HOME

An Electrodynamic Model of Atomic Structure

by

A. C. Sturt

Summary

A new model of atomic structure is developed using the established laws of electrodynamics. It is shown that uniform motion of an electron in a circle does not cause loss of energy, so that it is sustainable in orbit around a nucleus.

A basic structure is proposed for the hydrogen atom in which the radius of the electron's orbit is determined by the balance of electrical and gravitational attraction and centrifugal forces. The electron has a speed which is a significant fraction of the speed of light.

The atomic structure gains stability from the generation of equal and opposing magnetic fields by the electron and the nucleus at the axis of rotation of the atom. This requires separation of charges at the nucleus, which in this case is a proton, and rotation at an appropriate rate in the same sense as the electron orbits. Since the proton has mass, it also has angular momentum and may undergo precession. When the electron is displaced from its ground state, it accelerates back towards the nucleus with the emission of quanta of radiation generated by interaction with the medium of space.

At the instant of each emission of a quantum the electron has a constant velocity, which corresponds to the radius of an 'orbit'. Velocity increases as the electron approaches the nucleus. The quanta emitted increase in energy as the velocity at the instant of emission increases, in accordance with the inertial resistance theory proposed in a previous paper.

The model is extended to the helium atom in which two electrons share the same orbit and travel in the same sense but at opposite ends of the diameter. The nucleus has a planar structure, which makes it easier to envisage a separation of charges than in a proton. The helium nucleus is shown to have a particularly stable structure.

For the next set of higher atomic numbers electrons are added on the principle of equal attraction by the nucleus, least repulsion by other electrons and identical speeds to the first two. The third electron goes into a polar orbit in lithium. The fourth electron goes into the same orbit in the same sense but at the opposite end of the diameter. Subsequent electrons are added in similar pairs in orbits which are great circles in a diagonal north west to south east direction and two other diagonals in planes at 120° to it. The resulting structure is that of the element neon. All ten electrons have the same velocity and distance from the nucleus, which is different from other models.

Stability of such orbits depends on the synchronicity of movement of the electrons to keep them as far apart as possible. When ten electrons are orbiting in this way, there is room for no more; the next electron goes into an orbit of greater radius at a slower speed, which is the beginning of a new shell, and the process repeats itself.

The analysis depends on the interaction of electrons with the medium of space to generate electromagnetic radiation. If the medium of space exists, and can present increasing inertial resistance to the acceleration of mass as velocity increases, it seems possible that it may have similar interactions with other phenomena such as electrical charge and gravity, which permeates everything. Thus other parameters measured under static conditions may also have magnitudes which depend on velocity through the medium of space. It is proposed that tests should be carried out to establish whether this is so, because it may explain the apparent equivalence of mass and energy.

The model is deterministic; it does not require probability distributions of primary particles. It is in effect a return to the familiar Newtonian balance of forces.

1. Introduction

The discovery of the electron and the proton led to speculation about where they were located in the atom, and the way in which they interacted. By analogy with the solar system it was proposed that the electron with its negative charge orbited in a circle around the proton with its positive charge and much greater mass. However, this simple model was soon discounted, because in classical physics the electron would radiate electromagnetic energy as a result of its circular acceleration, and so it would collapse into the nucleus, which it manifestly did not, because the essential characteristic of atoms is their stability.

This led Bohr to postulate that electrons did in fact circle around the nucleus, but in certain prescribed orbits which were deemed to have the property that energy was not radiated away, so that they were stable. These orbits represented discrete energy levels. He further postulated that quanta of electromagnetic energy were emitted when the electrons in excited atoms dropped back into lower energy orbits, though not when they rose to higher energy levels.

Bohr’s equation derived on this basis had the same form as equations which were already known to describe the spectroscopic series for the hydrogen atom. When successive integers were inserted into the equation, the three emissions series of the excited hydrogen atom were predicted extremely well. However, the theory had the disadvantage that it was constructed by the application of arbitrary constraints to classical theory, and in the event it was not possible to extend it to atoms with more than one electron, because of interaction between the electrons.

Around this time the concept of uncertainty entered into physics. Light, which had long been considered to consist of waves, was shown also to act as what seemed like particles. Since these two manifestations could not be reconciled, consensus settled for a mysterious state of wave/particle duality.

By analogy with light, the concept of wave/particle duality was extended to electrons, which were certainly particles as in classical physics, but sometimes appeared to behave as waves with the properties of diffraction and interference. The location of an electron became a probability distribution.

Eventually it was concluded that all fundamental particles behaved either as waves or as particles depending on the method of observation. To add to the uncertainty, it was also proposed that mass and energy were related, and under the appropriate conditions they were even interchangeable.

In these circumstances it was not out of the question to consider the electron inside the atom as a wave circling the nucleus. Wave mechanics had the desirable effect of introducing whole numbers into orbits, provided it was assumed that the wave circulated at such a distance from the nucleus that its peaks were always in alignment on each cycle. Waves out of phase would simply have annihilated.

Thus the entire orbit could be represented as a circle of waves in which the wavelength was always exactly the same. There would, of course, be other orbits further away from the nucleus with longer pathways which were also defined in terms of whole wavelengths. The wave concept introduced the whole numbers which Bohr had used, but in a more sophisticated, more general and very successful way.

2. An Alternative Physical Model

Previous papers in this series (1) describe a model of the physical world which is quite different from the wave mechanical model. The differences are wide-reaching and profound. They can be grouped in three main areas as follows.

a. In the new model the entire physical world consists of particles which can be neither destroyed nor created but only rearranged into different structures. All particles, right down to the most fundamental, are separated by a medium which is the medium of space. The medium of space has its own characteristics; it is not total void. Particles are linked in structures by the known gravitational, electrical and magnetic forces of attraction or repulsion, which form bonds between them. Rearrangement of structures is by breaking some bonds and forming others. Ultimately the process is driven by the spatial translation and collision of particle structures. What we call energy is in fact the vibration of bonds between particles. Mass, which resides in particles, and energy, which lies in the bonds between them, are never interchangeable.

b. Energy is transmitted from structure to structure through the medium of space by electromagnetic radiation, which takes the form of rotating electromagnetic dipoles. The frequency of rotation of the dipole denotes the quantum of energy which it is transmitting. Rotating electromagnetic dipoles are formed when bonds are excited to such an extent that they generate circular electric currents in the medium of space by electromagnetic induction. When excitation reaches a level which exceeds the excitation energy of the particular bond, the circular current is completed and thrust off into the medium of space by the induced

magnetic field at the speed of light. The velocity through the medium of space is determined by the nature of the medium of space itself.

