhaps the angular frequency of the electron is less than that of the photon by a factor of 2/3. This might be the case if the photon were a soliton supported on four nodes instead of six as is the case with the electron. The inertial mass energy is therefore just the total energy contained in the three pairs of rotating nodes.

Electron Gravitational Mass

We saw in the last two sections how electric and magnetic fields curve space which according to GR, causes gravity. I don't think curvature of space is sufficient to explain gravity. I accept that a moving body may follow curved space and therefore it appears that a force is acting on it, but this does not work for stationary bodies. For a stationary particle like an electron to have a gravitational attraction to another particle, they must exchange energy. Discrete breather solitons in Bose Einstein condensates have been shown to pulsate in size, and I propose that this also happens with the discrete breather soliton that is the electron. As it contracts in size it will generate tension in the lattice around it and cause a distortion of space. As it cyclically contracts and expands it will generate a longitudinal wave that radiates away symmetrically around the particle. I call these waves, Katrina waves, as they are not gravity waves as we understand them. When a particle encounters these Katrina waves, they interfere with the particles ability to scatter phonons and as they pass through the particle, they will affect the far side less than the near side thus causing a force. If the diameter, d, of an electron is of the order of 10^{-21}m and the effect of the Katrina waves is reduced by a factor proportional to d^2 then the force produced by this mechanism will be 10^{-42} times less than the electric force. The actual ratio is approximately 10^{-42} so perhaps there is some validity in this approach to explaining what gravity is and why it is so weak compared to the electric force. GR tells us that moving bodies follow the geodesics of curved spacetime which we perceive as gravity, but this fails to explain how two stationary bodies can have a gravitational attraction. In my opinion only energy transferred between the two masses in the form of Katrina waves can generate the gravitational force between two stationary bodies.

The Photon

Earlier I suggested that the photon may be a soliton based on four nodes. Fig 4 shows a possible configuration. The four nodes are at the centre of four of the faces of the FCC cell unit and they are all spinning in the same direction (green arrows), so their angular momentum vectors (blue arrows) all point in the same direction. As the photon consists of two pairs of nodes its angular momentum is 2 x ħ/2 or simply ħ. If the angular frequency of the nodes is 2πf then the energy of the photon is hf. The direction of the photons travel is either parallel or antiparallel to the momentum vector. As the photon travels through the lattice parallel to the momentum vector each node will trace out a helical path which has a sine wave profile as shown in fig 5. I'm assuming this soliton discrete hops to adjacent cells and it is the series of nodes in adjacent cells along the path that progressively trace out the helical path. When viewed perpendicular to the velocity these nodes are rotating clockwise for half the cycle and anticlockwise for the other half (red circles). As circulating nodes constitute a magnetic field, we therefore have an

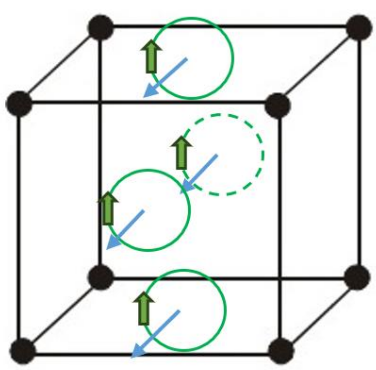

Fig 4

alternating magnetic field with a frequency the same as that of the rotating nodes in the photon. Electric field phonons (blue waves) are also scattered at right angles to the magnetic field and also alternates at the photon frequency. As the nodes in the photon can rotate at any speed up to c there exists a continuous spectrum of em waves up to a maximum. If the photon's angular momentum is parallel to the direction of motion, then the helicity of the path will be right handed and vice versa for when it is antiparallel. This simple model therefore is able to explain the Quantum Mechanical particle properties of the photon while also explaining its Classical electromagnetic and wave properties.

