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Vir Theory of Particles

M. J. Germuska
Retired, 47 Clifden Road, Worminghall, HP18 9JR, UK.
mgermuska@aol.com, phone: +(44) 1844 339754

Abstract

A new theory of particles is presented based on solid mathematical foundations of Variational Calculus, Euler's Equations of Motion and Special Relativity. The Vir Theory of Particles explains that a particle is a stationary circular wave created by the motion of a quantum vortex in the relativistic ether. Mathematical equations show that they must have integer or half-integer spin, explain why $E = h\nu$, why the electric charge must be plus, minus or zero, why neutral particles come in right-handed and left-handed pairs, why charge-parity-time (CPT) transformation are invariant and why there is no stable anti-matter, except for the very light anti-atoms. A simple formula for the relationship between particle spin and mass is also derived, that can be used to verify the theory using the existing PDG data.

Keywords: particles, theory, spin, mass, electric charge, CPT, anti-matter

1. Introduction

All known matter has a hierarchical structure with smaller and smaller entities. The smaller entities orbit the centre of a larger entity, or each other. It is believed that in the centre of each galaxy is a black hole orbited by stars. Stars are orbited by planets. Planets are made of atoms that have a nucleus made of protons and neutrons, while the nucleus is orbited by electrons. It is also believed that protons, neutrons and other hadrons are made up of quarks that orbit inside them giving particles the spin and almost all of their mass.

It is conceivable that this structure goes on for ever. However, this paper explores the possibility that the process is finite, ending with some fundamentally different ultimate entity that must be unique, with the least resistance to some kind of motion. The theory must have solid mathematical foundations based on the principle of least effort, i.e. least action [1], [2], which is shared by all successful theories including Optics [3], Newtonian Mechanics [4], Special Relativity [5], General Relativity [6] and Quantum Mechanics [7].

For the ultimate entity to be fundamentally different it must have no orbiting parts, although it must have integer or half-integer spin like all particles. The spinning motion of macroscopic bodies is governed by the Euler's equations of motion [8] which tell us that a spinning top in fluids can create a circular wave. The wave destroys itself, unless it has integer or half-integer spin. Hence the ultimate entity should have the shape with the least resistance to spinning. This shape is a spheroid [9], a convex object with a circular footprint and elliptical profile. This may explain why stars, planets and moons are all spheroids.

However, the integrals for mass and moments of inertia of spheroids do not lead to a formula connecting spin and mass, since there is no algebraic solution to polynomials with powers greater than three. On the other hand, if instead of convex shapes we consider concave we find that the shape with the minimum moment of inertia is that of a vortex [9] and we obtain an algebraic spin-mass formula that gives the mass for over 200 particles with the accuracy of the measurement errors, as will be shown in the next paper.

We propose that a particle is a three dimensional quantum vortex in relativistic ether [10] consisting of twin vortices with the common spin axis connected at the large ends, a shape called Vir [11]. Vir Theory explains mathematically why spin is quantised, why $E = h\nu$; why electric charge is positive, negative or neutral; why neutral particles come in right-handed and left-handed pairs; why particles are invariant under the charge-parity-time (CPT) transformation; why there are stable anti-particles, but no stable anti-mass, except for the anti-atoms with very few anti-protons and anti-neutrons.

Quarks are simply assigned spin and charge and do not provide an explanation for any particle properties mentioned above. In fact using quarks and quantum mechanics we are unable to calculate any of the main properties of hadrons, such as the mass, Breit-Wigner width and branching ratios.

However, using quantum mechanics we can calculate properties of much larger objects, such as the radius of the hydrogen in the ground state. The radial probability density for the hydrogen ground state is obtained by multiplying the square of the wave function by a spherical shell volume element.

$$dP = \frac{4}{{a_0}^3} r^2 e^{-2r/a_0} dr$$

It takes this comparatively simple form because the 1st state is spherically symmetric and no angular terms appear. Dropping off the constant terms and taking the derivative with respect to *r* and setting it equal to zero gives the radius for maximum probability we get the expression

$$dP = 2r^2 e^{-2r/a_0}\left[1 - \frac{r}{a_0}\right] = 0$$

Thus for the radius we have

$$r = a_0 = 0.0529nm$$

The most probable radius is the ground state radius obtained from the Bohr theory. The Schrodinger equation confirms the first Bohr radius as the most probable radius.

We cannot use this simple approach because it assumes that a particle consist of several much smaller parts, which our theory excludes. Furthermore, we will not use the Schrodinger equation either because this was attempted to calculate the mass of hadrons using quarks and the attempt failed. However, we will use quantum mechanics mainly in the form of stationary waves and DeBroglie waves.

Using the Euler equation for the movement of macroscopic spinning tops in the absence of external forces (such as the gravity) where the top and the bottom parts are identical we find that the combination of spinning, precession and nutation make the spin axis describe an almost circular wave. If the spinning top is not solid but is a heavy fluid submerged in a lighter fluid then the head of the wave interferes with the tail and if they are in phase a stationary wave is created. If the head and tail are way out of phase the wave destroys itself, the spinning top loses its energy and may eventually stop spinning or dissipate.

An example of a macroscopic spinning top with a heavy fluid submerged in a lighter fluid is a hurricane where the cold air at high altitude falls down the hurricane's eye down to the ground. However because of the gravity the top of the hurricane is very different to its bottom which does not satisfy the Euler's conditions above and thus the stationary circular waves do not occur. The situation is different in the outer space with negligible gravity where the "top" and the "bottom" of a vortex are the same. Such a vortex may look like two identical vortices on Earth joined at the large ends and having a common axis of rotation.

Thus we assume that a particle is a three dimensional quantum vortex, essentially a three dimensional stationary wave. Throughout the paper we refer to macroscopic spinning tops in order to provide a visual aid for easier understating of the equations and the concepts involved.

We will show by solving the Euler equations of motion for rotating bodies that in the absence of external forces a Vir with its spinning, precession and nutation can under suitable conditions result in a circular wave, where the head chases its tail. Such a wave destroys itself after one precession if the head and tail are out of phase, but results in a stationary circular wave if they are in phase.

If a spinning top has a perfectly circular footprint then its spin axis precesses in a perfect circle, with no nutation and the spinning does not create any waves if its environment is friction-less. If the top has an elliptical footprint then its spin axis follows a wavy circular motion, but this motion is such that the top never returns to its initial state and thus it cannot produce a stationary wave. However, if the top is only very slightly elliptical and its axis almost coincides with the total angular momentum vector then its motion can produce an almost standing wave, if some additional conditions are met.

A spinning top that is symmetrical about axis z and about xy plane has three moments of inertia Ix, Iy and Iz, where $Ix \approx Iy$ if its footprint is almost circular. The additional conditions are that the ratio of its moments of inertia Ix/Iz is an integer or half-integer. If the ratio is an integer then the top (almost) returns to its initial state after one precession and if it is a half-integer then after two precessions. This restricts particles to the spin that we observe.

Electro-magnetic fields for two inertial observers moving with relative velocity v are related by Lorentz transformations used in Special Relativity. If the relative velocity $\boldsymbol{v}$ between two observers is along their z axes then the z components of the electric and magnetic fields are the same for both observers, but the x and y components are different [12]. If in a "stationary frame" the electric field is absent then the "moving" frame acquires electric field with non-zero x and y components. In Vir theory this leads to the explanation why particles have electric charge.

Lorentz transformations can be expressed by hyperbolic functions of a real argument that is zero for $v = 0$ and infinity for $v = c$ [13]. Alternatively we can use an imaginary argument with trigonometric functions. Thus we can consider these transformations as rotations by an imaginary angle in zt plane, where axis z is aligned with the velocity of the moving observer. If the rotation in zt plane is positive the ether flows out from the ends of the Vir and we have a positive particle. If the ether flows in through the ends of the Vir we have a negative particle. If it flows in from one end and out from the other we have a neutral particle.

This completes the description of all possible Vir rotations in space-time. These rotations reveal the origin and nature of spin and electric charge in particles and lead to explanations of other particle properties.

CPT is the most fundamental conservation law observed in particle physics, but there is no explanation for this in terms of quarks. The time transformation T reverses all motion and transforms a particle to an anti-particle. Using this concept of anti-particles Vir Theory shows that CPT transformation must be invariant.

The integrals for the mass and the moments of inertia for the Vir can be evaluated algebraically and using these expressions one can obtain an algebraic formula for the relationship between the spin and mass of Vir. It is a formula that allows several masses for a given spin and vice-versa. This formula can be tested using the existing particle data and thus verify the correctness of Vir Theory.

2. Vir moments of inertia and mass

It has been proven mathematically using the Euler-Lagrange equations that the symmetric concave spinning top with the minimum moment of inertia, i.e. with the least resistance to spinning, has the shape of a solid of rotation generated by the profile function r(z) called Vir [9].

$$r(z) = a\left(\frac{a}{|z|}\right)^{\alpha} \qquad \text{where} \qquad \alpha \succ 0 \quad a \succ 0 \quad r(0) = \infty \tag{2.1}$$

The parameter *a* gives the size, if *z* = *a* then *r* = *a* and vice versa, while the parameter α gives the shape. It has also been shown experimentally [11] that water and air vortices have the Vir shape with α = [0.6, 2.5].

Vir Theory of Particles assumes that particles are symmetric twin vortices in the relativistic ether, i.e. consisting of two vortices spinning about a common axis that are joined at the large ends. For the purpose of calculating the volume, mass and the moments of inertia we can treat a particle as a symmetric solid of revolution generated by the profile function r(*z*) in (2.1).

Since for symmetric twin vortices *r*(*z*) = *r*(-*z*) it is sufficient to consider *r*(*z*) only on the interval [0, *Z*] where *Z* is half height of the Vir. For a profile curve *r*(*z*) the expressions for mass *m* and the moments of inertia around axes *z* and *x*, i.e. *Iz* and *Ix* are

$$m = 2\rho\pi\int_0^Z r(z)^2 dz \tag{2.2}$$

$$I_z = \rho\pi\int_0^Z r(z)^4 dz \tag{2.3}$$

$$I_x = \rho\pi\int_0^Z \tfrac{1}{2} r(z)^4 + 2r(z)^2 z^2 dz \tag{2.4}$$

Since the shape of the vortices is the solid of rotation around axis *z* generated by the profile function *r*(*z*) the moment of inertia around axis *y* is the same as around axis *x*. The evaluation of the above integrals gives the following formulas with finite values, provided the parameter α is restricted as shown below.

$$m = 2\rho\pi\frac{a^{2+2\alpha}}{1-2\alpha}Z^{1-2\alpha} \qquad \alpha < ½ \tag{2.5}$$

$$I_z = \rho\pi\frac{a^{4+4\alpha}}{1-4\alpha}Z^{1-4\alpha} \qquad \alpha < ¼ \tag{2.6}$$

$$I_x = \rho\pi\frac{a^{2+2\alpha}}{3-2\alpha}Z^{3-2\alpha} \qquad \alpha < 3/2 \tag{2.7}$$

Using the formulas (2.5), (2.6) and (2.7) above we find the following formula for mass m

$$m = b(2\sigma - 1)^{\beta} \tag{2.8}$$

where
$$\sigma = \frac{I_x}{I_z} \tag{2.9}$$

and
$$\beta = \frac{1-2\alpha}{2+2\alpha} \qquad 1/2 \geq \beta > 1/5 \tag{2.10}$$

thus
$$\alpha = \frac{1-2\beta}{2+2\beta} \qquad 0 \leq \alpha < 1/4 \tag{2.11}$$

while
$$b = 2\rho\pi a^3 \frac{1}{1-2\alpha}\left(\frac{1}{4}\frac{3-2\alpha}{1-4\alpha}\right)^{\beta} \tag{2.12}$$

When we know the parameters b and β we can find the corresponding parameters a and α

$$a = \left(\frac{3b}{2\rho\pi}\frac{\beta}{1+\beta}\right)^{\frac{1}{3}}\left(4\frac{5\beta-1}{5\beta+2}\right)^{\frac{\beta}{3}} \tag{2.13}$$

Using the formulas (2.6), (2.7) for Ix, Iz we can obtain the expression for σ in (2.9) in terms of a, α and Z. Then using the formula (2.5) for mass m we obtain the formula for Z

$$Z = a\left(\frac{3-2\alpha}{1-4\alpha}\frac{2\sigma-1}{4}\right)^{\frac{1}{2+2\alpha}} \tag{2.14}$$

$$m_{\sigma} = 8\rho\pi\frac{1-4\alpha}{(1-2\alpha)(3-2\alpha)(2\sigma-1)}Z_{\sigma}{}^{3} \qquad 0 < \alpha < 1/4 \tag{2.15}$$

Since α and σ are dimensionless quantities we have the height Z in the units of the parameter a. The radius r in the formula (2.1) is also in units of a. In all the formulas shown in this section it is assumed that the radius r is infinite at z = 0. This is of course unrealistic, for a particle cannot span the whole of the universe. The infinite radius is assumed here because it leads to much simpler formulas and because it may give a sufficiently good approximation to our needs, but this will have to be found out experimentally.

