Journal of Scientific Exploration, Vol. 21, No. 1, pp. 13–26, 2007 0892-3310/07

Linking String and Membrane Theory to Quantum Mechanics and Special Relativity Equations, Avoiding Any Special Relativity Assumptions

M. G. Hocking

Materials Dept, Imperial College, London SW7 2AZ
e-mail: m.hocking@imperial.ac.uk

Abstract—M-brane quark string theory and the Supergravity theory require 10 spatial dimensions. But if dimensions greater than 3 do exist, this must have important effects in other branches of physics, as quark theory cannot be compartmentalised-off. This paper shows how the concept of multi-dimensional space, essential to explain particle physics phenomena, removes conflicts between quantum theory and relativity. This leads, extremely simply, to both Schroedinger's Equation and to the Special Relativity equations in terms of absolute motion instead of assuming the 2 Principles of Relativity. The origin of the Big Bang provides an absolute spatial reference frame.

Keywords: Schroedinger—relativity—M-brane—supergravity—particle physics—multiple dimensions

Introduction

String theory and M-brane theory predict 10 or 11 dimensions but suggest that 7 are coiled up to a very small diameter so that we only perceive the remaining 3. If it is assumed that the extreme temperature of the Big Bang prevented any complexity of structure, then it is likely that at the beginning there was no coiling and so matter initially was in 10-dimensional space. As temperatures dropped, structuring became possible and on this model matter then evolved into the lower dimensions. In this case, ordinary 3-dimensional (3-D) matter is formed by an energy entering from the next higher 4th dimensional space. This model leads to the equations of quantum mechanics and Special Relativity in 2 lines but without requiring either of the 2 Relativity Principles.

About 90% of the matter in the universe is described as "missing", meaning missing from 3-D space, but this could be because it is distributed among the higher 7 dimensions, which gravity can access but not photons, electrons etc., so it would be apparent only from gravity measurements and be missing from all other observations.

Schroedinger's Equation $d\psi/dt = (hi/4\pi m)\ [d^2\psi/dx^2]$ is functionally exactly like Fick's 2nd Law of Diffusion $dC/dt = (\text{const.})\ [d^2C/dx^2]$, if C (concentration of a diffusate) is replaced by ψ. This comparison suggests the following simple model.

A hypothesis of Dirac (1962) is that an electron resembles a bubble, rather than a point of matter, and this idea also accords with current membrane theories of space. It is supported by other indications that space is not "empty" but is filled with a continuous all-pervading background medium (Besant & Leadbeater, 1994), in which bubble-like particles move. Their movement through such a "space" (even in a vacuum) must then be by a diffusion process and hence Fick's Laws of Diffusion would be expected to apply, and in fact Fick's Law does appear, in the form of Schroedinger's Equation which is Fick's 2nd Law of Diffusion but with an imaginary diffusion coefficient. 3-D matter in space would then be bubbles in the continuous medium of space, inflated by containing an energy of creation (rest mass) welling-up from 4-dimensional (4-D) space as mentioned above.

Schroedinger's Equation

Individual pollen grains in air diffuse jerkily due to molecular kinetic motion. Their diffusion follows Fick's 2nd Law of diffusion, $dC/dt = D(d^2C/dx^2)$. But there is no wavelike effect at all in the microscopically-observed diffusive jumps. Fick's Equation (1855) is exactly similar to Schroedinger's Equation (written 70 years later) which describes the motion of an elementary particle through free space, except that the "diffusion constant, D" becomes imaginary. Nature may be trying to tell us something here.

Figure 1 shows a solution of Schroedinger's Equation for the motion of an elementary particle in free space, and ψ is imaginary in between the points on the trajectory where $\psi = 1$. This is like diffusive jumps but where the particle is imaginary during its jump. An obvious interpretation of this imaginary feature is that the particle may perform its diffusion jumps via a hidden dimension, the 4th dimension, in which it is momentarily absent from 3-D space and hence is "imaginary" during its jumps. This is an interpretation of Schroedinger's Equation. In earlier years, before the advent of M-brane quark string theory, which requires multi-dimensional space, many standard textbooks avoided this problem by an (unjustified) assertion that "the particle must be somewhere" at all times and they then square ψ to prevent it from being imaginary (nowhere in 3-D space).