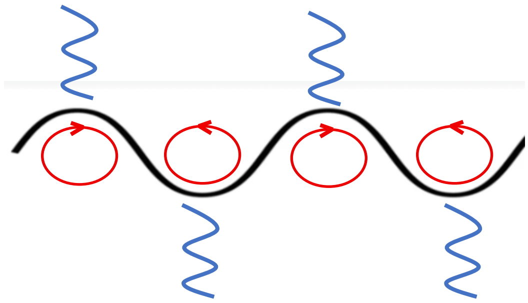

Fig 5

Lorentz Magnetic Force

I described earlier that a magnetic field is just a volume of space where all the electron lattice nodes are moving synchronously in parallel circular orbits about their equilibrium position and all the positron lattice nodes are moving synchronously in the same parallel circular orbits about their equilibrium position in the opposite direction. Fig 6.1 shows a stationary electron (i.e. it has no velocity relative to the lattice). The black circles rotating clockwise are the electron lattice nodes rotating around their equilibrium positions. This is the magnetic field. The direction of the magnetic field is into the page. The green lines are the nodes on the top and bottom faces of the electron. The other four faces are not included as they do not contribute to the lorentz force. The blue waves represent the electric charge phonons being scattered by the electron. When the electron is stationary the amplitude of the phonons is the same in all directions so there is no net force on the electron.

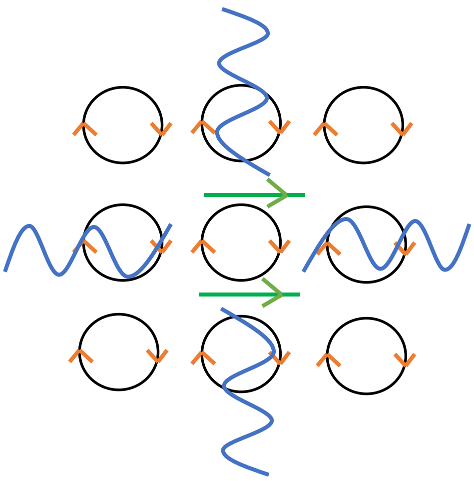

Fig 6.1 Stationary Electron

The lorentz force only appears when a charged particle is moving. Earlier I explained that electrons hop from one cell to the next and therefore the velocity is related to the frequency of hopping. The lorentz force is therefore produced during the hopping process. It is reasonable to assume that the electron hops only when the orbiting nodes on the top and bottom faces are travelling in the same direction that the electron is moving. When it hops into a new cell, that cell will already have its nodes rotating with the magnetic field. At the top of the electron in fig 6.2 the velocity of the electron node (green line) will add to the velocity of the circulating magnetic field node (black circle) and increase the amplitude of the electric charge phonon emitted from the top of the electron. At the bottom of the electron the velocity of the circulating magnetic field node (black circle) will subtract from the velocity of the circulating node in the electron and reduce the amplitude of the emitted electric charge phonon. When the electron is moving with a velocity relative to the lattice the generation of electric charge phonons is asymetrically affected which produces a net force downwards on the electron at right angles to both the velocity vector and the magnetic field vector. The greater the velocity, the greater the number of hops and therefore the greater the force the electron experiences. There is no net effect on the nodes of the electron as they move around the other axis of rotation as it is at right angles to the velocity vector. I did not include the positron lattice nodes in Figures 6.1 and 6.2 for clarity but as they oscillate at 180^0 out of phase with the electron lattice nodes, and are not part of the electron, they do not affect it. However, when a positron enters the same magnetic field as depicted in fig 6.2 with the same velocity, it will be deflected in the opposite direction. This is because the positron lattice nodes that constitute the magnetic field will be rotating in the opposite direction. The force exerted on the positron will therefore be in the opposite direction to that experienced by the electron.

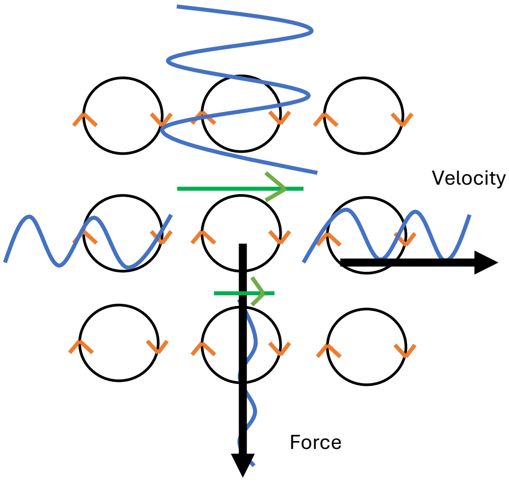

Fig 6.2 Moving Electron

Stern Gerlach Experiment

In a Stern Gerlach type experiment a beam of neutral atoms with an unpaired electron (usually silver) is passed through an asymmetric magnetic field. It is observed that the beam splits into two distinct beams, one being attracted to the North pole and the other to the South pole. As neutral atoms are used, the Lorentz force as described above has no affect as the force on the positive charges exactly cancles out the force on the electrons. A different mechanism is required to explain the observed splitting of the beams. Figs 7.1 and 7.2 show an electron in an