It was shown that such a theory could account for diffraction and interference by a mechanism of orbital deflection through the coincidence of dipoles, and tests were proposed to confirm it (2). If this model holds up, any analogy between light and particle behaviour is totally misleading. Diffraction of electrons, for example, is not wave behaviour, but direct interaction of charged particles with the orbits which are inherent in atomic structures.

None of this can be reconciled with the wave mechanical model of electrons in atoms.

c. When a mass accelerates towards the speed of light, it begins to shed electromagnetic radiation by the induction process of interaction with the medium of space which is described above. As velocity increases, so increasingly greater forces are required to achieve acceleration, a phenomenon which is termed inertial resistance. The consequence is that eventually, when the mass is approaching the speed of light, quanta of radiation begin to be emitted as fast as energy is pumped in to produce acceleration. Hence the limiting velocity of the speed of light (3).

   To take account of this, an Inertial Resistance Factor *R* which increases hyperbolically with velocity is introduced into Newton's Second Law of Motion. The limiting value of *R* is the asymptote corresponding to the velocity of light. If this theory holds good, there is no reason to postulate that mass increases with velocity, as claimed in Relativity.

   Electrons travel at a fairly leisurely pace in electric current in a conductor; a value of less than 1m per second has been quoted. By contrast electrons in an atomic orbit have been calculated to travel at about a tenth of the speed of light. In particle accelerators they may travel much faster still. Since electrons have mass, the possible effect of an inertial field needs to be taken into account.

   Rutherford himself noted that electrons appeared to increase in mass at high velocities.

Taken as a whole the new physical model presents a world which is definitely deterministic.

As a consequence of this analysis, the present paper suggests that the very first step of the traditional classical analysis was in error: the movement of electrons in circles does not necessarily cause loss of energy by emission of radiation. If this is so, an electron could remain indefinitely in stable circular orbit.

As a result it may be possible to construct an electrodynamic theory of the atom using only the conventional Newtonian balance of forces.

However, first it is necessary to identify the assumptions which underlie the classical analysis of gravitational, electrical and magnetic forces, and examine the reasoning which it is suggested led to erroneous conclusions.

3. The Equivalence of Forces

It was Newton who first defined quantitatively the forces which underpin the units used today. Brought up to date, the line of reasoning starting with his and others' observations on gravity, was as follows.

a. Gravity

- Objects fell to earth, and at an accelerating rate, because there was a force pulling them down, the force of gravity.

- Objects of the same weight but different bulk densities, such as cannonballs and feathers, fell side by side at the same rate in vacuo. They must be separately pulled down by forces of the same magnitude.

- For this to happen they must have in common some inherent property on which gravity acted to produce acceleration. This property he called mass.

- Cannon balls of different weights, and so different masses, also fell at the same rate.

- The forces on them must be different, and so force must be proportional to mass to produce the same acceleration i.e. twice the mass, twice the force.

- The Earth also had mass, because this was the origin of the force which caused the objects to fall.

- The mass of the Earth was subject to the same law as the objects which were falling i.e. the force of attraction which the Earth exerted was also proportional to its mass.

- The objects attracted the Earth with the same force as the Earth attracted the objects, by the law of action and reaction.

- The force between them was therefore proportional to the product of the two masses, which is *(the mass of the Earth) x (the mass of the object).*

- The mass of the Earth or any other object could be considered as acting at a point called the centre of gravity.

- The force between two masses was proportional to the inverse of the square of the distance between their centres of gravity. This was subsequently verified by experiment.

- The force between two objects was not affected by other masses, or by the gravitational force between other masses i.e. it was one to one. Thus the gravitational force between two masses could be treated quite independently of other masses.

- There was no limit to the number or magnitude of masses towards which an individual mass could exert gravitational attraction.

- There was no distance at which the force of gravitational attraction ceased to operate.

- The corollary was that every mass in the Universe exerted gravitational attraction on every other mass.

This allowed him to formulate an equation which described the force between any two masses m_1 and m_2 a distance d apart, wherever located in the Universe i.e.

$$F = G\frac{m_1 m_2}{d^2}$$

where G is the Universal Gravitational Constant.

b. Definition of force

The argument then broadened even further to a definition of force in the abstract. No force can operate in the absence of gravity, by the equation above, but a theoretical situation can be imagined in which its effect can be ignored.

- The effect of force is to produce acceleration, as with objects accelerating towards Earth.

- Force is proportional to acceleration i.e. twice the force, twice the acceleration, and vice versa.

- Since force is also proportional to mass:

$$force = mass \times acceleration$$

from which our definition of force.

The implications of this are: if there is no force, there is no acceleration; if there is no mass, there is nothing to accelerate; and if a mass does not accelerate, it is because no resultant force is being applied.

However, the next step is to consider the force of gravity on a mass at rest. Force is experienced by a mass which is not even moving, let alone accelerating. Any mass resting on a platform, or anybody sitting on a chair can testify to that. The answer was

to extend the term acceleration to include the acceleration which a mass would have if it were free to fall. Bodies which are not moving nevertheless experience a "*g*" force.

The conclusion was that the force of gravity on a mass at rest was identical to the force on the mass if it were free to fall. In other words the acceleration produced by a force is independent of the velocity of the body.

In fact the Inertial Field analysis (3) suggests that the force required to produce unit acceleration increases as a hyperbolic function of velocity, which is why it is impossible for a mass to reach the speed of light. Hence the need to introduce a factor *R* into the Second Law of Motion, which then becomes

$$F = mRa$$

The consequence for units is that the standard unit of force which causes unit acceleration, the newton, is the force exerted by unit mass at extremely low accelerations, even down to zero, which is rest mass. Increasing resistance to acceleration with velocity is not observed in practice because the effect of *R* is negligible except at magnitudes of velocity great enough to be a significant fraction of the speed of light, which is outside ordinary experience.

c. Electrical charges and magnetic poles

The next stage of the argument was to apply the definition of force to torsion by applying torque to a rod of material by means of known rest masses running over pulleys. In the form of a torsion balance, torque can be applied to the measurement of forces of other origins. So,

- An apparatus was constructed in which electrical charges Q_1 and Q_2 repelled each other so as to produce a torque which was counteracted by weights on pulleys.

- When the weights exactly compensated for the repulsive forces of the charges, the force of repulsion was calculated from the known masses of the weights.

- The force of repulsion between the two charges was found to be in inverse proportion to the square of the distance *d* between them.

- The equation for force was therefore:

$$F = \frac{Q_1 Q_2}{K_0 d^2}$$

  where the constant K_0 was required to maintain the dimensions the same on both sides of the equation i.e. MLT^{-2}.

The same method was used for magnetic poles.

There was the same assumption as with gravity that the interaction between the charges or poles is one to one. They all act independently on all other charges. There is no limit to the number of other charges with which each can interact. Since charges come as units in the form of electrons, as far as we are aware, charges of different magnitude are the sum of the unit charges of which they consist.