Pursuing the analogy between Fick's Law of Diffusion and Schroedinger's Equation, assume that elementary particles move in a similar way as diffusive jumps, but at their size, comparable to a 4th dimension's coiling-up size, there is some accessibility to a 4th spatial dimension (thus appearing to us as a "quantum-mechanical tunnelling"). An ad-hoc assumption of diffusive jumps into 4-D is not required if the Zero-Point energy oscillations routinely involve very frequent regular excursions into 4-D where motion is not restricted by the 3-D background medium—a continuous medium would trap bubbles (see

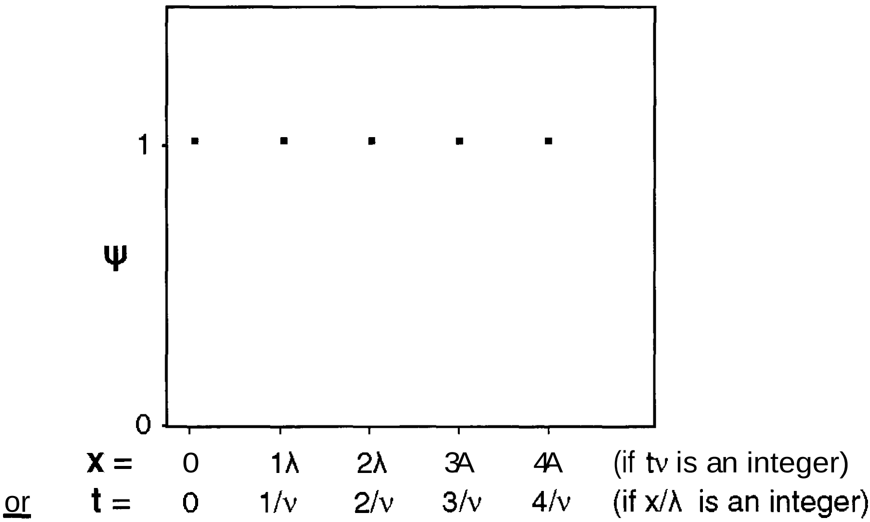

Fig. 1. Plot of Equation ii, $\psi = \exp[-2i\pi\{x/\lambda - tv)]$ or Equation iii, $\psi = \exp[-2i\pi\{(xmv/2h) - tE/h)]$. $\psi = 1$ whenever the particle has made an integral number of jumps, n (of length A), which is when its distance travelled $= x = n\lambda$, or when its time of travel $= t = nlv$.

Dirac's hypothesis mentioned above) static in 3-D, like tiny air bubbles are trapped static in a block of ice (discussed later).

It would be strange if the existence of higher spatial dimensions required by string and membrane theories had no effect at all on fundamental physical processes such as atomic-scale motion.

So here now is a 3-line derivation of the Schroedinger Equation for motion in "free space" of an atomic-size particle, which does not require any kind of wave:

A remarkable equation in pure mathematics (Euler's Equation) is:

$$\exp[-2i\pi] = 1, \tag{i}$$

Write:

$$\exp[-2i\pi\{x/\lambda - t\nu\}] = \psi, \tag{ii}$$

so that whenever the item in braces {} is an integer, then $\psi = 1$, but ψ is otherwise imaginary. ψ is not a wave: see Figure 1. The choice of x/λ – tv for the term in braces {} is explained as follows:

x is the distance of a moving elementary particle along a free-space trajectory and t is its time along that trajectory.

λ is the jump distance of the particle along its trajectory and v is its jumping frequency—a diffusion-type model. So x/λ is an integer if the distance X is a whole multiple of h. tv is the number of jumps in time t.

Whenever x/λ and tv are both integers, the particle is at a jump halt and is considered to be "present" (here in 3-D), but otherwise it is in transit and is considered to be in a higher (4th) spatial dimension and thus not present (imaginary) in our 3-D world.

The difference of 2 integers is also an integer, so they can be conveniently combined as in Equation ii above, to represent travel through both space and time. Figure 1 plots this equation, showing ψ is unity where and when x and t are both integers, but ψ is imaginary elsewhere as required on the above model.