3. Euler's equations of motion

To find the relationship between the moments of inertia and spin we start by investigating Euler's equations of motion for a solid rotating body [8]. We consider an inertia frame *XYZ* and a spinning top with the angular momentum vector ***M***. Since ***M*** is a constant of motion we can align axis *Z* with ***M***. We also have a frame *xyz* with the origin at the centre of mass of the spinning top and axis *z* coincides with the spin axis.

From the Euler's equations of motion we find that a symmetrical spinning top, i.e. one with the moments of inertia *Ix* = *Iy*, rotates (spins) about its axis *z* with a constant angular velocity Ω_z. Spin vector ***s*** precesses at a constant angular velocity Ω_{Pr} and at a constant angle θ relative to the total angular momentum ***M***.

The movement of axis *z* creates the surface of a cone and the end of the spin vector ***s*** describes a circle in a plane perpendicular to vector ***M***. The assumptions (3.1) and the solution (3.2) are below [14]:

$$\vec{M} = \text{constant} \qquad I_x = I_y \qquad \vec{I} = \text{constant} \tag{3.1}$$

$$\Omega_z = \frac{M}{I_z}\cos\theta \qquad \theta = \text{constant} \qquad \Omega_{\text{Pr}} = \frac{M}{I_x} \tag{3.2}$$

From (3.2) we find the following relationship between moments of inertia and angular velocities:

$$\frac{\Omega_z}{\Omega_{\text{Pr}}} = \frac{I_x}{I_z}\cos\theta \tag{3.3}$$

From the definition of the moments of inertia we have for any body the following inequality:

$$I_x + I_y \geq I_z \qquad \text{equality for a planar body} \tag{3.4}$$

For a symmetrical top we have *Ix* = *Iy* and therefore from (3.4) we get the following restriction:

$$\frac{I_x}{I_z} \geq \frac{1}{2} \qquad \text{for any symmetrical top} \tag{3.5}$$

There is a bottom limit of ½ on the ratio *Ix*/*Iz* for a symmetrical top. The limit is reached only by an idealized planar body, for a true three dimensional body the ratio is always greater than ½. Now, from equation (3.3) we find that for very small angle θ we have the following relationship:

$$\frac{\Omega_z}{\Omega_{\text{Pr}}} = \frac{I_x}{I_z} \qquad \text{as } \theta \to 0 \tag{3.6}$$

Therefore, there is a bottom limit on the rotation velocity Ω_z relative to the precession velocity Ω_{Pr} of ½ as θ tends to zero. There isn't any body that can rotate slower relative to precession.

4. Return of the symmetric top to the initial state

Euler's equations give us also an expression for the angular velocity **-** Ω_ζ (note the minus sign) with which vector ***M*** orbits an observer that is attached to the rotating body [15].

$$\Omega_\zeta = \Omega_z - \Omega_{\mathrm{Pr}} \cos\theta \tag{4.1}$$

An observer attached to the top in such a way that in the initial state is facing vector ***M*** will face vector ***M*** again on completion of one precession if $\Omega_\zeta/\Omega_{\mathrm{Pr}} = n$, where n is 0, 1, 2, 3, etc. The number n tells us how many times the observer will face vector ***M*** during one precession, including the final state, but excluding the initial state. When $n = 0$ then $\Omega_\zeta = 0$ and the observer is facing vector ***M*** all the time, never see any change. From (4.1) we get two equivalent return conditions:

$$\frac{\Omega_\zeta}{\Omega_{\mathrm{Pr}}} = n \qquad \frac{\Omega_z}{\Omega_{\mathrm{Pr}}} - \cos\theta = n \qquad n = 0, 1, 2, \text{etc.} \tag{4.2}$$

From (3.3) and (4.2) we find another condition for the return to the initial state after one precession:

$$\left(\frac{I_x}{I_z} - 1\right)\cos\theta = n \tag{4.3}$$

For very small precession angle θ we get $Ix/Iz = n + 1$ from (4.3), which means that the ratio Ix/Iz takes values of 1, 2, 3, 4 etc. Thus, when θ is very small the top returns to its initial state on completion of one precession under the following conditions:

$$\frac{I_x}{I_z} = 1, 2, 3, \text{ etc. as } \theta \to 0 \tag{4.4}$$

The conditions for returning to its initial state only on completion of the second precession are:

$$\frac{\Omega_\zeta}{\Omega_{\mathrm{Pr}}} = \frac{2n-1}{2} - 1 \qquad \frac{\Omega_z}{\Omega_{\mathrm{Pr}}} - \cos\theta = \frac{2n-1}{2} - 1 \qquad n = 1, 2, 3, \text{etc.} \tag{4.5}$$

$$\left(\frac{I_x}{I_z} - 1\right)\cos\theta = \frac{2n-1}{2} - 1 \tag{4.6}$$

Number $|2n\text{-}3|$ tells us how many times the observer will face vector ***M*** during the first two precessions, including the final state, but excluding the initial state. This time there is no solution for $n = 0$ since that would require negative Ix/Iz. For $n = 1$ we have $\Omega_\zeta/\Omega_{\mathrm{Pr}} = -1/2$ which means that the observer orbits vector ***M*** in the opposite direction to all other values of n. Thus, when θ is very small the top returns to its initial state only on completion of the second precession under the following conditions:

$$\frac{I_x}{I_z} = \frac{1}{2}, \frac{3}{2}, \frac{5}{2}, \text{ etc. as } \theta \to 0 \tag{4.7}$$

Figures 1 to 4 below show graphically the return to the initial state of the symmetric spinning top with a square footprint after one precession. The initial state is shown on the extreme right of each diagram. The condition for this return to occur is that $\Omega_\zeta/\Omega_{Pr} = n$, where n is 0, 1, 2, 3, etc. For the angle $\theta \rightarrow 0$ this is equivalent to the condition Ix/Iz = 1, 2, 3, 4, etc.

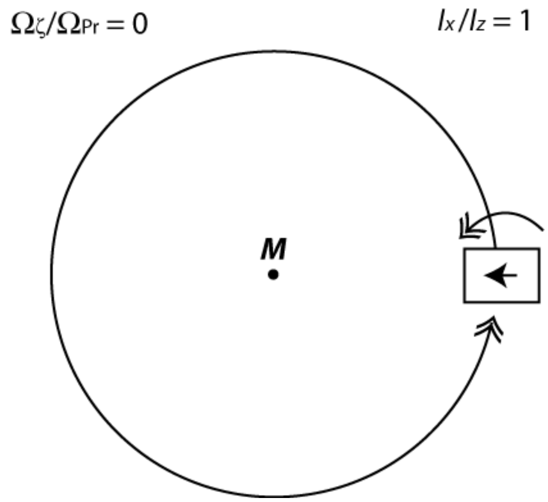


Figure 1. $\Omega_\zeta/\Omega_{Pr} = 0$

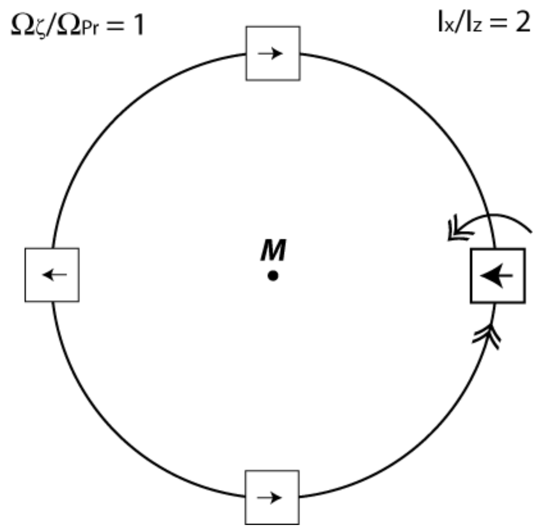


Figure 2. $\Omega_\zeta/\Omega_{Pr} = 1$

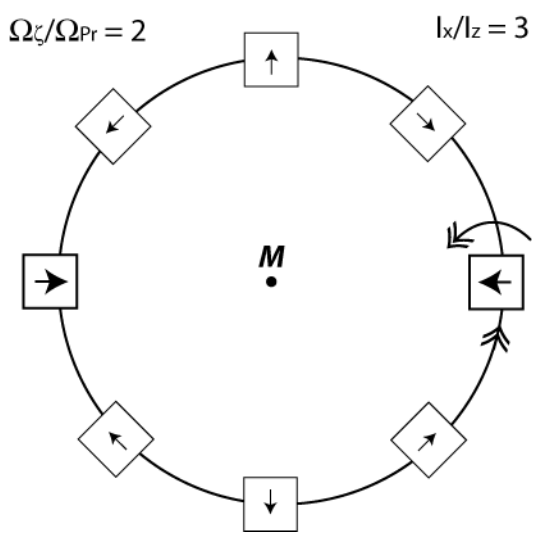


Figure 3. $\Omega_\zeta/\Omega_{Pr} = 2$

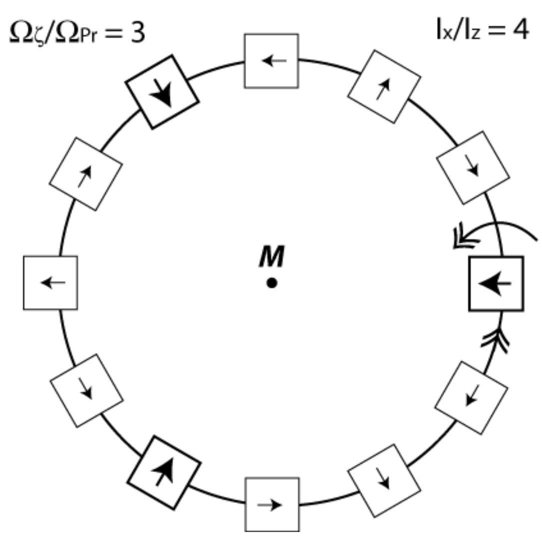


Figure 4. $\Omega_\zeta/\Omega_{Pr} = 3$

The diagrams show the movement of the spinning top in the XY plane of the inertial frame, where the axis Z is aligned with the angular momentum ***M***. The top spins anticlockwise and the precession is in the same direction, as indicated by the double arrows. The arrows inside the squares show the orientation of the observer on the spinning top and the bold arrows show when the observer faces directly vector ***M***.

The figures 5 to 8 below show graphically the return to the initial state of the symmetric spinning top with a square footprint after two precessions. The condition for this to occur is that $2\Omega_\zeta/\Omega_{Pr} = n$, where n is -1, 1, 3, 5, etc. For the angle $\theta \rightarrow 0$ this is equivalent to the condition Ix/Iz = 1/2, 3/2, 5/2, 7/2, etc.