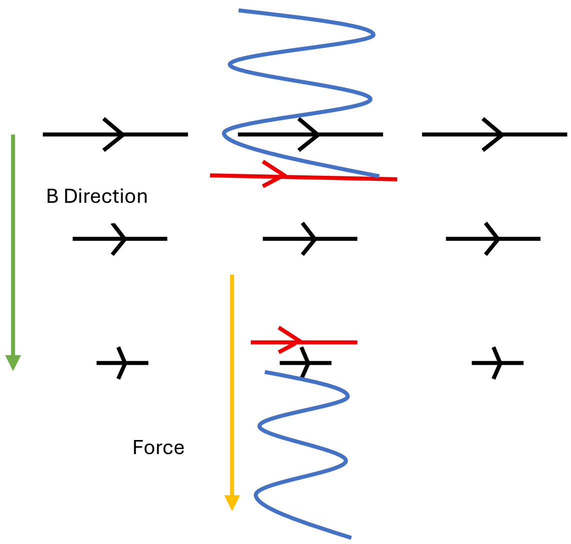

Fig 7.1

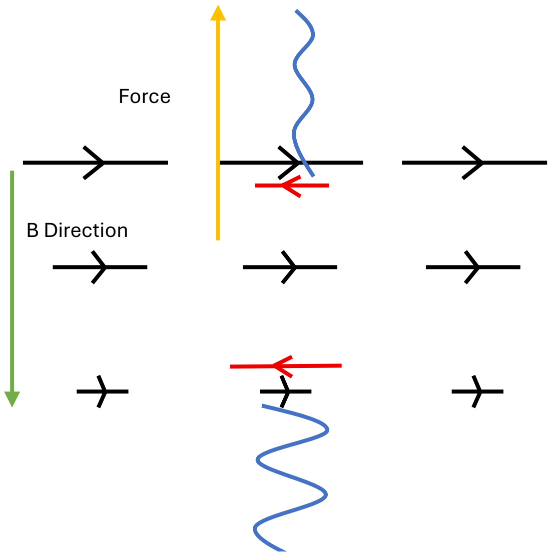

Fig 7.2

asymertic field. The black arrowed lines depict the electron lattice nodes rotating in their orbits at right angles to the magnetic field direction. The field is stronger at the top than at the bottom. In fig 7.1 the nodes at the top and bottom of the electron (red lines) are spinning in the same direction as the electron lattice nodes (black lines) that constitute the external magnetic field. As the external field at the top of the electron rotates in the same direction as the electron node it speeds up the top node causing it to more effectively scatter phonons. At the bottom, the node in the electron also speeds up but not by as much, as the external field is weaker. The bottom node therefore does not scatter phonons as effectively as the top node and therefore there is a force downwards on the electron. In fig 7.2 the nodes at the top and bottom of the electron (red lines) are spinning in the opposite direction as the electron lattice nodes (black lines) that constitute the external magnetic field. As the external field at the top of the electron rotates in the opposite direction to the electron node it slows down the top node causing it to less effectively scatter phonons. At the bottom, the node in the electron also slows down but not by as much, as the external field is weaker. The top node therefore does not scatter phonons as effectively as the bottom node and therefore there is a force upwards on the electron.

There is a 50/50 chance that an electron's spin will be clockwise or anticlockwise so the beam of atoms will be split 50/50. In a Stern Gerlach experiment where the top beam emerging from one SG device is introduced into another SG device that has its magnetic field aligned with the first, there is no splitting of the beam but if it is aligned orthogonal to the first then the beam is split in two again. This is easily explained with this model of the electron. In the case where the two SG devices are aligned, the spin of the top and bottom nodes of the electron are still rotating in the same direction as the external field when they enter the second device and therefore they are all deflected in one direction only. When the external field in the second device is orthogonal to the first, then the spin of the nodes in the electron that are now parallel to the external field will have a 50/50 chance of being clockwise or anticlockwise and therefore will be split into two beams as is observed.