Finally, apply De Broglie's Equation to the x/λ term, and Planck's Equation to the tv term, to get

$$\exp[-2i\pi\{xmv/2h\} - tE/h] = \psi, \tag{iii}$$

which is a well-known solution of Schroedinger's Equation, where E is kinetic energy only: Schroedinger's time equation is

$$d\psi/dt = (hi/4\pi m)[d^2\psi/dx^2]$$

Cf. Fick's 2nd Law:

$$dC/dt = D[d^2C/dx^2],$$

derived 70 years earlier.

As mentioned above, diffusion of pollen grains, or of ions jumping through a lattice, have no wavelike character, so Schroedinger's Equation need not have, either.

Schroedinger's Equation gives correct results for atomic-scale phenomena and so must form a part of any valid theory of Nature.

No Wave Function

Thus the "diffusivity", D, of a moving elementary particle is imaginary, meaning simply that it does not continuously exist in 3-D space. Prior to the introduction of 10-D space by quark string theory, the imaginary values of ψ embarrassed physicists, who only considered 3 dimensions and thus decided in effect to square ψ to force it to be real and thereby artificially created "matter waves". They called this process "normalising" ψ, and it compelled ψ to conform with the then "world view" of what Nature was felt to be. This understandable attitude at that time (that there are no higher dimensions) is very well illustrated by many standard textbooks which assert that "the particle must be somewhere", to "justify" effectively squaring ψ to prevent it from being imaginary (nowhere in 3-D space)! This procedure discounts the possibility that it actually could sometimes be nowhere in our 3-D space, if it oscillates or spins in and out of 4-D space. This "normalising" approach artificially creates a fractional probability (i.e., an uncertainty) that a particle is present at any given location, which creates the notion that particles can somehow exist as waves and leads to interpreting ψ as a "wave function". But De Broglie intuitively said that "matter waves" are "ondes fictives".

The following assertions are cited from classic texts which pre-date quark string theory and are based on the then "world view" of Nature. In considering these, a remark by Huxley should be recalled: "Nature is not only stranger than we have thought, It is stranger than we *can* think!"

Moelwyn-Hughes (1961) asserts, "the particle must be somewhere".

Margenau & Murphy (1961) remark, "if initially there was a certainty of finding a particle somewhere in space, there might later be uncertainty, this is a situation which would clearly be physically untenable".

Cottrell (1960) asserts, "... the chance of finding the free electron somewhere in the metal must be unity".

Moore (1962) remarks, "ψ must be finite and continuous for all physically possible values of x. The requirement of continuity is helpful in the selection of physical reasonable solutions for the wave equation".

They then all effectively use ψ^2 to ensure that this view prevails and discard ψ.

Margenau & Murphy (1961) grumble that a function like Equation ii above, which, when plotted, is a series of horizontal points separated by imaginary gaps, "is a monstrosity"! It is shown in Figure 1. But it comes directly from Euler, whose equations (18th century) are also used in modern quark string theory.

Feynman (1966) avoids being so blunt, but instead asserts, "*We want* a function to be *zero* everywhere but at a point". But he admits, "there is *no* mathematical function which will do this!" (his exclamation mark). But instead of accepting this strong hint from Nature not to do it (you can lead a horse to water but you cannot make it drink!), the unnatural step is then customarily taken of artificially *defining* such a made-up function, called the Dirac delta function.

Schroedinger (1926) with some insight said, "One may be tempted to associate ψ with a *vibrational process* in the atom, a process possibly more real than electronic ..." and "The ψ function itself cannot and may not in general be interpreted directly in terms of 3-D space—because it is in general a function in configuration space and not in real space". Before the advent of 10-D quark string theory, "configurational space" was the only term that could be used.

Quantum-Mechanical Tunnelling

"Quantum-mechanical tunnelling" (well named) then becomes the ability of an elementary particle to pass in a non-3-D-material form, from one 3-D location to another without moving through any of the 3 dimensions—i.e., via a "worm-hole" in 3-D (but without any Relativity connotations—its motion is absolute—see below). There is no need for a "wave-nature" explanation for quantum-mechanical tunnelling.