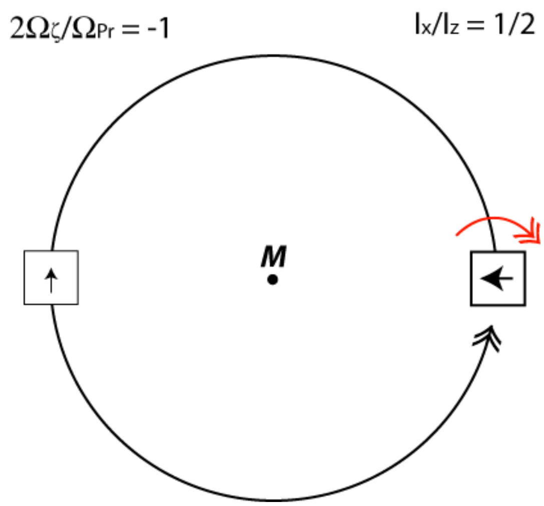


Figure 5. $2\Omega_\zeta/\Omega_{Pr}$ = -1

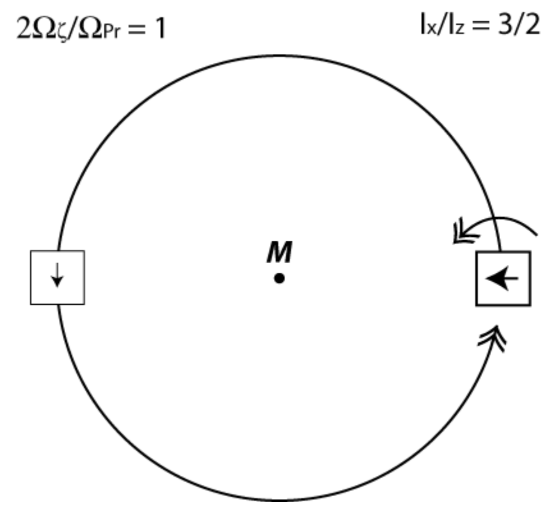


Figure 6. $2\Omega_\zeta/\Omega_{Pr}$ = 1

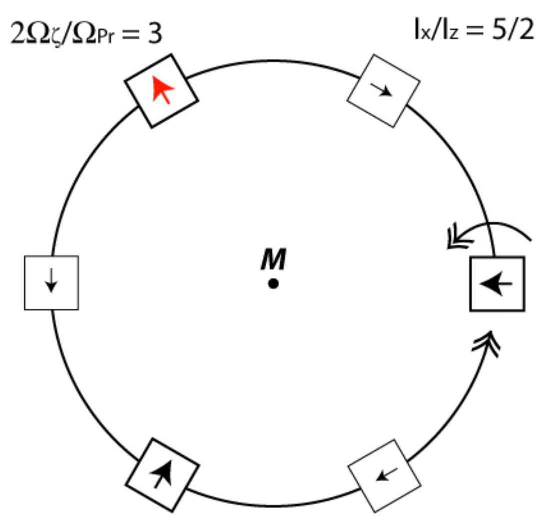


Figure 7. $2\Omega_\zeta/\Omega_{Pr}$ = 3

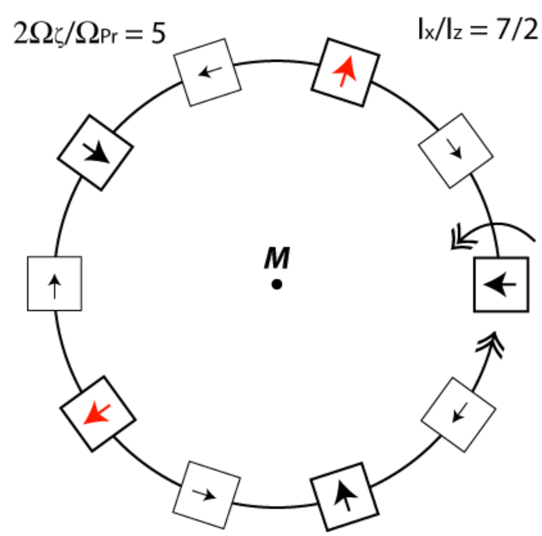


Figure 8. Ω_ζ/Ω_{Pr} = 5

The top spins anticlockwise, except for figure 5, and the precession is also anticlockwise as indicated by the double arrows. The diagrams show only the first precession, but we can visualise the second precession by turning the arrows in the boxes to face the opposite direction. The arrows in red show the state where the observer on the spinning top faces directly vector ***M*** on the second precession.

5. Slightly asymmetric almost vertical spinning top

A spinning top is called asymmetrical when *Ix* not = *Iy*, it may for example have an elliptical footprint in the *xy* plane. It does not mean that there is asymmetry between the upper and lower halves. An asymmetrical spinning top never returns to its initial state [16]. The angle θ and all angular velocities Ω vary periodically in time. As θ increases, vectors Ω decrease and change not only their magnitudes but also their directions.

The unit vector **z** that starts in the centre of the spinning top is align with the spin vector ***s*** and moves on the surface of a sphere between two concentric circles, lying in two parallel planes perpendicular to the vector ***M*** aligned with axis ***Z*** [17]. This wavy circular movement, known as nutation, is shown in figure 9.

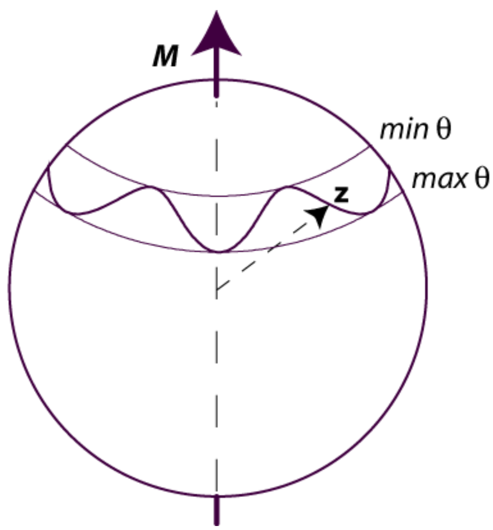


Figure 9. The trajectory of the spin vector ***s***.

Looking from above we see the trajectory of the end of the spin vector ***s*** as a periodic wave confined between two concentric circles. The trajectory touches the inner circle when θ is at its minimum and the outer circle when θ is at its maximum. The variation Δθ = ½ (max θ – min θ) decreases with ΔI = |Ix - Iy| and disappears when Ix = Iy.

Formula (4.1) for Ω_ζ still holds at any instant of time, i.e. only for the instantaneous angular velocities. When the spinning top is almost vertical (θ → 0) then the formula is almost linear and taking the average of the angular velocities over one precession we get

$$\overline{\Omega_\zeta} = \overline{\Omega_z} - \overline{\Omega_{\mathrm{Pr}} \cos\theta} \tag{5.1}$$

The average Ω_ζ may be different for each precession, but only very slightly when $Ix \approx Iy$. Thus the equations (4.2) to (4.7) for the return of symmetrical spinning tops to the initial state hold approximately also for slightly asymmetric and almost vertical spinning tops. For the return after one or two precession we have

$$\frac{I_x}{I_z} = 1,\ 2,\ 3,\ \text{etc.} \qquad \frac{I_x}{I_z} = \frac{1}{2}, \frac{3}{2}, \frac{5}{2},\ \text{etc.} \qquad \text{for } Ix \approx Iy \text{ and } \theta \to 0 \tag{5.2}$$

Only ideal symmetric spinning tops ($Ix = Iy$) can return to their initial state. Real spinning tops, represented in figures 10 to 13 by a top with a rectangular footprint, never return to the initial state. The position of a top at 0, 360 degrees and multiples thereof (in polar coordinates) are different. This is indicated by a gap in the trajectory of the spin axis close to 360 degrees. However, such spinning tops can come close to the initial state if $Ix \approx Iy$ and $\theta \rightarrow 0$. The condition for this to occur after one precession is $Ix/Iz = 1, 2, 3,$ etc.

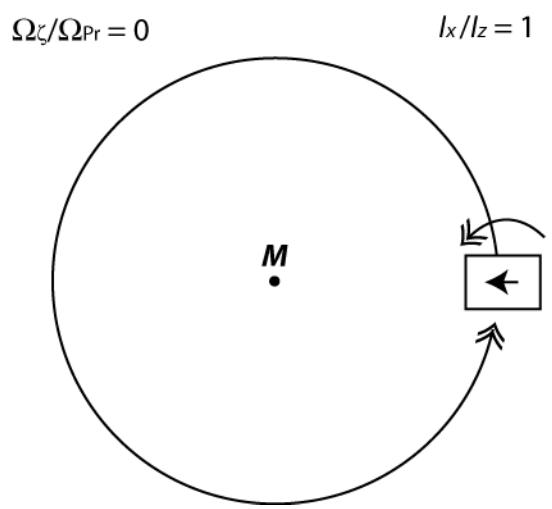


Figure 10. $\Omega_\zeta/\Omega_{Pr} = 0$

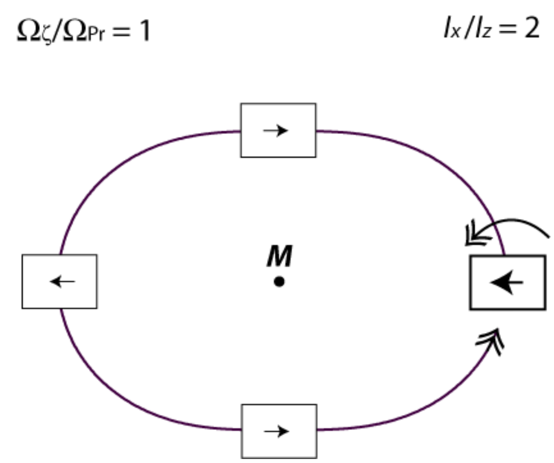


Figure 11. $\Omega_\zeta/\Omega_{Pr} = 1$

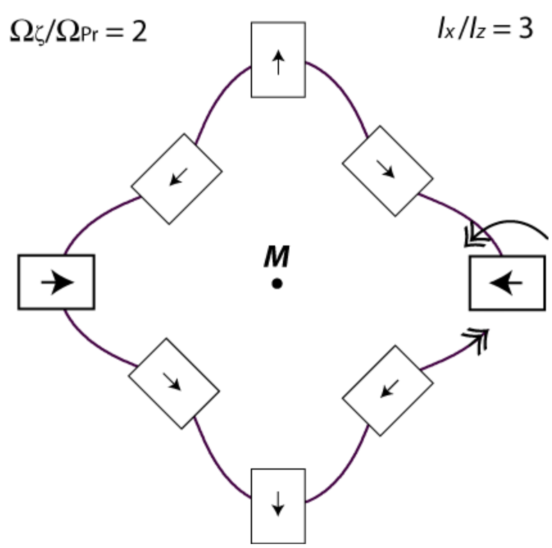


Figure 12. $\Omega_\zeta/\Omega_{Pr} = 2$

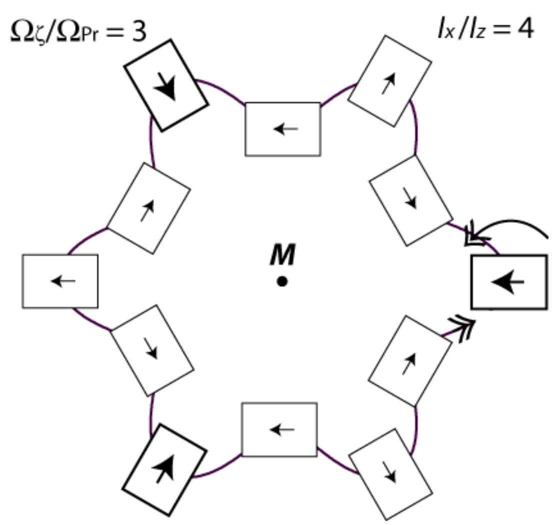


Figure 13. $\Omega_\zeta/\Omega_{Pr} = 3$

As with the symmetrical spinning tops the arrows inside the rectangles show the orientation of the observer on the spinning top and the bold arrows show when the observer faces directly vector ***M***.

Figures 14 to 17 show the trajectory of the end of the spin vector $\boldsymbol{s}$ and the movement of the spinning top. The condition for the top returning to the initial state only after two precessions is Ix/Iz = 1/2, 3/2, 5/2, etc. Again the gap in the trajectory of the spin vector close to 360 degrees indicates that this is only approximate.