However, unlike gravitational forces, electrical charges can move on a conductor and concentrate at particular points on its surface. They can be screened from interaction by enclosing them completely in a conductor, whereas gravity acts on each individual particle of mass in a structure, even though it is conveniently referred to as a summation acting at a centre of gravity. Electrical charges can neutralise each other, and discharge through space.

This says something about the nature of the two phenomena; there is no gravitational permittivity or permeability. There are no gravitational conductors; there are no mobile particles of gravity to transfer the property from one corpuscle to another. The probable conclusion is that there are no particles of gravity at all, because sooner or later they would be found to move. Gravity is a kind of tension set up between masses in the medium of space.

The comparison of forces exerted by these phenomena resulted in a definition of electrical force which included neither acceleration nor mass, far from the original components of the definition of force.

d. Possible interactions

There is no doubt that these various forces are equal in magnitude under the circumstances under which they are compared, which is essentially static. However, it cannot be assumed that the relationships are always identical under all circumstances. Since they too are interactions with the medium of space, charge and pole strength may not be independent of their velocity through it. Their responses as they approach the speed of light might be different from what is observed at rest. In support of this caveat it is noted that it is a fundamental tenet of classical physics that electrical and magnetic phenomena interact when electrical charges move at constant velocity as in electric current, or accelerate as in electromagnetic phenomena.

There are two other points to note. First, every process at every level takes place in the presence of gravity; nothing can be shielded from it. Thus whatever transmits gravitational attraction may also influence the spatial transmission of other phenomena. It is worth noting that Newton himself was in no doubt that there was a medium which transmitted gravitational attraction (4). Secondly, the medium of space permeates the interstices between all structures i.e. everything but the entity of fundamental particles. Any interaction between a phenomenon and the medium of space will occur at any size of particle or structure.

Faraday himself thought the medium in an electric field was under stress or strain, and essentially different from the same medium when no field existed. As far as he was concerned, the intervening medium between electric charges played an essential part in the action.

If experiments eventually reveal that there are velocity effects on forces of electrical origin, it is possible that electric charges may not be independent of mass with its inertial field effects e.g. in the electron and the proton. It ought to be possible to confirm whether or not mass and charge interact by measurements over a range of velocities.

In the absence of experimental evidence the assumption must be that forces of different origin are best treated as equivalent forces in the conditions under which they were compared.

The reason for this detailed scrutiny of equivalence of forces is that the forces inside the atom relate to particles with velocities which are significant with respect to the speed of light. Velocity through the medium of space may have significant and differential effects, like that on inertial resistance.

4. Uniform Motion in a Circle

An extension of these arguments is to consider uniform motion in a circle. Acceleration in a straight line is given by the equation:

$$force = mass \times acceleration$$

If a mass moving along the straight line at an even rate covers distance dl in time dt, then its velocity v is

$$v = \frac{dl}{dt}$$

and its acceleration a is

$$a = \frac{d^2l}{dt^2}$$

The term a relates force, which is expressed in terms of mass, time and distance, to the change in the rate at which the mass cuts the medium of space. This might be called line acceleration (not linear, which may have a different connotation); it is the change in the number of points of the medium of space cut per unit time.

To find the force required to keep mass m moving uniformly in a circle of radius r, the methodology is to transfer the force by vector calculations from a tangential straight line to a radial component, which results in the expression for force of mv^2/r. By analogy with the basic equation for force, v^2/r is then called the acceleration. A further geometrical transformation shows that:

$$m\frac{v^2}{r} = mr\omega^2$$

where ω is the angular velocity, which is the number of radians covered per second. Again by analogy with the equation for force, $r\omega^2$ is called the acceleration in uniform circular motion.

However, when "acceleration" consists of a constant angular velocity in a circle of constant radius, there is no change with time in the rate at which the mass cuts the medium of space. The line traversed per second is the number of rotations multiplied by $2\pi r$, the circumference of the circle, neither of which changes. So if v is the velocity through the medium of space,

$$v = r\omega$$

and

$$a = \frac{dv}{dt} = r\frac{d\omega}{dt}$$

But r is constant, and $d\omega/dt = 0$ because the motion is uniform, and so $a = 0$.

Thus there is no line acceleration in uniform circular motion. Therefore the equation for circular motion is not relevant when phenomena depend on changes of the rate at which the medium of space is cut i.e. line acceleration. In fact the force required to maintain uniform motion in a circle may be construed as the force required to prevent any increase in line acceleration.

I have proposed that when a mass is accelerated towards the speed of light, the vibration of bonds causes the emission of quanta of electromagnetic radiation. The acceleration in question is line acceleration, because the phenomenon results from interaction with the medium of space, and therefore depends on change in the rate at which the length of space is cut.

Similarly the analysis suggests that the emission of radiation from an electron also depends on line acceleration, when the electron cuts the medium of space at an increasing rate. Thus there is no reason why an atomic electron moving in a circle at a uniform rate should give off radiation and lose energy. There is no reason on this count why it should not go on circling the nucleus indefinitely.

The concept of line acceleration is consistent with Laplace's Law of magnetic intensity due to a current-carrying conductor. It is also compatible with the classical laws of physics governing emission of electromagnetic radiation by a conductor when electrons are caused to accelerate back and forth in oscillation.

5. Proposed Model of the Simplest Atom

a. Basic structure

The simplest atom, hydrogen, is a stable entity composed of a nucleus in the form of a proton around which an electron circulates. The line velocity of the electron is a significant fraction of the speed of light. The atom is filled with the medium of space, which according to our previous analysis provides inertial resistance. The mass of the

nucleus (m_p) is much greater than that of the electron (m_e), but their charges are of equal and opposite magnitude.

The electron is held at a distance r_0 from the nucleus by the balance of the attractive gravitational and electrical forces and the centrifugal force of the circular orbit. This is the ground state. Thus

$$G\frac{m_e m_p}{r_0^2}+\frac{e^2}{K_0 r_0^2}=\frac{m_e v^2}{r_0}$$

The term for gravitational attraction is included because the process takes place in the presence of the gravitational field. The orbit is not necessarily circular; it may be an ellipse of nearly zero
eccentricity, but it can be treated as a circle to a first approximation.

The assumption is that the total effect is the sum of the gravitational and the charge effects, but there may be an interaction which could be important if both increase in magnitude with velocity.

The electron circulates at a constant line velocity, and so there is no electromagnetic emission. The electron is an electric current, which by convention is considered to flow in the opposite direction, and according to Laplace's Law it generates a magnetic intensity which exerts a force on a positive charge at the centre of the atom along the axis. The direction of the force is given by the corkscrew rule.