In diffusion through oxide layers, for example, quantum-mechanical tunnelling allows electrons to reach the outer surface of the thin highly insulating oxide film on aluminium and thus creates a billion volts/metre field, which then drives further oxidation unless prevented (Moussa & Hocking, 2001). These electrons cannot have reached the outer surface of the alumina layer by moving through the alumina, as there is no electronic conductivity.

Special Relativity Equations Derived Assuming Absolute Motion: Rest Mass; Length and Time Dilation; $E = mc^2$

On the basis of the "Big Bang" theory with its residual microwave radiation, it is concluded that there is an absolute reference point of origin (the "Big Bang" site) in space. This negates the 1st Principle of Special Relativity, which denies an absolute reference point in space. A Big Bang point of origin in 3-D space would also be accessible in higher dimensional spaces.

A 2-line derivation is given below, of the mass, time and length dilation formulae of Special Relativity but without assuming any relativity.

2-D space is not viable for the existence of life forms because the complexity required for brain interconnections, digestive tracts, etc. requires 3-D. Simple calculations show that electron orbitals in atoms would not be stable for dimensions higher than 3, which makes only 3-D space uniquely suitable for life:

The electrostatic force falls off as the inverse square of distance in 3-D, but it would fall off as the inverse cube in 4-D space (it would then be too weak to bind electrons to their atoms). The inverse square arises simply because a given flux through unit element of area on the surface of a 3-D sphere is spread out in proportion to the square of the radius, as the area of a 3-D sphere is $4xr^2$, but the volume of the 4-D analogue of a sphere is proportional to r^3.

A 3-D elementary particle and derived particles like atoms and molecules cannot make up a 4-D object, because they have no extension in the direction of a 4th spatial dimension. So they (and any larger body they constitute) are thus confined to 3-D space only and so cannot enter 4-D space, with the 1 very localised exception described in the section on Rest Mass below, as part of a very small amplitude oscillation. For a larger scale excursion into a 4th or higher dimensions, the 7 orders of coiling-up of the 7 higher dimensions in 3-D particles must be reduced by 1 order, each time the next higher dimension is reached.

Rest *Mass*

In 3-D space, elementary particles which constitute molecules, etc., are proposed in the Introduction above as being like gas bubbles in a continuous medium (Dirac, 1962; Besant & Leadbeater, 1994). However, a continuous medium cannot be described as a "fluid" because a fluid is able to flow and thus permits particles to move through it due to mobile atomic-size "holes" in it (in the conventional well-known "hole theory" of fluid flow). E.g., a solid metal does not flow—its viscosity is extremely large, but in the liquid state metals contain a large proportion (about 10%) of "holes", which confers a very low viscosity to them and they then flow very easily.

An analogy is the common observation of a solid block of ice which has tiny bubbles of air trapped in it—these bubbles are "locked up solid" and cannot move at all.

Thus it is proposed that 3-D elementary particles (bubbles) in the continuous background medium can only have zero velocity in it. Actual physical movement which is of course commonly observed in 3-D space can then be postulated as occurring by the following mechanism, which is necessarily similar to diffusion (being movement through a medium). This accords with the identical functional forms of Fick's 2nd Law of Diffusion and Schroedinger's Equation.

If 3-D space consists of a 3-D continuous background medium (Besant & Leadbeater, 1994) as explained above (cf. air bubbles in block of ice model) an elementary particle (bubble) would be unable to move in any of the 3-D directions. But if it were able to jump out as part of an oscillation into a higher spatial dimension where there is no such continuous medium, it could then move and then land back in the 3-D space medium in a different place.

An elementary particle might be rotating and vibrating continuously (even if at rest in 3-D space) in a path which takes it continuously in and out of the 4th dimension (an effect similar to zitterbewegung). "Zero-Point Energy" means that even at zero degrees Kelvin "rest", a particle is still oscillating incessantly (called "zitterbewegung", *Ger.* "trembling"). If the energy (welling-up from a 4th spatial dimension) creating the 3-D bubble has a characteristic velocity of c, then an observed average velocity v through the 3-D medium would consist of periods at zero velocity in 3-D (due to its very large viscosity) alternating with jumps at velocity c in 4-D. A characteristic velocity of c is not extraordinary—e.g., a photon in free space has only got this 1 velocity, c, the velocity of light.