Planck's Constant

The moment of inertia I, of a mass m, rotating about a point at a distance r, is.

$$I = mr^2 \qquad Js^2 \qquad \text{eq 12}$$

If it is rotating at some frequency ω then its angular momentum L, is given by

$$L = I\omega \qquad Js \qquad eq\ 13$$

And its Energy E, is given by

$$E = L\omega \quad = I\omega^2 \qquad J \qquad eq\ 14$$

Planck's constant has units of angular momentum but since the energy of a photon is only dependent on ω and not ω^2 as is the case in eq 14 then the angular momentum must be independent of ω, and therefore the moment of inertia must vary inversely with ω. Earlier I claimed that the mass property of matter and magnetic fields comes from the movement of nodes in the lattice. If the mass of a node is dependent on its frequency of oscillation then the greater the frequency the more massive it becomes. From the Planck Einstein relation and the mass energy equivalence formula we get

$$mc^2 = hf \qquad eq\ 15$$

$$m = \frac{hf}{c^2} \quad = \frac{\hbar}{c^2}\omega \qquad eq\ 16$$

If the nodes move at a velocity of c then as the frequency increases, the smaller the radius of oscillation will become. The relationship is as folows.

$$r = \frac{c}{\omega} \qquad eq\ 17$$

The moment of inertia of a node is therefore

$$I = mr^2 \quad = \frac{\hbar}{c^2}\omega\,\frac{c^2}{\omega^2} \quad = \quad \frac{\hbar}{\omega} \qquad eq\ 18$$

The angular momentum is therefore

$$L = I\omega \quad = \frac{\hbar}{\omega}\omega \quad = \quad \hbar \qquad eq\ 19$$

The angular momentum of a node is therefore independent of the frequency of oscillation so the energy is

$$E = L\omega \ = \hbar\omega \ = \ hf \qquad eq\ 20$$

In this derivation I have used the concept of the Planck Einstein relation and the mass energy equivalence formula and I assumed that the node is travelling with a velocity c. If it were travelling at c then the radius of the electron would be on the scale of the Compton wavelength (2.4×10^{-12}m) which does not seem credible to me. If the lattice cubic cell length is of the order of 10^{-21}m then the velocity of the node would only be about $0.3ms^{-1}$. As the moment of inertia, angular momentum and energy are all independent of the velocity it doesn't matter what the velocity is. It is more likely that the radius of the node oscillation is constant and that the velocity of rotation, *v*, is what changes. The relationship would therefore be

$$r = \frac{\nu}{\omega} \qquad eq\ 21$$

The "mass" of the node would therefore be

$$m = \frac{\hbar}{\nu^2}\omega \qquad eq\ 22$$

And the angular momentum would be

$$L = I\omega \quad = \frac{\hbar}{\nu^2}\omega \,.\frac{\nu^2}{\omega^2}.\omega \quad = \quad \hbar \qquad eq\ 23$$

The velocity of the node can therefore rotate at any velocity from 0 to c to give the continuous spectrum of em radiation that we observe. At the maximum velocity of c the wavelength of the photon will be approximately two cell length which as per my calculation with the electric charge is approximately $2 \times 7.4 \times 10^{-21}$ or 1.4×10^{-20} m. The Large High Altitude Air Shower Observatory (LHAASO) in China have detected a small number of photons with energies of approximately 1 PeV which have a wavelength of 1.2×10^{-21}m[3]. They also claim to have detected a single 2.4 PeV photon. As these measurements are indirect measurements of the photons energy it is possible that the original interaction in the upper atmosphere is a very low probability two photon interaction. Electron scattering experiments put an upper limit on the radius of the electron at 10^{-22}m[4]. It is certainly possible that my calculation of the latttice length from the electric charge is missing some component of displacement e.g. the electron is pulsating in size, but in any event the size of the electron appears to be in the range 10^{-20} -10^{-22}m.