The hypothesis is that there is a separation of charge on the nucleus, the corollary of which is that charge moves on the surface of the particle. The nucleus rotates in the same sense as the electron moves in orbit, which is equivalent to an electric current in the opposite direction to that represented by the electron. It rotates at such a rate, and the separation of charges is such, that it generates a magnetic field equal and opposite to that generated by the electron. When the electron and proton have approached close enough to form a stable entity, the magnetic effect holds them so that the electron orbits the nucleus in a plane i.e. the atom takes the form of a disc.

Since the disc has a mechanical axis of rotation, and its components have mass, it has angular momentum and may undergo precession.

However, it cannot be assumed that the axis of the rotating proton entity always coincides with the axis of the atom. It seems likely that the nucleus wobbles like a star and a planet, which itself may add to the separation of charge if, for instance, the positive charge is on the outside of the nuclear orbit as a result of the attractive influence of the electron.

b. Displacement of the electron

If the electron is deflected by some means, it orbits further away from the nucleus, but still within the same plane. There is no increase of line velocity of the electron during deflection, and so there is no emission of electromagnetic radiation from that cause. However as the forces of attraction begin to pull the electron back towards the

nucleus, line velocity in the medium of space increases until the activation energy of emission is reached, and a quantum of electromagnetic radiation hf is emitted.

The emission of the quantum of energy stops acceleration for an instant at a distance of, say, r_{n-1} from the nucleus, and leaves the electron with kinetic energy $\frac{1}{2}m(v_{n-1})^2$ where constant velocity $v_{n-1}>v_n$.

The electron immediately resumes its acceleration. When its line velocity reaches the activation energy of emission, it emits another quantum of electromagnetic radiation. This quantum of energy is greater than the first, because it is emitted at an increased line velocity, according to the factor R in the inertial field analysis. The higher energy manifests itself as higher frequency radiation.

The emission of the quantum of energy leaves the electron closer to the nucleus at distance r_{n-2} with kinetic energy $\frac{1}{2}m(v_{n-2})^2$ as before, but the value of the constant velocity is now greater than before the quantum was emitted i.e $(v_{n-2})>(v_{n-1})$. And so on.

Thus the emission of quanta determines the distance between 'orbits'. These 'orbits' represent the instants of constant velocity at which no quantum of electromagnetic radiation is being generated and emitted. The progressive increase of the energies of quanta emitted as the electron descends to ground state results from the progressive increase of velocities at which the emission takes place through interaction with the inertial field.

The model is shown schematically in Figure 1. The process is summarised in Table 1 below. Velocity, kinetic energy and emitted quantum energy increase as the electron approaches the ground state. Quanta are labelled according to the 'orbit' into which the electron falls.

Electron velocity	v_n	$<v_{n-1}$	$<v_{n-2}$	…	$<v_2$	$<v_1$	$<v_0$
Electron Kinetic Energy	$\frac{1}{2}m(v_n)^2$	$<\frac{1}{2}m(v_{n-1})^2$	$<\frac{1}{2}m(v_{n-2})^2$	…	$<\frac{1}{2}mv_2^2$	$<\frac{1}{2}mv_1^2$	$<\frac{1}{2}mv_0^2$
Quantum energy		hf_{n-1}	$<hf_{n-2}$	…		$<hf_1$	$<hf_0$

Table 1 Succession of Quantum Emissions

Thus

- The line velocity of the electron and hence its kinetic energy increase as it drops back towards the nucleus.

- One quantum hf_n is the energy generated in the inertial resistance field and emitted as the electron drops back from the 'orbit' r_n, in which the velocity is constant, to the 'orbit' r_{n-1} at which line velocity is also constant, but greater.

– It is the quantum hf_{n-1} which determines the difference between r_n and r_{n-1}.

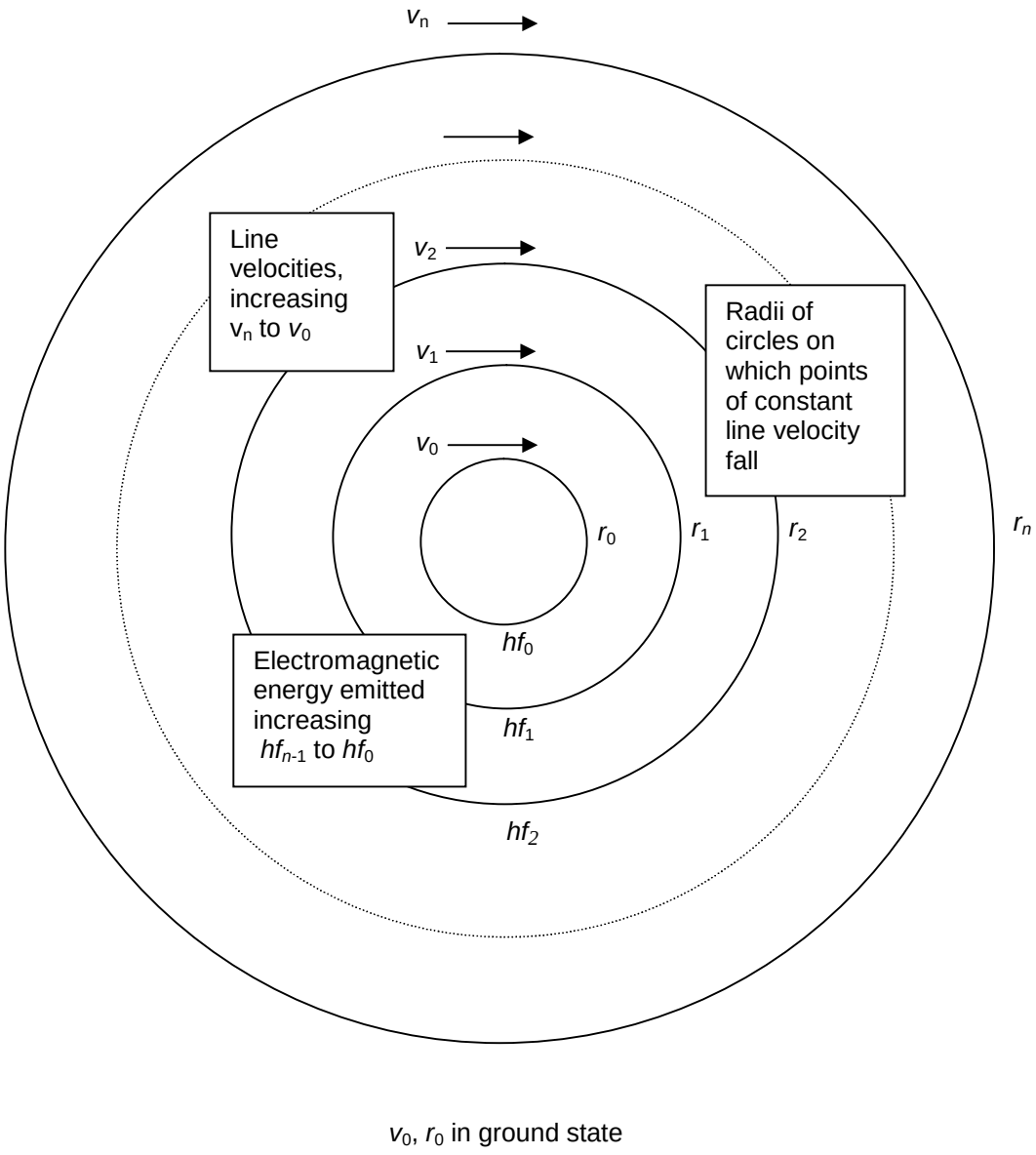

Figure 1. Schematic Representation of Electron Line Velocities and Electromagnetic Emissions from the Simplest Atom