Jumps into the next higher dimension would only be possible for elementary particles as the amplitude of an excursion into 4-D space would be limited to the very small diameter of the coiled-up 4th dimension for 3-D particles, and not available to large bodies, and it is called "quantum-mechanical tunnelling" in physics but not yet interpreted as involving jumps into 4-D space. If there are higher dimensions, it would be very odd if they were not involved at all in atomic-size processes. They cannot just apply to quark physics and nothing else.

Such a model leads immediately to Schroedinger's time and distance equations (for a case with zero potential energy), as shown above. It also provides a theory of rest mass, and leads to the same experimentally verified *equations* of Special Relativity but for *absolute* motion. The derivation is far simpler than that from Special Relativity. This absolute motion derivation uses the assumption of quark string physics that there are more than 3 dimensions in space.

The mass, length and time dilation equations are easily obtained immediately

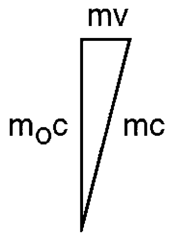

Fig. 2. $(m_0c)^2 + (mv)^2 = (mc)^2$.

by solving a Pythagorean triangle with sides m_0c, *mv* and the resultant *mc* (Figure 2).

m_0c can be regarded as the momentum of creation of a particle at rest in 3-D space, due to an energy welling-up from the direction of a 4th spatial dimension (which is at right-angles to any 3-D direction); m_0 is the rest mass of the resulting stationary particle in 3-D space, which this force creates. If the particle is then made to move in 3-D space, by giving it momentum in a direction in 3-D space, it will then have an *extra* momentum *mv* (see Figure 2), at right-angles to its rest-mass (4-D) momentum-of-creation vector, where *m* is its mass and v is its observed velocity in 3-D space. The resultant *total momentum content of the particle* due to these 2 momenta is *mc* (see Figure 2), *m* being the dilated (increased) mass of the particle due to incorporation of its extra energy of motion in 1 of the 3-D directions (this is additional to its rest-mass energy welling-up from the 4th dimension). The momentum of creation must be at 90° to any momentum of motion in 3-D, because the 4th dimension direction by definition is at 90° to all 3-D directions—hence the Pythagoras triangle in Figure 2.

So, from Figure 2:

$$(m_0c)^2 + (mv)^2 = (mc)^2,$$

which rearranges to:

$$m_0 = m\sqrt{1 - v^2/c^2}$$

This is the well-known and experimentally verified "relativistic" mass dilation formula but has been derived above for absolute motion in only 2 lines and without assuming the 2 principles of Special Relativity.

Time Dilation

Time dilation will also occur, because when a particle (e.g., a meson) is jumping in the 4th dimension, its internal decay processes will be frozen for the duration of that jump and so its lifetime will be extended. The well-known time

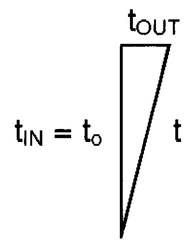

Fig. 3. $t^2 = t_0{}^2 + t_{OUT}{}^2$.

dilation formula can then also be obtained immediately, as above, from a Pythagorean triangle (Figure 3) with sides t_0, t_{OUT} and t, as explained below.

To explain this, pursuing the analogy with diffusion, assume that the motion of an elementary particle occurs by very short jumps alternating with longer stationary periods, thus allowing any observed overall velocity to be made up, modelled on the conventional mechanism of diffusive jumps of atoms or ions through a lattice, from site to site.

There are only 2 velocities possible, zero for the periods at rest in the 3-D world, and c for the periods when the energy constituting the particle is moving in 4-D space. Any actually observed overall velocity, v ($0 < v < c$), is then made up of rapidly alternating combinations of these 2 values. The moving particle travels in a series of very small jumps each of which is at velocity c, separated by a series of short pauses at velocity zero (analogous to the movement of the frames of a film strip), so that the overall actually observed velocity is apparently v. This 4-D jumping model is consistent with the explanation given of the imaginary values of ψ given above.