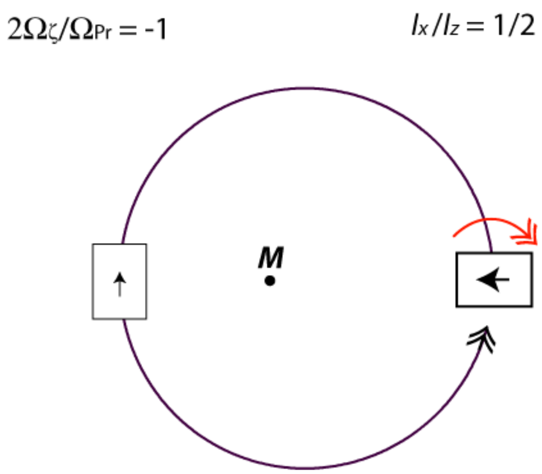


Figure 14. $2\Omega_\zeta/\Omega_{Pr}$ = -1

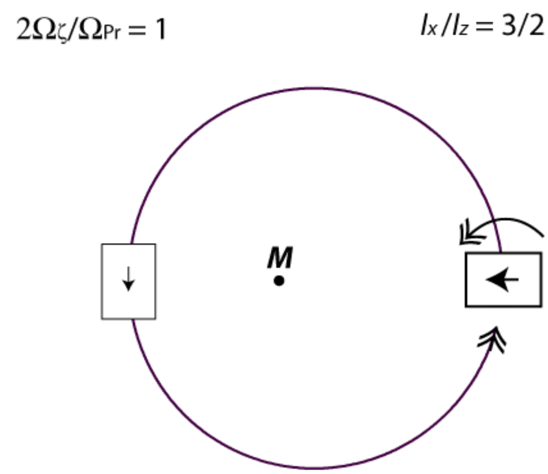


Figure 15. $2\Omega_\zeta/\Omega_{Pr}$ = 1

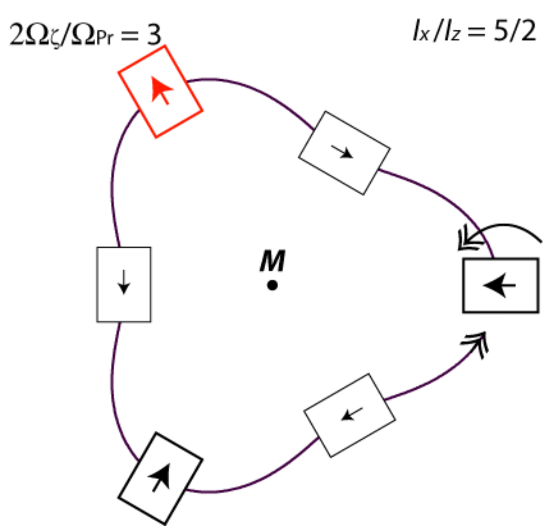


Figure 16. $2\Omega_\zeta/\Omega_{Pr}$ = 3

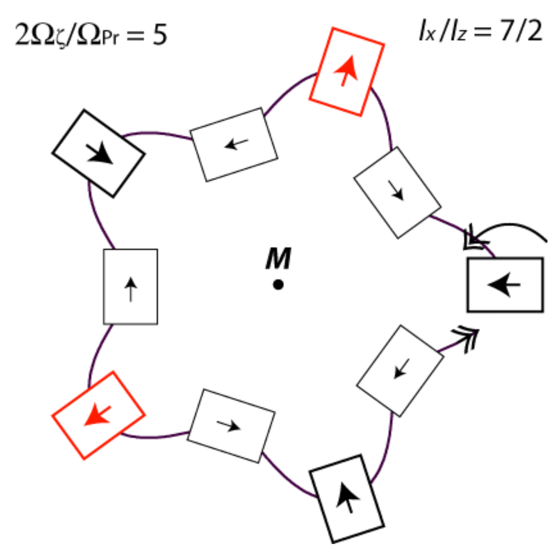


Figure 17. Ω_ζ/Ω_{Pr} = 5

The top spins anticlockwise, except for figure 14, and the precession is also anticlockwise as indicated by the double arrows. The diagrams show only the first precession, but we can visualise the second precession by turning the arrows in the boxes to face the opposite direction. The arrows in red show the state where the observer on the spinning top faces directly vector $\boldsymbol{M}$ on the second precession.

6. Particles as stationary circular waves

Euler's equations of motion do not require that the body must be rigid, i.e. that parts of the body remain in constant distance from each other, the conditions are much more relaxed. In the absence of external forces, any internal forces cancel out and the centre of mass of any body moves at a constant velocity. The angular momentum ***M*** also remains constant. The moments of inertia remain constant not only for rigid bodies, but for a varied length of time also for deformable bodies. Hurricanes retain their shape for days or at least hours, tornados for minutes and dust devils for tens of seconds. During this time Euler's equations apply.

From formulas (4.2) and (4.3) we know that a symmetrical top ($Ix = Iy$) returns to its initial state after one or two precessions if the following equivalent conditions are satisfied

$$\frac{\Omega_\zeta}{\Omega_{\mathrm{Pr}}} = \frac{\Omega_z}{\Omega_{\mathrm{Pr}}} - \cos\theta = \left(\frac{Ix}{Iz} - 1\right)\cos\theta \quad = \quad -\frac{1}{2}, 0, \frac{1}{2}, 1, \frac{3}{2}, 2, etc... \tag{6.1}$$

However, for a perfect circular top the axis z follows a perfect circular cone and in the absence of friction its movement does not generate any waves in its environment. If such an absolutely perfect top exists in the relativistic ether then it cannot be detected as a wave and thus it is not a suitable model of a particle. An alternative, and a more appropriate description of particles, is provided by considering asymmetrical tops ($Ix \neq Iy$). We shall assume that in nature there is always some asymmetry and consider particles as near symmetrical (Ix is close to Iy) and near vertical (θ is close to 0) spinning tops.

For an asymmetrical top the axis z follows a periodic wavy trajectory so that the top generates circular waves in its environment. If the top is not rigid then the waves that it generates interfere with the top itself. The top effectively becomes a circular wave that is chasing its tail, as shown in figure 9. The head interferes with the tail in a positive or a negative way depending on the phase difference. If the head and tail are in opposite phases after one precession then the top destroys itself. If there were no phase difference at all we would get a stationary circular wave.

Using formula (6.1) we find that a slightly asymmetric almost vertical spinning top almost returns to its initial state after one or two precessions if the following equivalent conditions are approximately satisfied

$$\frac{\Omega_\zeta}{\Omega_{\mathrm{Pr}}} + 1 = \frac{\Omega_z}{\Omega_{\mathrm{Pr}}} = \frac{Ix}{Iz} \quad \rightarrow \quad \frac{1}{2}, 1, \frac{3}{2}, 2, \frac{5}{2}, 3, etc... \qquad \text{for } Ix \rightarrow Iy \text{ and } \theta \rightarrow 0 \tag{6.2}$$

It may be tempting to think that if the ratio Ix/Iz were slightly greater, to compensate for $\cos(\theta)$ being less than one, then the formula above would result in $\Omega_\zeta/\Omega_{\mathrm{Pr}}$ becoming an integer or half-integer. This would mean that asymmetric spinning tops would return to their initial state, which we know to be impossible. However, an asymmetric top can almost return to its initial state and create an almost stationary wave. The closer it returns to the initial state the longer it will take for the top to destroy itself.

7. Spin and energy of particles

We have defined σ in (2.9) as the ratio I_x/I_z and we have shown that it is also equal to the ratio Ω_z/Ω_{Pr}

$$\sigma = \frac{I_x}{I_z} = \frac{\Omega_z}{\Omega_{\mathrm{Pr}}} \tag{7.1}$$

$$\sigma = \text{ the number of Vir rotations about its axis in one precession} \tag{7.2}$$

For disturbances in the relativistic ether that last long enough to be observed the values of σ are integers or half-integers, just as for the observed spin of particles. There σ is a frequency per precession, similar in nature to the frequency ν in the Quantum Mechanics formula E = hν. Hence for spin s we will assume

$$s = \hbar\sigma \tag{7.3}$$

We have also shown that the spinning of a Vir produces a standing circular wave. Now we will show that the standing circular wave produces in turn a standing linear wave along the axis of the Vir stretching from one to the other end of the Vir.

We will show further that they are not just any standing linear waves, but that their wavelength is such that for the particle energy we get

$$E = h\frac{c}{\lambda} \tag{7.4}$$

where

$$E = mc^2 \tag{7.5}$$

We remind ourselves that according formula (2.2) the particle mass in Vir theory is the volume V of the Vir multiplied by the mass density ρ that is common to all particles.

$$V = 2\pi\int_0^Z r(z)^2 dz \tag{7.6}$$

with $\rho =$ mass density of the Vir $\quad m = \rho V \quad V =$ volume of the Vir (7.7)

Thus Vir theory explains how the fundamental laws of Quantum Mechanics in (7.3) and (7.4) come about.

We show here why the rest mass of particles obeys the Quantum Mechanical formula $E = h\nu$ or equivalently $E = hc/\lambda$. Using the spin-mass formulas (2.8) and (2.10) we can express mass m_σ in terms of m_1

$$m_\sigma = b(2\sigma - 1)^\beta = b(2\sigma - 1)^{\frac{1-2\alpha}{2+2\alpha}} \tag{7.8}$$

where $$b = m_1 \tag{7.9}$$

In Special Relativity we have $E = mc^2$ and hence we have

$$E_\sigma = E_1(2\sigma - 1)^{\frac{1-2\alpha}{2+2\alpha}} = E_1(2\sigma - 1)^\beta \tag{7.10}$$

where $$E_1 = m_1 c^2 \tag{7.11}$$

Similarly using the spin-height formula (2.14) we can express half height of the Vir Z_σ in terms of Z_1

$$Z_\sigma = Z_1(2\sigma - 1)^{\frac{1}{2+2\alpha}} \tag{7.12}$$

where $$Z_1 = a\left(\frac{3-2\alpha}{1-4\alpha}\frac{1}{4}\right)^{\frac{1}{2+2\alpha}} \tag{7.13}$$

First we will consider a special case where the exponent $\alpha = 0$ for which we have simpler formulas

$$m_\sigma = m_1\sqrt{2\sigma - 1} \qquad \alpha = 0 \tag{7.14}$$

$$E_\sigma = E_1\sqrt{2\sigma - 1} \qquad \alpha = 0 \tag{7.15}$$

$$Z_\sigma = Z_1\sqrt{2\sigma - 1} \qquad \alpha = 0 \tag{7.16}$$

From the Vir formula (2.1) we see that for $\alpha = 0$ the Vir has the shape of two identical cylinders length Z, with a small gap between them. The Vir must have $Ix \neq Iz$ and hence the cylinders must be slightly oval.

When we have a cylinder and blow air over it we generate a musical note. The note corresponds to a standing wave created inside the cylinder. For an open ended cylinder each end is an anti-node and the length of the pipe is half-wave, also called the fundamental note. One cannot influence the note by blowing harder. However, in musical wind instruments one can generate harmonic waves where inside the pipe are two, three, four etc. half-waves. This is achieved by forced vibration of the player lips or a reed. With the higher frequency of the forced vibrations we get higher harmonics, but we can introduce only the harmonics.

We get the same effect if we move the cylinder in the direction perpendicular to the cylinder. We also get the same effect when we rotate an oval cylinder about its axis of symmetry. In all these cases the cylinder behaves as a pipe with open ends. Thus a particle with $\alpha = 0$ creates by its spinning a standing wave with the length of two Z.

Below are two diagrams of particles with spin one and three, already shown in figures 10, 12. In the first one rotation and in the second three rotations are completed round the spin axis in one precession, when the particles almost return to the initial state. In the process they generate an almost standing circular wave.

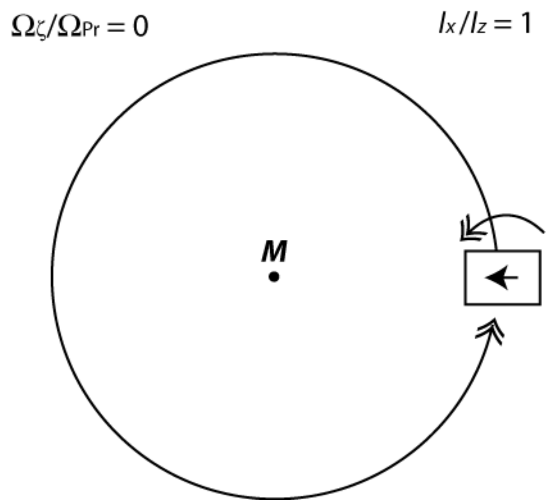


Figure 18. $\sigma = \Omega z/\Omega_{Pr} = 1$

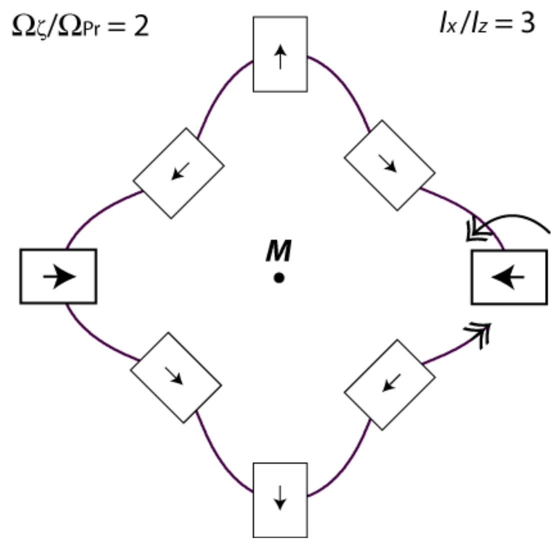


Figure 19. $\sigma = \Omega z/\Omega_{Pr} = 3$

The waves shown are the trajectories of the spin axis, so that the cylinders move towards and away from the total angular momentum vector ***M***. The number of vibrations for $\sigma = 1$ is 0, for $\sigma = 3$ is 4 and in general it is 2σ -2. Each vibration inserts a harmonic so that together with the fundamental each cylinder has 2σ -1 half-waves. Thus the two cylinders combined are filled with 2σ -1 waves, giving the following wavelength

$$\lambda_\sigma = \frac{2Z_\sigma}{2\sigma - 1} \qquad \alpha = 0 \tag{7.17}$$

The resulting standing waves are shown diagrammatically for the particles with σ = 1, 2 and 3 below