This compares with Bohr's hypotheses for the hydrogen atom, which were that:

– Only orbits for which $mr\omega$ x $2\pi r$ were a multiple of Planck's constant did not emit radiation.

- Each of these orbits was characterised by a number in order of increasing energy.

- A single quantum of electromagnetic radiation was emitted when the electron dropped from an orbit to the orbit with the next lower number.

- The orbital number determined the size of the quantum of electromagnetic radiation emitted.

However, these hypotheses were not justified by reference to physical mechanisms.

6. Magnitude of Electromagnetic Quanta

The forces which attract the electron back towards the ground state accelerate it from one constant velocity to another with emission of a quantum of electromagnetic radiation. The magnitude of this quantum of radiation can be calculated from the work done against the inertial field during the process of increasing velocities.

According to the analysis of inertial resistance (3), the energy W_f required to overcome the inertial field in accelerating from v to $v+dv$ is the difference between the total energy expended and that which is consumed in increasing the Newtonian kinetic energy. This is given by the following expression:

$$W_f = m\int_0^v Rvdv - \frac{1}{2}mv^2$$

where R is the Inertial Resistance Parameter.

In the model of the atom proposed here, the parameter W_f is the energy of the quantum of light emitted.

Using the notation developed above, the quantum of energy emitted in accelerating an electron from velocity v to velocity v_{n-1} is therefore

$$hf_{n-1} = m_e\left(\int_{v_n}^{v_{n-1}} Rvdv - \frac{1}{2}\left(v_{n-1}{}^2 - v_n{}^2\right)\right)$$

7. Elliptical Orbits

The electron may be deflected entirely out of a circular orbit into an ellipse, which has eccentricity. Two possibilities result from this: the ellipse may be in the same plane as the circular orbit, or it may be inclined at an angle to the plane.

a. Ellipse in the same plane

The line velocity in an elliptical orbit is no longer constant, but greatest when the electron approaches its closest to the nucleus. The increase of velocity as it orbits the nucleus causes the emission of a quantum of radiation. The magnitude of the quantum is smaller than in circular orbit, because the velocity is lower. The reduction of energy may thus cause a sequence of emissions which brings the electron back to circular orbit, from which it drops back to ground state. The orbit may also rotate in the plane as the Earth around the Sun, but this additional motion may not involve enough energy to cause a change in the pattern of emissions.

The nucleus responds to deflection of the electron through the forces of attraction by changing the rate of rotation, changing the separation of charges and greater oscillation within the plane.

b. Ellipse in an inclined plane

If the deflection causes the electron to orbit out of the plane of the circle, the change of angular momentum causes precession of the elliptical orbit. This also causes the nucleus to precess. The result is a different series of changes of velocity and emission of quanta of electromagnetic energy to bring both rotations back into the same plane. This is followed by the sequence of emissions which brings the orbit back to a circle.

8. The Helium Atom

The hydrogen atom is unique in having a nucleus consisting of a single proton, which makes it more difficult to introduce the concept of the separation of charges required if the spinning nucleus is to counteract the field effect of the orbiting electron. However, all other atoms have more than one particle in the nucleus, which introduces an obvious distance of separation.

The helium atom comprises two electrons orbiting a nucleus containing two neutrons and two protons, which give electrical neutrality. There are no stable nuclei with a single neutron and two protons, and so it seems unlikely that the role of the neutron is simply as a separator of protons. Otherwise they could just line up, with the protons sandwiching the neutron.

a. Proposed structure of helium nucleus

The most likely arrangement of the four particles is shown in Figure 2.

The radii of protons and neutrons is assumed to be the same i.e. r_p. The nucleus is planar with an axis of rotation at the centre. If the radius of rotation of the nucleus about its axis is r_n, then

$$r_n = r_p\left(1+\sqrt{2}\right) = 2.4r_p$$

This represents the minimum radius of rotation, assuming the particles do not penetrate each other i.e. they are like billiard balls. They may, of course, be held apart by a balance of attractive and repulsive forces, which would increase r_n.

The two electrons are likely to be in the same orbit, given the identical forces attracting them to the nucleus i.e. diametrically apart. They travel in the same sense, staying as far apart as possible, because of the repulsion of their negative charges. By the same argument as before, the axis of their orbit coincides with the axis of rotation of the nucleus.

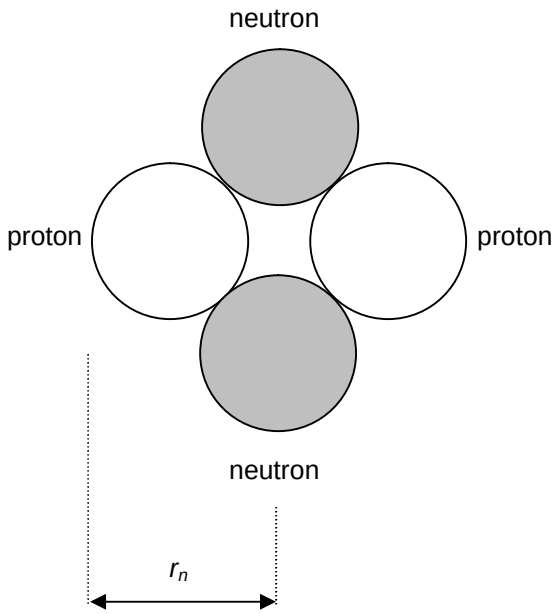

Figure 2. Proposed Arrangement of Protons and Neutrons in Helium Nucleus

b. Atomic radius of helium

The forces attracting each electron are considerably greater than in the hydrogen atom. The nucleus has four times the mass, and so gravitational attraction is increased fourfold, plus the gravitational attraction of the opposing electron. The electrical charge on the nucleus has doubled, so that the electrical attraction is doubled, but there is a repulsive force from the opposing electron.