A moving atomic-size particle is thus a "particle" when stationary and may appear to be an apparent "wave" (a non-particle) when jumping. Light photons alternately jump a distance λ in λ/c seconds followed by a stationary instantaneous wait or appearance. It is thought that photons (unlike gravitons) cannot move appreciably away into 4-D and so are bound to continually intersect our 3-D world.

Let the total stationary time (spent residing at successive positions) be t_{IN} and the total transition time (spent in jumping between these positions) be t_{OUT}. The inactive stationary time elapsing between jumps (t_{IN}) can have any value ($0 < t_{IN} < \infty$). t_{OUT} is the time taken for a transition or jump between residences, and represents a non-material (non-particle, apparently wavelike) condition in between the physical sites at which the moving particle successively resides. It means that there is no physical movement at all and that all actual movement occurs during the time when the particle is in 4-D, by a series of non-material (non-3-D) jumps. It is somewhat analogous to the conventional diffusion mechanism for an atom or ion diffusing between fixed lattice sites. If Zero-Point energy involves continuous vibration, or rotation, into and out of 4-D, then this process is facilitated by that and does not need a separate ad-hoc mechanism for it.

Consider now the motion of a mechanical clock which contains a balance wheel. On the proposed theory, the balance wheel (=B) jumps have their specific discrete B activations, but when the clock (clock = C) as whole is also set in motion, specific discrete C activations will occur additionally. Any activation effect which becomes due to cause an imminent balance wheel (B) jump during the course of a clock (C) jump, would be inoperative, as the clock is "frozen"— already engaged in a jump and so its balance wheel cannot also simultaneously move then. Consider the clock to be moving much faster than the balance wheel rotations. Then the balance wheel (B) jump frequency is comparatively very low and those B jumps which arise during a regular C jump will be lost. The consequent loss of some B jumps will (in effect) slow down the balance wheel. Consider now the motion of a clock whose tick-tick period is t_0 *at rest,* which corresponds to t_{IN} as defined above. Let this clock travel with a constant overall velocity v and record the passage of 1 tick-tick time period t_0 during its travel through a certain distance s. The total C jumping time (at velocity c) which is non-material (being in 4-D), is not sensed or recorded by the clock (by B jumps, as explained above) is t_{OUT} where

$$t_{OUT} = \text{distance}/\text{velocity} = s/c = vt/c \tag{iv}$$

A stationary observer would have a total time t in Equation iv above, elapsed on his watch, as being the time taken for the moving clock to travel the distance s. Now, $t > t_0$ or t_{IN} due to the additional time t_{OUT} taken for the journey, noticed only by the stationary observer, which must be added to t_0. This addition must be vectorial, because as the moving clock does not sense or record t_{OUT} there is no break (in its sensation of time) at which t_{OUT} can be added in a scalar manner. t_{OUT} and t_{IN} have no component in common and must thus be added as vectors at right-angles (Figure **3).** This gives

$$t^2 = t_{IN}^2 + t_{OUT}^2, \tag{v}$$

by Pythagoras' Theorem, or

$$t^2 = t_0^2 + t_{OUT}^2.$$

Substituting t_{OUT} from Equation iv above,

$$t_0^2 = t^2 - v^2t^2/c^2,$$

which is the well-known Time Dilation formula of Special Relativity, but all the assumptions of Special Relativity are avoided. This equation has been well-verified experimentally, e.g., by the increased lifetimes of decaying mesons which are moving very fast, compared with slow-moving mesons.

The time dilation formula can also lead to an alternative derivation of the mass dilation formula, already derived otherwise, above.

Fitzgerald-Lorentz Length Contraction

Similarly, the length of a moving body will contract (only in the direction of travel) due to the interatomic cohesive forces pulling in its length across planes of jumps when it is in 4-D space (where it is not affected by 3-D electrostatic cohesive physical forces; only gravity can enter 4-D space and gravity is not involved in cohesive forces).