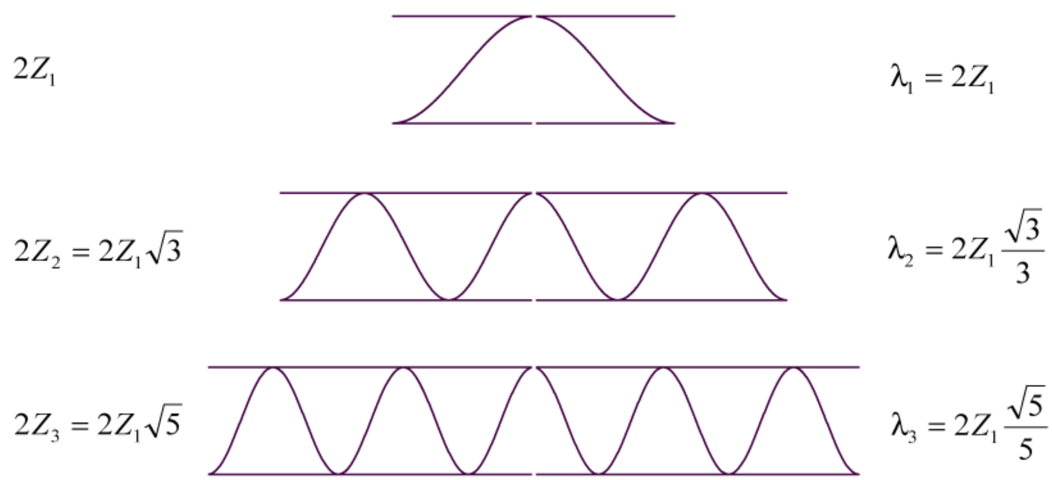


Figure 20. Linear standing waves for σ = 1, 2 and 3

We need to use the units of measurements consistent with the Heisenberg constant h, we do it by setting

$$E_1 = \frac{hc}{\lambda_1} \tag{7.18}$$

Using Z_σ from (7.16) we can rewrite formula (7.17) for λ_σ as follows

$$\lambda_\sigma = \frac{2Z_1\sqrt{2\sigma-1}}{2\sigma-1} = \frac{2Z_1}{\sqrt{2\sigma-1}} \qquad \alpha = 0 \tag{7.19}$$

Substituting formula (7.18) for E_1 into formula (7.15) for E_σ we get

$$E_\sigma = \frac{hc}{\lambda_1}\sqrt{2\sigma-1} \qquad \alpha = 0 \tag{7.20}$$

From (7.17) we find the relationship between λ_1 and Z_1

$$\lambda_1 = 2Z_1 \qquad \alpha = 0 \tag{7.21}$$

Substituting the above into (7.20) we get

$$E_\sigma = \frac{hc}{2Z_1}\sqrt{2\sigma-1} \qquad \alpha = 0 \tag{7.22}$$

Finally using (7.19) and (7.22) we get

$$E_\sigma = \frac{hc}{\lambda_\sigma} \qquad \alpha = 0 \tag{7.23}$$

Thus once we find the actual value of λ_1 for a given family of particles (b, β) then we can find the energy of any particle in the family with any given value of σ. To do this we need one more formula, substituting (7.21) into (7.19) and obtain

$$\lambda_\sigma = \frac{\lambda_1}{\sqrt{2\sigma-1}} \quad \text{i.e.} \quad \frac{1}{\lambda_\sigma} = \frac{1}{\lambda_1}\sqrt{2\sigma-1} \qquad \alpha = 0 \tag{7.24}$$

We remind ourselves that $E_\sigma = m_\sigma c^2$ where m_σ is given by formula (2.8) and is directly proportional to the volume V_σ of the Vir with $m_\sigma = \rho V_\sigma$ where ρ is the mass density of the relativistic ether (7.7). We emphasize that if we were to use a different formula for λ_σ we would not be able to obtain the Quantum Mechanical formula (7.23). Further that the linear standing wave along the spin axis is a direct consequence of the circular stationary wave and there are no assumptions involved.

What remains now is to show that the Quantum Mechanical formula (7.23) applies not only to particles with $\alpha = 0$ but to all valid values of α. Once again we will resort to musical instruments, in particular to a trumpet. The trumpet consist of a straight pipe that is followed by a bell shape, remarkably similar to the shape of one of the twin vortices in a Vir. Thus one end of a trumpet has a considerably larger opening than the other, by a factor of seven or there about.

The amplitude of the waves decreases in the bell and becomes zero at the end of the bell. Hence at the start of the trumpet we have a standing wave node as in a pipe, but at the end an antinode, as shown diagrammatically in figure 21. The length of standing wave is constant in the cylinder and a part of the bell, but varies toward the end of the bell [18]. The effective length of the trumpet is shorter than its actual length.

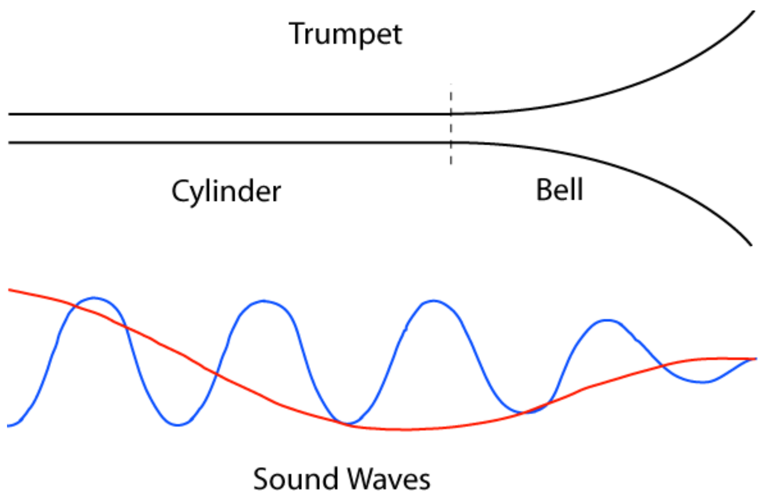


Figure 21. Standing waves in a trumpet

The equations for calculating the relationship between Z and λ are too complex to solve, but we can make an assumption (7.26) below that leads to the desired result. From (7.10) we can go from the general case for any valid α to the special case of $\alpha = 0$

$$E_\sigma = E_1(2\sigma - 1)^\beta \qquad 0 \le \alpha < ¼ \qquad \text{i.e.} \qquad E_\sigma = E_1\sqrt{2\sigma - 1} \qquad \alpha = 0 \tag{7.25}$$

In reverse, we can go from the special case $\alpha = 0$ (7.24) to the general case (assuming) for any valid α

$$\frac{1}{\lambda_\sigma} = \frac{1}{\lambda_1}(2\sigma - 1)^\beta \qquad 0 \le \alpha < ¼ \qquad \text{i.e.} \qquad \frac{1}{\lambda_\sigma} = \frac{1}{\lambda_1}\sqrt{2\sigma - 1} \qquad \alpha = 0 \tag{7.26}$$

This assumption may be tested experimentally using formulas given in the section just before the summary. Finally using (7.25) and (7.26) above we obtain again the same formula as (7.23), this time for all valid α.

$$E_\sigma \lambda_\sigma = E_1 \lambda_1 = hc \qquad 0 \le \alpha < ¼ \qquad \text{i.e.} \qquad E_\sigma = \frac{hc}{\lambda_\sigma} \qquad 0 \le \alpha < ¼ \tag{7.27}$$

Thus we have an explanation how one of the fundamental laws of Quantum Mechanics comes about.

8. Baryons, mesons and their mass

The spin values *Ix*/*Iz* in (6.1) do not include 0 and for ½ we have a disc that has virtually no mass and hence cannot be a hadron. We address this below and in the process explain the structure of baryons and mesons. The mass formula (2.8) can be modified to take into account the structure of particles. Figures 22 and 23 show a baryon with $\sigma = 2.5$ and a meson with $\sigma = 3$. The parameter σ is the spin of a particle when the entire particle rotates in the same direction. The horizontal lines show the heights for baryons with $\sigma = 0.5$, 1.5, 2.5 and mesons with $\sigma = 1$, 2 and 3. The line through the centre of the baryon is a disc with spin 0.5.

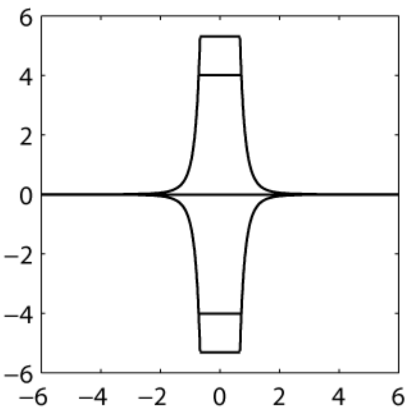


Figure 22. Baryon

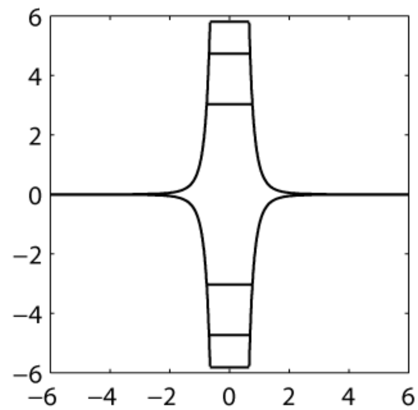


Figure 23. Meson

To obtain a baryon with spin 0.5 we take the height and mass of $\sigma = 1.5$, but with the disc rotating in the opposite direction. In the absence of the disc the spin would be reduced by 0.5 and with the disc rotating in the opposite direction the spin is reduced by another 0.5. We find a similar phenomenon to the baryon disc in hurricanes where the visible part (warm air) rises up from the ground (or sea) rotating anticlockwise, but when it ascends above the hurricane it suddenly turns and rotates clockwise. We can extend this idea, by rotating not only the disc, but also its adjacent parts in the direction opposite direction to the end parts. This way we can obtain any half integer spin *s* smaller than σ with the mass of σ.

We can do the same for mesons, although in the absence of the baryon disc we have to start with an even σ to obtain spin 0, if we want a symmetrical arrangement of the top and bottom. If we are prepared to accept asymmetrical particles, for example the top rotating in the opposite direction to the bottom, then we can start with any σ.

The horizontal lines in figures 1 and 2 separate the particles into "slices", each contributing with spin ½. The slices that rotate in the opposite direction to the particle with spin *s* are called "contras" and the number of contras is denoted by the variable *c*. Thus the relationship between the variables σ, *s* and *c* is as follows: $s = \sigma - c$, i.e. $\sigma = s + c$. Substituting this into the mass formula (2.8) we obtain

$$m = b\left[2(s+c)-1\right]^{\beta} \tag{8.1}$$

The formula above allows one family of particles to have particles with the same mass but different spin and vice-versa, for a given spin there may be particles with different masses.

9. Electric charge of particles

In Special Relativity the electro-magnetic field is transformed between two inertial observers using Lorentz transformations. If the relative velocity ***v*** between the observers is along their *z* axis then the electric field *Ez* and the magnetic field *Hz* are the same for both observers, but the *x* and *y* components are different [12].

$$E_x = \frac{E'_x + \frac{v}{c} H'_y}{\sqrt{1-\frac{v^2}{c^2}}} \qquad E_y = \frac{E'_y - \frac{v}{c} H'_x}{\sqrt{1-\frac{v^2}{c^2}}} \qquad E_z = E'_z \tag{9.1}$$

The same formulas are for the magnetic field H, but the + and – signs in the nominator are swapped round. Let us assume that in a "stationary frame" the values of *Ex*', *Ey*' and *Ez*' are zero. Then the frame moving in the direction of axis *z* acquires electric field that demonstrates itself in non-zero *Ex* and *Ey*.