Given these increased forces, the a first approximation of the new radius may be made as follows.

$$force \propto \frac{1}{radius^2}$$

The gravitational force attracting the electron towards the nucleus has increased by , say, 4¼ times. The square of the new radius, which is the radius of the helium atom, is therefore decreased by 4¼ times, so that

$$r_{helium}{}^2 = \frac{r_{hydrogen}{}^2}{4.25}$$

and

$$r_{helium} = \frac{r_{hydrogen}}{2.06}$$

If the radius of the hydrogen atom is taken as 0.46nm, then

$$r_{helium} = \frac{0.46}{2.06} = 0.223nm$$

However, the electrical force of attraction increases according to the same argument, say, by a factor of 1¾. Considering only the electrical forces,

$$r^2{}_{helium} = \frac{r_{hydrogen}{}^2}{1.75}$$

so that

$$r_{helium} = \frac{r_{hydrogen}}{1.32}$$

and

$$r_{helium} = \frac{0.46}{1.32} = 0.34nm$$

These are higher than the accepted figure for the atomic radius of helium by a factor of 2 and 3.

However, if both gravitational and electrical forces are taken into account, and on the hypothesis that they are of equal magnitude, the force pulling the electron towards the nucleus increases, say, by a factor of (4¼ + 1¾) or six times, which gives

$$r_{helium}{}^{2} = \frac{r_{hydrogen}{}^{2}}{6}$$

so that

$$r_{helium} = \frac{r_{hydrogen}}{\sqrt{6}}$$

and

$$r_{helium} = \frac{0.46}{2.45} = 0.188nm$$

This is not too far from the quoted atomic radius of helium of 0.122nm, which suggests that the basic model is reasonable.

Both calculations assume that gravitational and electrical forces are independent of speed.

In any case the result is that the electron is pulled much closer to the nucleus, which means it orbits much faster. There is twice the charge and four times the mass acting at only about a third of the distance. The electrical forces holding the nucleus and orbiting electrons in a plane are therefore more than 30 times greater than for the hydrogen atom. The helium atom is that much more resistant to deflection from a planar configuration.

c. Magnetic field in the helium atom

According to Laplace's Law, the magnetic intensity *H* at the centre of a circular coil of radius *r* is

$$H = \frac{2\pi I}{r}$$

i.e. magnetic intensity is proportional to the electric current through the coil and inversely proportional to the distance over which it acts.

The orbiting electrons of helium constitute an electric current, which generates magnetic intensity at the centre of the atom. The helium atom is electrically neutral, because of the positive charges on the nucleus. The hypothesis here is that there these positive charges separate on the nucleus as it rotates, so as to generate an equal and opposite magnetic intensity to that generated by the electrons.

The magnetic fields are then proportional to the relative rates of rotation and inversely proportional to the distance of their charges from the centre of rotation i.e. the centre of the atom.

If

- $r_{electron}$ is the radius of the orbit of the electrons i.e. the atomic radius,
- $n_{electron}$ is the number of orbits which an electron makes per second,
- $r_{nucleus}$ is the radius of the nucleus,
- $n_{nucleus}$ is the number of revolutions which the nucleus makes per second,

then,

$$\frac{n_{electron}}{r_{electron}} = \frac{n_{nucleus}}{r_{nucleus}}$$

and rearranging

$$\frac{r_{nucleus}}{r_{electron}} = \frac{n_{nucleus}}{n_{electron}}$$

from which

$$n_{electron} = n_{nucleus}\left(\frac{r_{electron}}{r_{nucleus}}\right)$$

The radius of the electron orbit is the radius of the helium atom, which has been measured at 0.12 nm.

The radius of the nucleus is 2.4 times the radius of a proton according to the geometrical model proposed above. The radius of the proton is measured at 10^{-15}m i.e. 10^{-6}nm. This gives a figure of 2.4×10^{-6}nm for the radius of the nucleus.

If the value of $n_{nucleus} = 1$, then

$$n_{electron} = \frac{0.12nm}{2.4 \times 10^{-6} nm} = 5 \times 10^{4}$$

Thus the nucleus at the centre of the helium atom rotates twice for 10^5 orbits of the electron to maintain equal and opposite magnetic intensities, and so a stable configuration. The nucleus spins in the direction in which the electrons orbit.

The angular momentum of this ‘disc’ is much greater than for the hydrogen atom, and so the helium atom will need much greater force to deflect its axis i.e. to make it precess.

d. Deflection of electron

An electron deflected to an orbit of greater radius in the same plane distorts the whole structure of the atom to some extent, but the distortion disappears as it accelerates back towards the nucleus. However, the ground state orbit of helium is already occupied by the other electron. This is travelling at the same constant velocity as before, but the deflected electron has a lower velocity until it reaches the ground state orbit.

Thus when the deflected electron reaches the ground state again, the two electrons will not be quite diametrically opposite. Their mutual repulsion will cause one electron to slow and the other to accelerate to reach their stable configuration at opposite ends of a diameter. This acceleration will be accompanied by the emission of a quantum of electromagnetic radiation, which will cause both electrons to settle down to the constant ground state velocity in the same sense but diametrically opposite.

e. Potential interaction of helium atoms

The proposed electronic structure of the helium atom suggests the possibility that under some conditions helium atoms may associate in ordered structures. Normally thermal motion would cause them to repel each other because of the negative charges carried by their electrons. However, if they are cooled sufficiently to allow them to approach, their electronic orbits may synchronise, so that an electron is shared between atoms as in Figure 3.

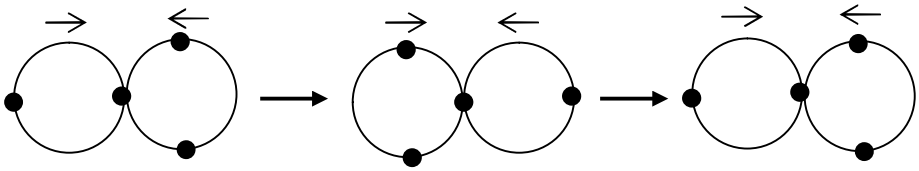

Figure 3. Association of Helium Atoms with Synchronised Opposing Orbits

All the electrons are travelling at the same speed. Their orbits are synchronous but 90° out of phase and in opposite senses. This is because orbiting in the same sense would require electrons to approach each other at some point in their orbits, and their like charges make this unlikely. The link between the atoms is the attraction which the joint electron has for both nuclei at the point shown. This falls short of covalency, which requires paired electrons, but nevertheless the association between the atoms is not random.

If this sort of link occurs, there is no reason why another atom should not join the first two atoms to form a line. In fact the process could continue indefinitely to form long

strings of helium atoms. Thermal motion is likely to be the limitation. Helium structures formed in this way seem likely to have unusual angular momentum and magnetic properties, with each atom opposing the next. It might be possible to detect such properties spectroscopically.