A similar Pythagorean triangle gives the well-known length contraction equation. The length of a moving object is proportional to the number of moving elements materially present ("IN") in it along any given line in the direction of motion. The term "moving element" merely refers to an elementary particle of the moving object. Along any such line through the object, some of its moving elements will be jumping ("OUT") and thus materially absent from the object. At a steady velocity there will be a steady proportion of moving elements thus missing, and a consequent shrinkage of the length of the object in the direction of its motion (due to the attractive forces of cohesion acting across the OUT gaps). Planes of OUT gaps (analogous to vacancies) would be expected to sweep through the object (which is not imagined to jump all at once, but as individual particles or moving elements) in the direction opposite to that of the motion; the planes of moving elements would be set perpendicular to the direction of motion; thus there is no reason for shrinkage of the object in other directions than that of the motion. Consider now a moving object, of rest length L_0 measured in the direction of its motion. At rest,

$$L = L_0 \text{ and } t_{\mathrm{IN}} = t.$$

The number of planes (perpendicular to the direction of motion), of moving elements which are materially present (IN), at velocity v, is

$$n = n_0(t_{\mathrm{IN}}/t),$$

where n_0 is the number of such planes present at *rest* (for which state $t_{\mathrm{IN}} = t$).

$$n_0 \propto L_0 \text{ and } n \propto L,$$

where n and L are number and length respectively, at a steady velocity v.

Thus, from $n = n_0(t_{\mathrm{IN}}/t)$ above, we have:

$$L = L_0(t_{\mathrm{IN}}/t) = L_0\sqrt{t^2 - t_{\mathrm{OUT}}^2}/t,$$

using Equation v above, so

$$L = L_0\sqrt{1 - t_{\mathrm{OUT}}^2/t^2},$$

and then using Equation iv above we obtain:

$$L = L_0\sqrt{1 - v^2/c^2},$$

which is the Fitzgerald-Lorentz length contraction.

An alternative approach also follows from the assumption that when an object is travelling, some of the elementary particles constituting it are engaged in a jump in *4-D* and are thus "missing" from the 3-D object, as suggested by the interpretation of Schroedinger's Equation given earlier. Consider the number of elementary particles in a line in its direction of travel to be n_0 at rest and n at velocity v, where $n < n_0$ as some of them are jumping. n and n_0 are their numbers in 3-D space.

As mass in conserved, $n_0 m_0 = nm$, (where m is the enhanced mass at velocity v given in $m_0 = m\sqrt{1 - v^2/c^2}$).

Then, as $n_0 \propto L_0$ and $n \propto L$, for a line in the direction of motion of the object, $L_0 m_0 = Lm$ and so $L = L_0\sqrt{1 - v^2/c^2}$.

This is the Fitzgerald-Lorentz length contraction.

$E = mc^2$ Derivation

The well-known Relativity equation $E = mc^2$ can also easily be obtained (for absolute motion), by elementary algebra: From the Pythagoras triangle of the Rest-Mass section above,

$$(m_0 c)^2 = (mc)^2 - (mv)^2.$$

(See Figure 1). Take differentials:

$$0 = 2c^2 mdm - 2mv^2 dm - 2vm^2 dv$$

Divide both sides by *2m:*

$$c^2 dm = v^2 dm + mvdv \quad \text{(vi)}$$

By definition, force is rate of change of momentum, so

$$F = d(mv)/dt = m(dv/dt) + v(dm/dt)$$

By definition, a force is also an energy field or gradient, *dE/ds* and velocity $v = ds/dt$ where s is distance. So

$$dE = Fds = m(dv/dt)ds + v(dm/dt)ds = mvdv + v^2 dm$$

Compare this with Equation vi above:

$$dE = c^2 dm,$$

so, integrating,

$$E = mc^2$$

(Einstein's Equation). The integration constant is zero, as $E = 0$ when $m = 0$.

Heisenberg's Uncertainty Principle

Heisenberg's Uncertainty Principle takes on a new meaning: a moving particle will actually spend most of its time at rest (punctuated by very short times at c), but its experimentally observed velocity is measured as v, and so a measure of the uncertainty in its velocity at any instant will be $v - 0 = v$. (This uncertainty depends on exactly when an observation is made and so is in the mind or control of the observer and is not a property of the particle.) From de Broglie's Equation, mv is proportional to *hlh*, and so the Uncertainty Principle becomes an expression of de Broglie's Equation if λ is interpreted as the moving particle's smallest jump length on the above diffusion model for motion.