Lorentz transformations are also used for the space-time coordinates, with the following formulas [13]

$$z = \frac{z' + vt'}{\sqrt{1-\frac{v^2}{c^2}}} \qquad ct = \frac{ct' + (v/c)z'}{\sqrt{1-\frac{v^2}{c^2}}} \qquad x = x' \quad y = y' \tag{9.2}$$

These transformations can also be expressed using the hyperbolic functions sinh and cosh [13]

$$z = z'\cosh(\omega) + ct'\sinh(\omega) \qquad ct = z'\sinh(\omega) + ct'\cosh(\omega) \tag{9.3}$$

The variable ω is related to velocity *v* as shown below [13], [19] thus $\omega = 0$ for $v = 0$ and $\omega = \infty$ for $v = c$

$$\tanh(\omega) = v/c \qquad \omega = \frac{1}{2}\ln\frac{1+v/c}{1-v/c} \tag{9.4}$$

If *v* is much smaller than *c* then we can expand the above formula for ω in terms of *v*/*c* as follows

$$\omega \cong \frac{v}{c} + \frac{1}{3}\left(\frac{v}{c}\right)^3 + ect \quad \text{i.e.} \quad \omega \cong \frac{v}{c} \quad \text{for } v \ll c \tag{9.5}$$

Yet another way to express the transformations is by geometric functions with imaginary argument i*w* [20]

$$z = z'\cos(i\omega) - ict'\sin(i\omega) \qquad ct = -iz'\sin(i\omega) + ct'\cos(i\omega) \tag{9.6}$$

In this form Lorentz transformations may be considered as rotations in *xt* plane. We have now explored all possible rotations in space time and we will show on the next page that they can provide an explanation not only for the spin of particles which was already explained, but also explain the electric charge.

Let us consider vortices and in particular the structure and the air flow of a hurricane. The hot air produced by the heat from land or sea rises up in a spiral twisting about the hurricane's eye. The cold air found at high altitudes spirals just above the visible hurricane cloud in an almost flat invisible disc. When it reaches the hurricane's eye it suddenly falls down at almost a constant stream to fill the void left by the hot air.

Let us now consider particles. In Lorentz transformations the electric field can be created only if the magnetic field is already present. Thus, let us assume that in the case of particles the spiral flow of the relativistic ether in *xy* plane creates the magnetic field and then the linear constant flow of the ether along the spin axis *z* creates the electric charge. More accurately perhaps, the two distinctly different flows of ether together create the electro-magnetic field and the electric charge.

Figures 24 and 25 show two man-made water vortices. One vortex is made by rotating a disc with a hole in its centre close to the bottom of a water container. The other vortex uses a couple of bottles firmly connected together at their necks. The bottles are half full with water and are given some angular momentum by a circular movement using hands. Then the coupled bottles are placed in a holder to keep them steady.

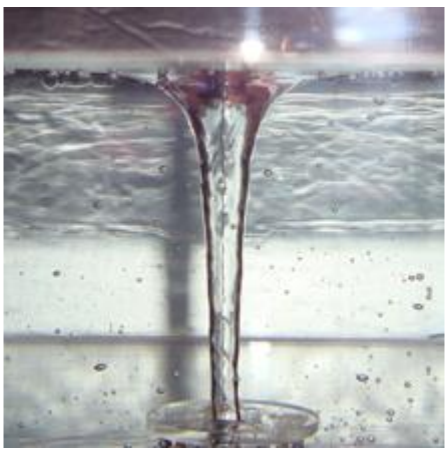


Figure 24. Air flows down the eye

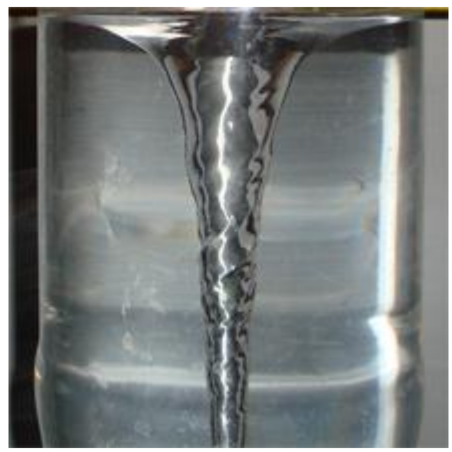


Figure 25. Air flows up the eye

The main difference between the two vortices is that in figure 24 the air comes down the vortex eye as in the case of a hurricane. This can be seen by the bubbles rising from the bottom of the container where the disc rotates. On the other hand in figure 25 the air comes up the vortex eye as the water is filling the bottom bottle and displaces the air within it. This is not what is observed on water vortices in nature, but the experiment shows that it is possible.

Thus we assume that a particle with the ether coming out from the narrow ends has a positive electric charge of 1 unit, while a particle where the ether comes in through the narrow ends has a negative charge -1. If the ether comes in from one end and goes out from the other end then the particle has zero charge. In addition to the vertical flow of ether there is a spiral flow of ether where the twin vortices are joined at their wide ends. Thus the ether that comes in through the wide end goes out through the narrow end and vice-versa.

This scheme satisfies the fundamental condition regarding anti-particles, namely that they can be described by the same equations as the particles, but with the reversed time axis. We can imagine this by filming the whole process and then playing the film backwards.

10. Hurricanes and Typhoons

We will now take a detailed look at the basic building blocks of particles and represent them by hurricanes and typhoons. For simplicity consider that hurricanes are confined to the northern hemisphere and typhoons to the southern hemisphere, rotating the opposite way. A hurricane has an eye that opens up to a wide spiral, as shown in figure 27. This spiralling cloud is fed by the hot air rising up from the ground or the sea and twisting round the eye, as shown in figure 26. The whole visible cloud rotates anti-clock wise.

In addition not seen on the photographs is the cold air falling down the eye. Also not seen on the photographs, there is a transparent accretion disc just above the clouds that brings the cold air to the edge of the eye. The disc rotates in the opposite direction to the cloud, i.e. clockwise, as shown in figure 23. Since the cold air is not visible its precise circulation is not known.

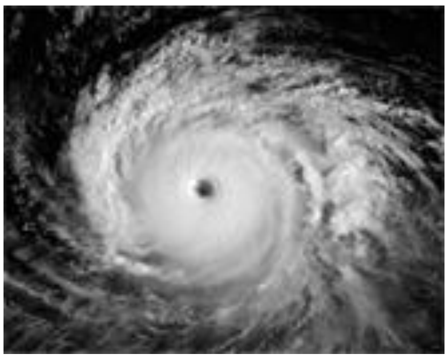


Figure 26. Hurricane top view

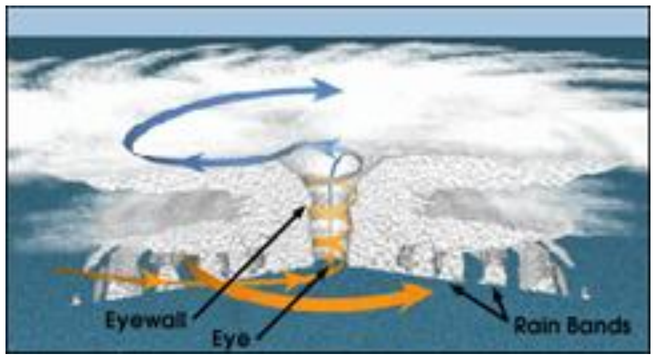


Figure 27. Hurricane side view

Schematically we shall represent hurricanes and typhoons by drawings shown in figures 28 and 29.

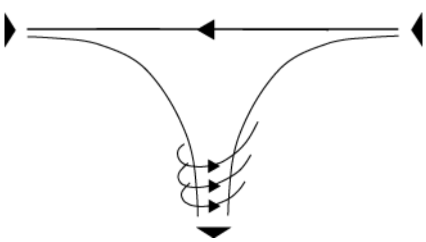


Figure 28. Hurricane diagram.

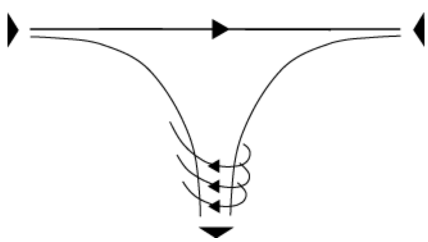


Figure 29. Typhoon diagram.

The wall of the hurricane eye may be thought of as a right-handed screw. If we hold the screw still pressing down on a piece of wood and rotate the wood, it will go up the screw. The hot air moves by a right hand rule, with the thumb up and fingers bent pointing anti-clockwise. Similarly, we can think of the typhoon wall as a left-handed screw (seldom used in practice). The hot air twists up the wall, but this time clockwise.

Anti-hurricanes do not occur on Earth, but we can imagine them as a film of a hurricane played backwards in time. In an anti-hurricane the eye is still while the hot air twists clockwise and moves down. At the same time a column of cold air is rising up through the middle of the eye. Similar time reversal takes place in anti-typhoons. Anti-hurricane is not a typhoon and anti-typhoon is not a hurricane.

11. Diagrams of h and t vortices

The schematic drawings of hurricanes and typhoons are shown in figures 30 to 37, where the subscripts "c" and "a" stand for clock-wise and anti-clock-wise. In reality the eye has more or less the same height as the width and flattens out much more suddenly, as given by formula (2.1). The vortices spinning anti-clockwise have the spin *s* of +½ and the those spinning clockwise have the spin of –½. The electric charge *q* is +½ if the stream through the eye exits via the narrow end, and –½ if it enters at the narrow end.

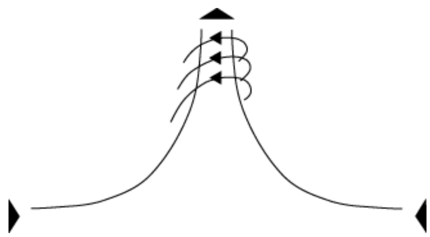


Figure 30. h_c s = -½ q = ½

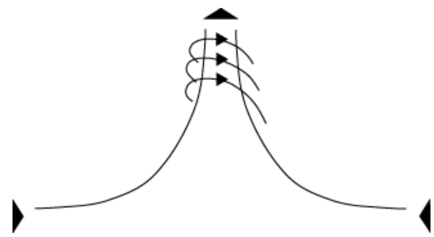


Figure 31. t_a s = ½ q = ½

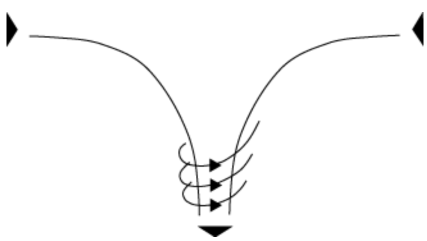


Figure 32. h_a s = ½ q = ½

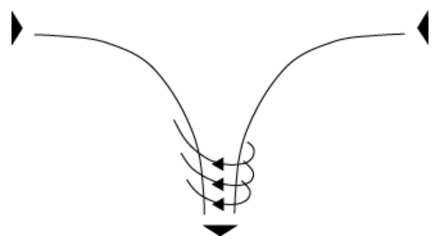


Figure 33. t_c s = -½ q = ½

The vortices h, t (above) have the electric charge +½, while ant-h, anti-t (below) have the charge -½.

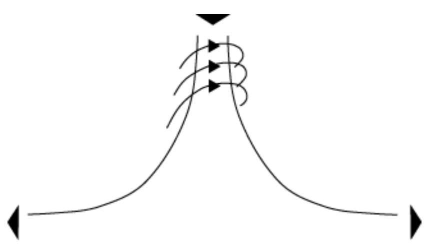


Figure 34. anti-h_a s = ½ q = -½

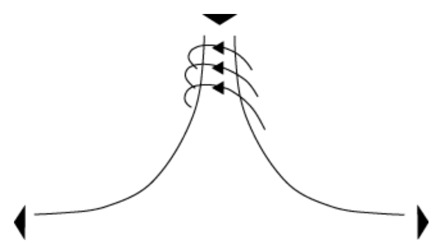


Figure 35. anti-t_c s = -½ q = -½

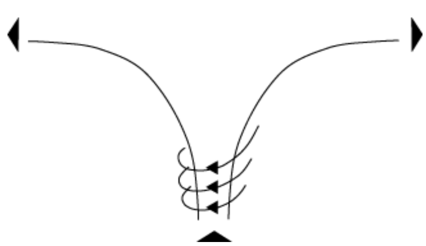


Figure 36. anti-h_c s = -½ q = -½

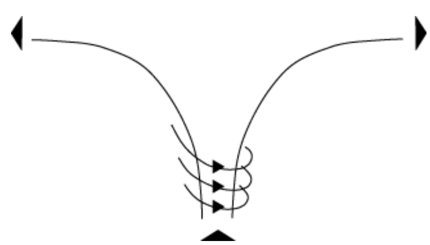


Figure 37. anti-t_a s = ½ q = -½

12. Diagrams of the baryon disc

The images below are the invisible discs of hurricanes, typhoons and their imaginary anti-partners. For hurricanes and typhoons the discs spin in the opposite direction to the visible clouds of the hot air and bring the cold air to the vortex eye, where the air falls down. The baryon discs do not carry any electric charge. The discs are the spiral inlets of ether for the positive particles and the outlets for the negative particles. The discs i_c and o_a (i = inlet, o = outlet) are anti-vortices annihilating each other, as are o_c and i_a.