The “discs” formed by the helium atoms have been drawn in the same plane, but the lines could equally well be formed of “discs” perpendicular to each other i.e. one “disc” in the plane of the paper and the next perpendicular to it, as in Figure 4.

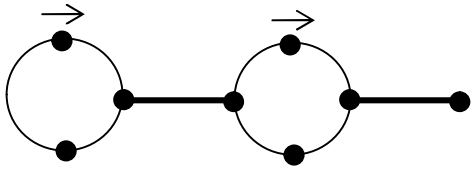

Figure 4. Association of Helium Atoms with Synchronised Contra-rotating Orbits in Perpendicular Planes

In this case each atom is 90° out of phase with the adjoining atoms.

In principle the “discs” may interact at any angle, and even rotate independently, as long as they retain their proximity. However, if the orbits are in the same plane or orthogonal, as shown in Figures 3 and 4, the structures may be extended in two or even three dimensions.

The essential conditions are enough mobility to manoeuvre into alignment, and the appropriate phasing. Since these imply opposite temperature requirements, there will be an optimum temperature for satisfying both. This temperature will be very low, probably close to absolute zero.

The electronic structure which permits such links is unique to helium. No other atom has the electronic balance and potential for synchronous orbits. Confirmation that such structures are possible might be relevant to the formation of cosmological structures from gases.

9. Atomic Structures from Lithium to Neon

The next element in the series is lithium with one more orbiting electron and a nucleus which contains one more proton and two more neutrons. It is suggested here that the additional electron goes into an orbit in a plane at right angles to the first. If the two electrons of helium orbit around the equator in the same sense but diametrically opposite each other, then the third electron goes into an orbit over the poles, where it interacts least with the other electrons. The third electron is the same distance from the nucleus as the other two, and travels at the same speed, but its timing is such that it crosses their orbit when they are furthest away.

It seems likely that the fourth electron, in the element beryllium, will enter the same polar orbit and travel in the same sense as the third, but in a diametrically opposite position. The orbits are synchronised so that as these two electrons leave the poles, say along 0° and 180° of longitude, the electrons in the equatorial orbit move along the equator to cut the lines of longitude at 90° and 270°. Thus all four electrons stay as far apart as possible at the same distance from the nucleus.

The next electron, in the element boron, enters an orbit on a north east/south west great circle, again timed to cross the other orbits so as to stay as far away from the other electrons as possible. The sixth electron, in the carbon atom, enters the same orbit in the same sense at the same speed, but in a diametrically opposite position, thus preserving the configuration established by the previous addition.

Similarly the next electron, in the nitrogen atom, enters a north west/ south east great circle orbit, and the eighth electron, in oxygen, enters the same orbit in the same sense at the same speed but in a diametrically opposite position.

The last pair of electrons, in fluorine and neon, enter a third ‘diagonal’ great circle.

The final result is that the five great circles are so spaced, and the electrons are so phased, as to maintain maximum distance between all electrons on the surface of the shell at all times.

10. The First Complete Sphere

Thus in the atomic series from hydrogen to neon the electrons of each species have identical orbital speeds and radii. They are not segregated into arbitrary shells, as in the current models. Successive electrons form pairs travelling in the same direction but at opposite ends of the diameters.

The analysis is as follows. There is no reason to believe that electrons are in any way differentiated. They will all seek a position as close to the nucleus as possible. As each additional electron joins the atom, the others move over to accommodate it, provided the force attracting it to the nucleus is greater than the force needed to make the others shift. They are in the same shell.

The radius at each stage depends on the balance of attractive and repulsive forces. Each electron is pulled closer to the nucleus by its increased mass and positive charge as atomic weight increases, but it is pushed further away by the negative charges of the other electrons in the shell.

The force of attraction F between each electron and the nucleus containing x protons and y neutrons is:

$$F = G\frac{m_e(x+y)m_p}{r_0^{\,2}} + \frac{xe^2}{K_0 r_0^{\,2}}$$

where r_0 is the radius of the orbit in the ground state, and the assumption is that there is no interaction between gravitational and electrical components of force.

Individual electrons do not have to have different energies to give different successive energies of ionisation for the atom. As one is removed, the others accommodate into a new stable configuration.

It might be expected for the sake of symmetry that the stable number of great-circular orbits would be 1,2,3,4,6 etc, but in fact it appears to be 5. This then is the maximum number which is compatible both with equal velocity of all electrons and with the synchronicity which prevents them from ever approaching too close against the force of their opposing like charges. The next electron would be too many for stability; the accommodation would be too great.

Thus the balance and synchronicity of the orbits ensures that the electrons are always as far away from each other as possible with this arrangement. At any instant of time each has the maximum space around it. If there were any tendency for one to slow or speed up, interaction with the other electrons through their mutually repulsive charges would bring them back into line. They form a self-regulating system of ten electrons.

This is the atomic structure of the inert gas neon.

11. Higher Atomic Numbers

There comes a stage at which the force required to expand the orbits of the existing electrons is greater than the force which is attracting a new entrant towards the nucleus. The result is that it cannot penetrate their sphere of orbit, and must assume an orbit of its own further away from the nucleus. The particular orbit which it adopts will be one which gives minimum interaction with the other electrons as it passes over their shell. Its line velocity will be slower than theirs.

12. Atomic Radii and Chemistry

The model is compatible with both the chemical attributes and the sizes of atoms of increasing atomic number.

The completed sphere of electrons corresponds to the number of electrons in inert gases. Since the next additional electron is out on its own, it is likely to be more reactive chemically than those occupying the inner sphere. It will also be monovalent. So sodium is the reactive, monovalent element which follows the inert gas neon in the Periodic Table.

Atomic radii decrease with atomic number as the nucleus increases in mass and charge, because electrons are pulled closer, which also increases their line velocities. Then at some point the structure begins to open up again until the last additional electron to enter the shell expands the structure to the point of ‘saturation’. At this point the radius of the element, which is the inert gas neon, jumps to a much higher level. The next additional electron, in the element sodium, is much more loosely

bound, and so further from the nucleus and slower. This is in agreement with the measured atomic radius of sodium which is greater than that of neon. At atomic numbers higher than sodium the increasing nuclear charge causes atomic radius to begin to decrease again.

The same pattern occurs with argon and potassium. Atomic radius increases in a looping fashion with increasing atomic number.

The volume of the atom expands and shrinks according to the forces of attraction and repulsion. The result is different from that predicted by other models in the sense that all 10 electrons are in the same orbit or 'shell'. The '1*s*, 2*s* and 2*p* electrons' of conventional analysis are a rationalisation of the response of the remaining electrons in this model, as they accommodate to the removal of successive electrons.