Spin

An object in 3-D requires a rotation of 360° to return it to its original position, but a bizarre 720° of rotation (not just 360°!) is required to bring fermions ("spin-½" particles, such as protons) back to their original state. This is easily explained as follows, on the above model:

For clarity, a 2-D/3-D analogue will be used, instead of 3-D/4-D. If a lowercase letter "d" is lifted out of its 2-D paper sheet and turned over in 3-D space and then put back as a "b", then this would appear to a 2-D inhabitant to be a d ⟵⟶ b vibration with only its antinodes (d & b) being visible. If this d ⟵⟶ b vibration is analogous to Zero-Point Energy vibration, then if the "d" is also spinning in 2-D (d ⟵⟶ p ⟵⟶ d), then after 360" of spin in 2-D it could have simultaneously rotated to a "b" by the 3-D rotation, which means that the 360" spin in 2-D did not return the "d" back to its initial state and that a further 360° of 2-D spin is needed, by which time the "b" would have rotated back to a "d" in its simultaneous 3-D rotation. Thus a bizarre (to a 2-D observer) 720" of spin is required for a "d" spinning in 2-D space to return to its original "d" state.

With this preamble, for our case in 3-D space, an observed (in 3-D) rotation of 720° is needed to return a proton to its original state, which can easily be explained analogously to the example above. In 3-D to 4-D terms, this means that (to give an analogy) a tennis ball spins in 3-D and 4-D simultaneously but after 360" of observed (in 3-D) rotation the ball would be everted (i.e., having its fluffy side inside and smooth side outside, without loss of the gas pressure which it contains) by the simultaneous 4-D rotation and so clearly a further 360° of observed (in 3-D) rotation would be needed for it to return (by further 4-D rotation) to its original state with the fluffy side outside, making a total of 720°!

This can only be understood in terms of the existence of 4-D space, and it happens routinely for elementary particles, which have access to 4-D space.

Note. A *rotation* in 3-D could only be perceived by a (hypothetical) 2-D observer as a *vibration* (like Zero-Point Energy). And a rotation in 4-D could only be perceived by us (in our 3-D world) as a vibration (Zero-Point Energy).

Access of large objects to 4-D space is problematical. Eversion of tennis balls has been reported anecdotally which is, of course, not scientifically acceptable, but there is a report in Nature by Hasted et al. (1975) of a refractory crystal of vanadium carbide being removed from a sealed tube in laboratory conditions, without any contact being made with the tube, which could only be feasible by transfer out via 4-D space.

References

Besant, A., & Leadbeater, C. W. (1994). *Space and Particles.* http://www.4-D.org.uk. Accessed November 2006.

Cottrell, A. H. (1960). *Theoretical Structural Metallurgy.* Arnold.

Dirac, P. A. M. (1962). *The Conditions for a Quantum Field Theory to Be Relativistic.* Proc Royal Soc (London) Series A 268, 57; see also Stedile, E. (2004). Quantum Aspects of the Fundamental Dirac Membrane Model. *Int J Theor Phys, 43,* 385.

Feynman, R. P., Leighton, R. B., & Sands, M. (1966). *The Feynman Lectures on Physics* (Vol. 3). Addison-Wesley.

Hasted, J. B., Bohm, D. J., Bastin, E. W., O'Regan, P., & Taylor, J. G. (1975). Recent Research at Birbeck College, University of London. *Nature,* 254, 470.

Margenau, H., & Murphy, G. M. (1961). *The Mathematics of Physics & Chemistry.* van Nostrand.

Moelwyn-Hughes, E. A. (1961). *Physical Chemistry* (chapter "Mathematical Formulation of the Quantum Theory"), Pergamon Press.

Moore, W. J. (1962). *Physical Chemistry.* Longmans.

Moussa, S., & Hocking, M. G. (2001). Photo-inhibition of Localized Corrosion of Stainless Steel in NaCl Solution. *Corrosion Science,* 43, 2037.

Schroedinger, E. (1926). Quantisation as a Problem of Eigenvalues. *Annalen der Physik, 79,* 372; and Schroedinger, E. (1926). Quantisation as a Problem of Eigenvalues. *Annalen der Physik, 81,* 135 [Quoted by M. Jammer in "Conceptual Development of Quantum Mechanics", p. 372, 267, McGraw-Hill (1966).]