Kinetic Energy of a particle

In order for a particle to gain kinetic energy and move it has to absorb energy first. We know that solitons can merge and create new solitons so a photon-soliton can merge with a stationary electron-soliton and form a new moving electron-soliton. When the photon merges with an electron then the energy in the rotating nodes gets transferred to the nodes in the electron. Its not possible for an electron to transfer all its energy and momentum to an electron due to the rules for energy and momentum conservation so only some of the momentum is transferred as in Compton scattering. We know that solitons in discrete environments can collide and move together at a new velocity and as the new structure is also a soliton molecule it will continue to travel at this new velocity. It will take a finite amount of time for the photon-soliton and the electron-soliton to merge and stabilise into a new soliton and this is what we observe as the inertia of the particle. There is initially a "resistance" to the acceleration as the energy is redistributed amongst the six nodes but once it does and the electron reaches its final velocity it continues at that velocity adinfinitum. I mentioned earlier that the lattice is filled with a sea of phonons and that the electric force is due to these phonons being scattered asymetrically. There are two types of phonon, acoustic and optical and I think that the optical phonons are what is refered to in QED as virtual photons. When an electron experiences the electric force these virtual photons add energy to it just as a real photon does.

The relativistic energy momentum formula gives the total energy of a particle as

$$E = \sqrt{(pc)^2 + (m_0c^2)^2} \qquad eq\ 24$$

This is obviously a vector sum of orthogonal vectors. We know from deBroglie relationship that

$$\lambda = \frac{h}{mv} = \frac{h}{p} \qquad \Rightarrow \qquad p = \frac{h}{\lambda} \qquad eq\ 25$$

If we put this expression for momentum into the first term in the square root above we get

$$E = \sqrt{\left(\frac{h}{\lambda}c\right)^2 + (m_0c^2)^2} \quad = \sqrt{(hf)^2 + (m_0c^2)^2} \quad eq\ 26$$

This first term in the square root is the energy of the photon added to the stationary electron and is associated with the angular momentum of the nodes rotating at right angles to their original angular momentum vector.

In general, if a sphere is rotating about one axis at frequency ω_1 and rotating around an orthogonal axis at ω_2 then there is a resultant axis of rotation and a frequency of rotation ω_3 where

$$\omega_3 = \sqrt{\omega_1^2 + \omega_2^2} \qquad eq\ 27$$

Since the magnitude of the angular momentum of the node is constant, only its direction is changed but since its frequency has increased then so has its energy. This increase in frequency of rotation constitutes an incresase in mass and this is where relativistic mass increase originates. Assuming that the additional angular momentum vectors for the three pairs of nodes are orthogonal to each other then they will add to the original angular momentum vector as per the energy momentum equation. (Strictly speaking, as per my model the term should be 3 hf/2 as there as six nodes each with h/2 so perhaps the frequency is 2/3 that of the absorbed photon).

De Broglie Wavelength

When an electron is moving through the lattice at some velocity it will discrete hop between lattice cells. As it does so it will cause acoustic phonons to be emitted as it vibrates the lattice.

Discrete solitons can absorb energy from their surroundings to balance energy lost through phonon emission, provided the system is actively pumped or driven. Without external energy, a soliton radiating phonons will inevitably decay. As the electron is bathed in the sea of background phonons (virtual photons) it is continuously having its disipated energy replenished.

These acoustic solitons will travel at the speed of light or greater depending the ratio of the bulk and shear modului of the lattice and will therefore have a wavelength. This is the deBroglie wavelength of the particle. As the velocity of the particle is directly proportional to the frequency of the hops, the wavelength will be inversely proportional to the velocity or momentum as per deBroglie's formula.

$$\lambda = \frac{h}{mv}$$

As these waves pass through e.g. a double slit they will create an interference pattern ahead of the electron which guides the electron to give the familiar interference pattern, even by passing one electron at a time through the slits. This process of discrete hopping causing waves which then guide the particle is very well demonstrated in this video[5].

Closing Remarks

Discrete soliton and breather soliton molecules in a tetrahedral lattice can be used to explain many of the properties of photons and electrons (and positrons) respectively. Solitons are ubiquitous in nature as can be atested to by the vast body of literature on-line, spanning many disciplines. Others have proposed solitons models for electrons and photons in the past but in proposing the tetrahedral lattice structure as the medium in which these solitons exist I hope I have helped to explain how nature actually is at the fundamental level.

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