The shape of the atom becomes more spherical with increasing atomic number, so that the magnetic effects described for hydrogen and helium progressively balance each other out. At higher atomic weights, the removal of an electron does not cause as great a reaction in the form of nuclear spin or wobble.

13. Discussion

The operation of the atom presented here lends itself very much to computer modelling, because of the balance of forces etc. However, it is implicit in the analysis that the parameters which feed the model may need re-examination in the light of the inertial field effect.

If resistance to the acceleration of mass increases hyperbolically with velocity through the medium of space, it may be that other phenomena which depend on the medium of space, such as charge, are also influenced by velocity. This will not normally be apparent, because the accepted values of parameters are those which have been measured under static conditions. However, when bodies or charges interact with the medium of space and with each other at velocities approaching the speed of light, the magnitude of their interactions may increase.

Thus it is possible that the gravitational attraction between two bodies, both moving at a velocity which is a significant fraction of the speed of light, may not be quite the same as at rest. In other words, the value of *G*, the Universal Constant of Gravitation, may change with velocity.

There is the further possibility that the phenomena may interact, so that, for example, a charged mass may encounter a different magnitude of inertial resistance from that encountered by mass alone, as velocity increases. This would change the hyperbolic curve of force required to produce unit acceleration against velocity. In particular it would cause a shift in the asymptote representing limiting velocity away from the speed of light.

The effect would be to introduce a constant α into the expression for the Inertial Resistance Factor (3). If the new factor is R_α and $\alpha>1$ then

$$R_\alpha = \frac{c}{c - \alpha v}$$

so that the asymptote occurs when

$$\alpha v = c$$

or when

$$v_{\lim it} = \frac{c}{\alpha}$$

Since charge always comes in association with a mass, what is basically needed, if it were possible, is a purely mechanical method of measuring mass without the complications of electrical or magnetic phenomena. However, at velocities approaching the speed of light this may be extremely difficult to achieve experimentally. Nevertheless it might be possible to investigate the inertial resistance for particles of different charges and different masses using an orthogonal experimental design.

Any interaction detected would be relevant to the comparison of masses by mass spectroscopy. This would be one of the major parameters of a computer model.

It is also possible that the measurement of atomic radii may need to be re-examined in the light of the likelihood that charged particles such as electrons interact with material structures by orbital interaction. There is no suggestion that momentum is not conserved, but the directions which particles take after interaction may represent deflections of orbits rather than classical rebounds. What is observed in bulk may not be directly applicable to single charged particles, since the bulk may average out such effects.

There is the further possibility that the electrical field generated by a moving charge may depend on the velocity of the charge through the medium of space. This is already implicit in the definition of electric current, which is the movement of charge per unit time. But conventional relationships refer to current in which electron velocities may be very low. The phenomenon could be quite different with electrical charges moving at a velocity which was a significant fraction of the speed of light.

Similarly, it is possible with electrical phenomena that the attractive force of opposite charges or the repulsive force of like charges may vary with velocity. It is also possible that the strength of magnetic fields generated by moving charges may vary with velocity, as in electromagnetism.

The reason for raising these questions is the apparent interchangeability of mass and energy in, for instance, the binding energies of atomic nuclei. This is considered to be the explanation of the apparent loss of mass when particles come together to form an atomic nucleus.

However, the thesis of the present analysis is that energy is never interchangeable with mass. The corollary would be that the measurement of the mass of particles in a

bottle in the laboratory may be different from the measurement of mass at high velocities, especially if charged. This would not be to discount binding energy, but rather suggest that the apparent loss of mass did not represent its magnitude. It may be that whatever affects the acceleration of mass at high velocities holds a clue to the nature of what binds nuclear particles together.

Then there is the question of rotation. The model is one which embodies circular motion, both in the form of electronic orbits and in the spinning of nuclei. However, there is no reason to believe that the phenomenon stops there. It has already been suggested that the proton of the hydrogen atom may not only rotate but present its positive charge to the electron in some way. There is no reason to believe that the electron does not in some way reciprocate.

Furthermore, when protons and neutrons, as well as electrons, of course, become bound in an atomic structure, there is no reason to believe that this prevents them from rotating on their axes.

If this is so, there exists a host of possibilities of clockwise and anticlockwise spin of every particle in association in structures, even down to the most fundamental. Different combinations of rotation may conceivably lead to local distributions of properties in what are ostensibly identical atomic structures. What is conventionally observed may be only the bulk properties; at the level of small particles it might be quite different.

Finally there is the separation of charges. The analysis suggests that the charges on electrons and protons may be superficial and mobile i.e. they may not permeate the body of the particle. If so, there may be smaller charges than that on the electron. It is possible that the charge on the electron may appear to be a unit because electrons are what we observe.

To sum up, there are enough degrees of freedom in the model to encompass the observed mechanical, electrical and magnetic phenomena, and account for the spectra of electromagnetic emissions. The model depends on the existence of a medium of space, and the inertial resistance effect on mass.

This is crucial for the analysis, and tests to confirm the phenomenon have already been proposed. If successful, it will mark a step on the way to establishing what connects all these phenomena together to form one Universal system.

A C Sturt

3 Oct 2003

Corrections and minor additions 25 June 2004

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4. Quoted in Physics, Ohanian, Norton Second Edition p587

"It is inconceivable, that inanimate brute matter, should, without the mediation of something else, which is not material, operate on and affect other matter without mutual contact. That Gravity should be innate, inherent and essential to Matter so that one Body may act upon another at a Distance thro' a Vacuum without the Mediation of anything else, by and through which their Action and Force may be conveyed from one to another, is to me so great an Absurdity that I believe no Man who has in philosophical Matters a competent manner of thinking can ever fall into it. Gravity must be caused by an Agent acting constantly according to certain Laws; but whether this agent be material or immaterial, I have left to the consideration of my readers."

Isaac Newton.

Addendum - Fission of Nuclei

A large nucleus may split under the impact of, say, a neutron. The analysis of this paper suggests that the result may be a dissipation of energy as follows.

The nucleus splits into two smaller, positively charged nuclei which therefore repel each other and recede through the medium of space at very high velocities. Their acceleration results in emission of electromagnetic energy at wavelengths which are determined by the nature of the two nuclei and their velocities through the medium of space at the instant of emission. The electrons rearrange themselves around the two new nuclei, and cause the emission of electromagnetic radiation as each electron accelerates back to its most stable state around its nucleus. The result is a spectrum of electromagnetic radiation which is characteristic of the decomposition of the large nucleus.

The result of the fission of the large nucleus is therefore:

- an explosion at high velocity of particles having kinetic energy, and therefore mass, and

- emission of a spectrum of radiation at the speed of light.

The indication of the fission of the nucleus will be arrival of the spectrum of electromagnetic radiation, because it travels faster, followed by the explosion of particles of matter having the property of mass. This is what seems to be observed in practice.