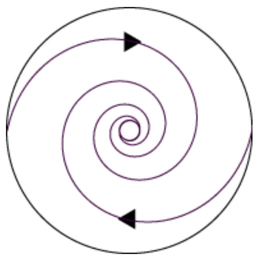


Figure 38. Inlet i_c s = -½

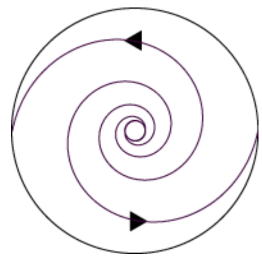


Figure 39. Outlet o_a s = +½

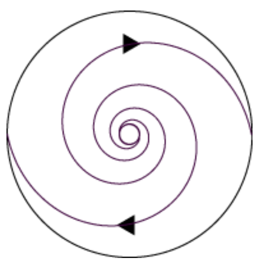


Figure 40. Outlet o_c s = -½

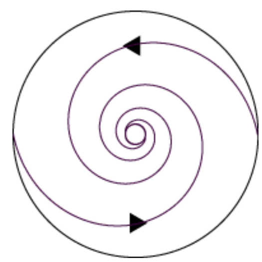


Figure 41. Inlet i_a s = +½

For the neutral particles one side of the disc is an outlet of ether and the other side an inlet of ether. Both disc sides spin in the same direction as one unit with spin ±½, there is no net flow of ether. The discs io_a and oi_c (io = inlet-outlet) are anti-vortices annihilating each other, as are oi_a and io_c.

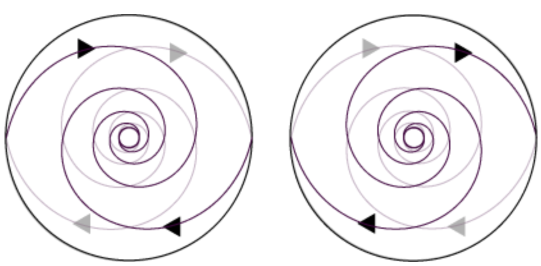


Figure 42. In-Out_c and Out-In_c

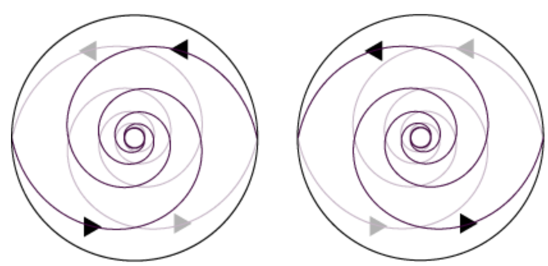


Figure 43. In-Out_a and Out-In_a

This scheme satisfies the fundamental condition regarding anti-particles, namely that they can be described by the same equations as the particles, but with the reversed time axis. We can imagine this by filming the whole process and then playing the film backwards.

13. Diagrams of proton and neutron

The notation for baryons is a column containing three entries, names of the vortices, as shown in (13.1). This reflects the structure of a proton and an anti-proton in figures 44 and 45. A proton spinning anti-clockwise consist of vortex h_a in the down entry, t_a in the up entry and i_c in the middle. The anti-proton is shown to spin the opposite way and consists of anti-h_c down, anti-t_c up and anti-i_a in the middle, that may be also denoted as o_a. Figures 46 and 47 show the structure of the discs from the bird's eye view.

$$p_a = \begin{bmatrix} t_a \\ i_c \\ h_a \end{bmatrix} \qquad \bar{p}_c = \begin{bmatrix} \bar{t}_c \\ \bar{i}_a \\ \bar{h}_c \end{bmatrix} \tag{13.1}$$

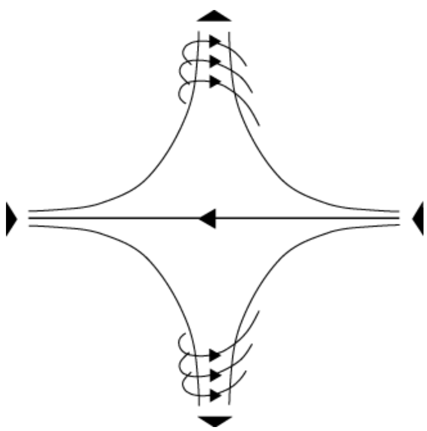


Figure 44. Proton

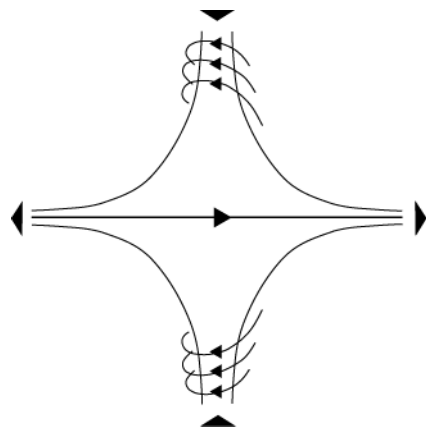


Figure 45. Anti-proton

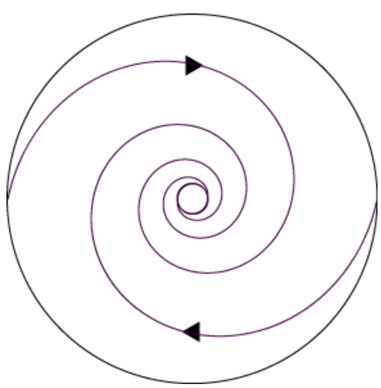


Figure 46. Proton inlet disc i_c

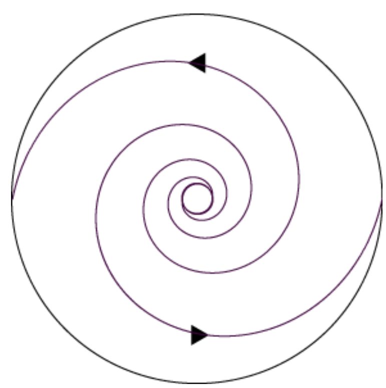


Figure 47. Anti-proton outlet disc o_a

On the diagrams the spin of the proton is +½ and that of the anti-proton is -½. Turning them upside down each would spin in the opposite direction. In a collision of these two particles the magnetic field that they generate make them aligned in such a way that they spin in the opposite direction and annihilate each other.

There are two varieties of neutrons, one consisting of vortex h and anti-h, the other of vortex t and anti-t. The notation for the neutron shown in (13.2) is for the h variety. This reflects the structure of a neutron h and an anti-neutron h in figures 48 and 49. A neutron h spinning anti-clockwise consist of vortex h_a in the down position, anti-h_a in the up position and oi_c in the middle. The anti-neutron h is shown to spin the opposite way, i.e. clockwise and consists of vortex anti-h_c down, h_c up and io_a in the middle.

$$nh_a = \begin{bmatrix} \bar{h}_a \\ oi_c \\ h_a \end{bmatrix} \qquad \overline{nh}_c = \begin{bmatrix} h_c \\ io_a \\ \bar{h}_c \end{bmatrix} \tag{13.2}$$

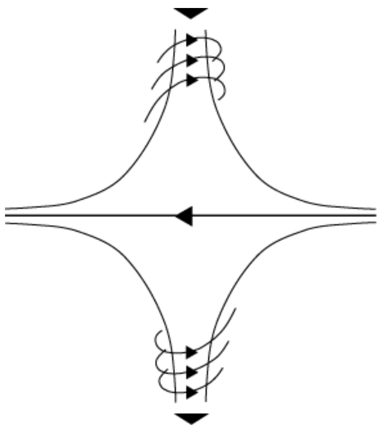


Figure 48. Neutron h

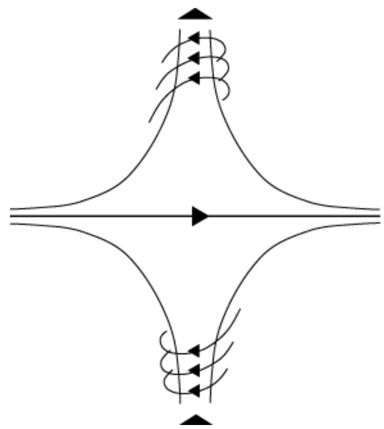


Figure 49. Anti-neutron h

Figures 50 and 51 show the structure of the discs from the bird's eye view. The baryon disc io_a is a part of a neutral particle and is equivalent to anti-oi_c.

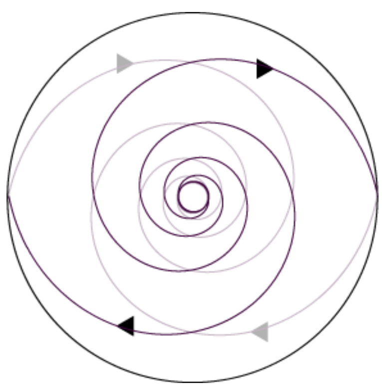


Figure 50. Neutron h disc oi_c

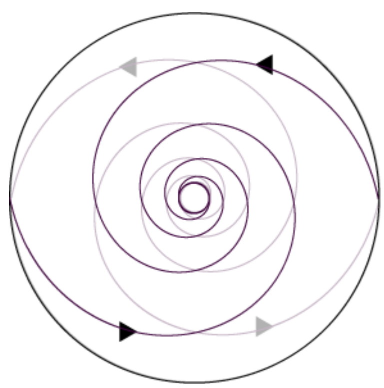


Figure 51. Anti-neutron h disc io_a

The spin of the neutron h is +½ and the spin of the anti-neutron h is -½. However, turning either of them upside down they would spin in the opposite direction. In a collision of these two particles they align in such a way that they spin in the opposite direction and annihilate each other.

The notation for the neutron shown in (13.3) is for the t variety. This reflects the structure of a neutron t and an anti-neutron t in figures 52 and 53. A neutron t spinning clockwise consist of vortex t_c in the down position, anti-t_c in the up position and oi_a in the middle. The anti-neutron t is shown to spin the opposite way, i.e. anti-clockwise and consists of vortex anti-t_a down, t_a up and io_c in the middle.

$$nt_c = \begin{bmatrix} \bar{t}_c \\ oi_a \\ t_c \end{bmatrix} \qquad \overline{nt}_a = \begin{bmatrix} t_a \\ io_c \\ \bar{t}_a \end{bmatrix} \tag{13.3}$$

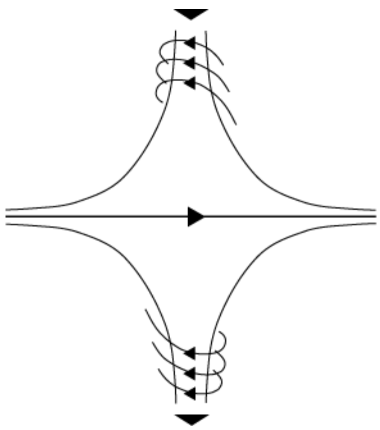


Figure 52. Neutron t

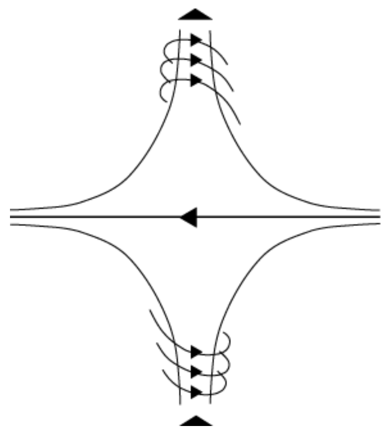


Figure 53. Anti-neutron t

Figures 54 and 55 show the structure of the discs from the bird's eye view. The baryon disc io_c is a part of a neutral particle and is equivalent to anti-oi_a.

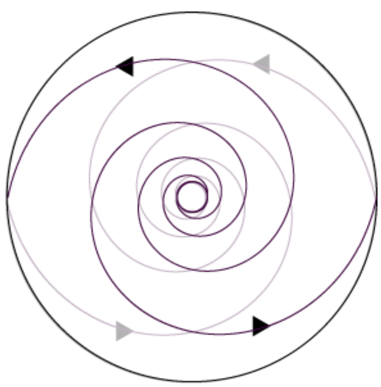


Figure 54. Neutron t disc oi_a

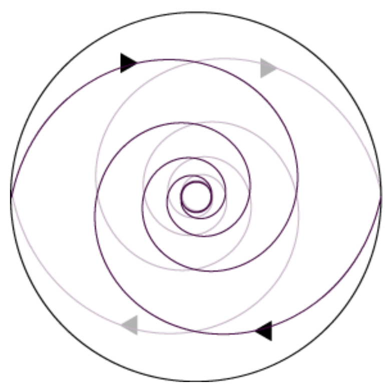


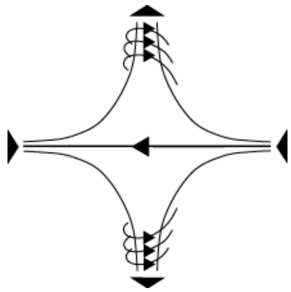
Figure 55. Anti-neutron t disc io_c

The spin of the neutron t is -½ and the spin of the anti-neutron t is +½. This is opposite to the neutron h and anti-neutron h in figures 50 and 51. For both neutrons h and t the ether flow is down, hence they have different chirality, one is right handed and the other left handed.

If we remove the baryon discs for all the drawings of protons and neutrons we obtain two mesons, one positive and one neutral, say ρ^+ and ρ^0. Thus there will be two versions of ρ^0, right handed and left handed.

14. CPT invariance of Particles

CPT stands for charge, parity and time transformation of particles. It always returns to the original particle. It is the most fundamental conservation law observed in particle physics, but there is no explanation for this in terms of quarks. We shall now use proton to demonstrate its invariance under CPT transformations.



$$p_a = \begin{bmatrix} t_a \\ i_c \\ h_a \end{bmatrix}$$

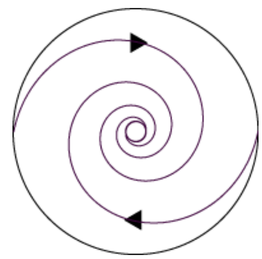
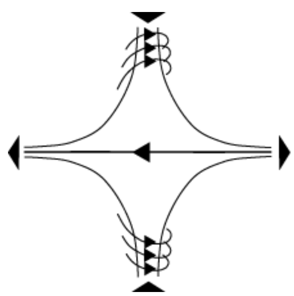


Figure 56. Proton anti-clock-wise (p_a)   **Figure 57.** Inlet disc clock-wise

To apply C transformation we change the direction of the ether flow, keeping the directions of all rotations.



$$\begin{bmatrix} \bar{h}_a \\ o_c \\ \bar{t}_a \end{bmatrix}$$

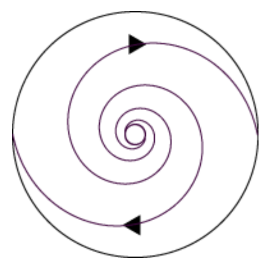
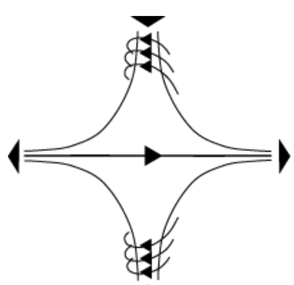


Figure 58. C(p_a) = anti-proton anti-clock-wise   **Figure 59.** Outlet disc clock-wise

To apply P transformation we change the handedness of particles, i.e. rotate them by 180 degrees about z axis and take the mirror image in yz plane. Rotation is not needed, since particles are symmetrical about z.



$$\bar{p}_c = \begin{bmatrix} \bar{t}_c \\ \bar{i}_a \\ \bar{h}_c \end{bmatrix}$$

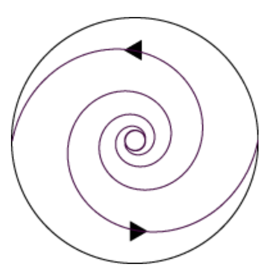
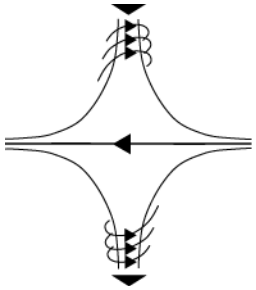


Figure 60. CP(p_a) = anti-proton clock-wise   **Figure 61.** Outlet disc anti-clock-wise

To apply T transformation we reverse the time, i.e. reverse all the arrows, leaving the rest untouched. This way the last images return back to the original proton images above, and therefore proton is CPT invariant.

Next we shall use neutron h to demonstrate its invariance under CPT transformations.



$$nh_a = \begin{bmatrix} \bar{h}_a \\ oi_c \\ h_a \end{bmatrix}$$

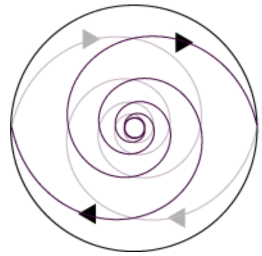
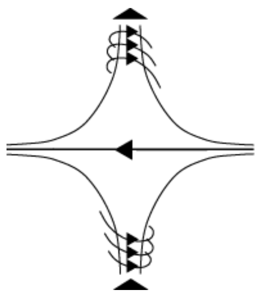


Figure 62. Neutron h anti-clock-wise (nh$_a$)

Figure 63. Neutron h disc out-in-c

To apply C transformation we change the direction of the ether flow, keeping the directions of all rotations.



$$\begin{bmatrix} t_a \\ io_c \\ \bar{t}_a \end{bmatrix}$$

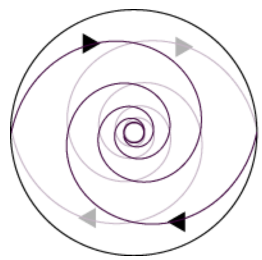
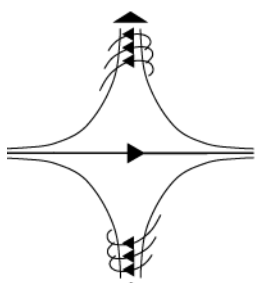


Figure 64. C(nh$_a$) = anti-neutron h anti-clock-wise

Figure 65. Neutron h disc in-out-c

To apply P transformation we change the handedness of particles, i.e. rotate them by 180 degrees about z axis and take the mirror image in yz plane. Rotation is not needed, since particles are symmetrical about z.



$$\overline{nh}_c = \begin{bmatrix} h_c \\ io_a \\ \bar{h}_c \end{bmatrix}$$

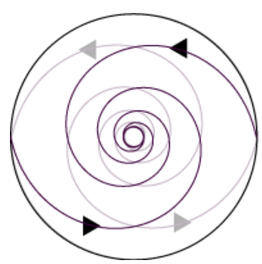


Figure 66. CP(nh$_a$) = anti-neutron h clock-wise

Figure 67. Neutron h disc in-out-a

To apply T transformation we reverse the time, i.e. reverse all the arrows, leaving the rest untouched. This way the last images return back to the original images above, and therefore neutron h is CPT invariant. For neutron t the figure headings above are identical, there is no need to demonstrate this separately. For the neutral mesons we simply remove the baryon disc, there is no need to demonstrate this graphically either.

15. Matter and anti-matter

Virtually all stable matter known to us is made of atoms that consist of protons, neutrons and electrons. The stable anti-atoms are very few, only those that contain very few anti-protons and anti-neutrons. We propose that the ether jets create the short range strong force as well as the long range electro-magnetic waves, as explained in section 7. The strong forces are shown diagrammatically in figures 68 and 69 below.

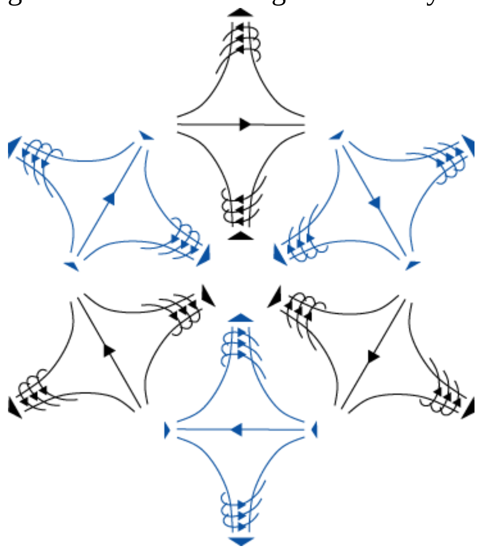


Figure 68. Matter

The protons are in blue, neutrons in black. The inner jets from the protons push the ether to the centre, while the neutrons suck it out. The outer jets push all particles to the centre keeping the atom together and stable.

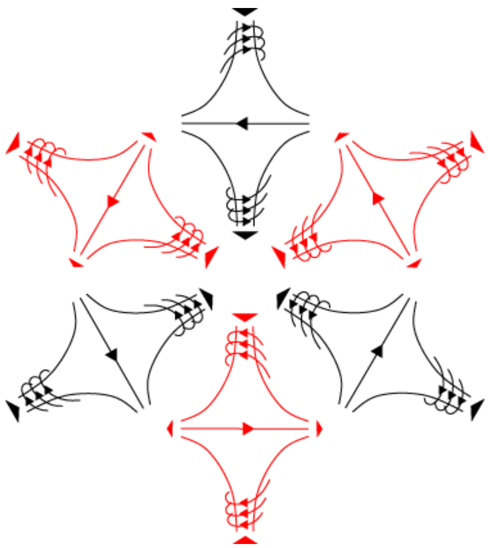


Figure 69. Anti-matter

The inner jets from the anti-protons suck out the ether from the centre and the anti-neutrons replenish it. The outer jets pull all particles away from the centre and make the anti-atom unstable. An anti-atom with one anti-proton and one or two anti-neutrons forms a single pipe that is more stable.

16. Energy density of particles

We found that for $\alpha = 0$ we have the relationship between Vir half-height Z and the wavelength of the standing linear wave λ. Choosing a family of particles with α close to zero, i.e. β close to ½, we can use the parameter b (which equals to m_1) to find λ_1, hence the length of Z_1 and thus the mass density ρ.

PDG mass data are given as the rest energy in terms of MeV, thus instead of the mass density ρ we will find the energy density ρc^2. Using formula (2.15) for the mass m we find

$$\rho c^2 = \frac{mc^2}{8\pi}\frac{(1-2\alpha)(3-2\alpha)}{1-4\alpha}\frac{(2\sigma-1)}{Z^3} \qquad 0 \le \alpha < 1/4 \qquad (16.1)$$

For $\alpha = 0$ and $\sigma = 1$ this becomes

$$\rho c^2 = \frac{3}{8\pi}\frac{E_1}{Z_1^3} \qquad \alpha = 0 \quad \sigma = 1 \qquad (16.2)$$

From (7.21) we have

$$Z_1 = \frac{\lambda_1}{2} \qquad \alpha = 0 \quad \sigma = 1 \qquad (16.3)$$

Hence we have

$$\rho c^2 = \frac{3}{\pi}\frac{E_1}{\lambda_1^3} \qquad \alpha = 0 \quad \sigma = 1 \qquad (16.4)$$

From (7.18) we have

$$E_1 = \frac{hc}{\lambda_1} \quad \text{i.e.} \quad \frac{1}{\lambda_1} = \frac{E_1}{hc} \qquad \alpha = 0 \quad \sigma = 1 \qquad (16.5)$$

Hence we have

$$\rho c^2 = \frac{3}{\pi}\frac{E_1^4}{h^3c^3} \qquad \alpha = 0 \quad \sigma = 1 \qquad (16.6)$$

Replacing E_1 by the parameter b given in eV according to (7.9) we finally get

$$\rho c^2 = \frac{3}{\pi}\frac{b^4}{h^3c^3} \qquad \alpha = 0 \quad \sigma = 1 \qquad (16.7)$$

We can use this formula to check that the energy density is close to that experimentally found for protons.

17. Size and wavelength λ of particles

Using the energy density ρc^2 of particles we can find the size and the wavelength for particles with non-zero α, i.e. with $0 < \alpha < ¼$. From (16.1) we get the expression for Z^3

$$Z^3 = \frac{mc^2}{8\pi}\frac{(1-2\alpha)(3-2\alpha)}{1-4\alpha}\frac{(2\sigma-1)}{\rho c^2} \qquad 0 \le \alpha < ¼ \qquad (17.1)$$

Substituting ρc^2 using formula (16.7) we get

$$Z^3 = \frac{mc^2}{24}\frac{h^3c^3}{b^4}\frac{(1-2\alpha)(3-2\alpha)}{1-4\alpha}(2\sigma-1) \qquad 0 \le \alpha < ¼ \qquad (17.2)$$

Replacing the rest energy of the particle mc^2 by E and expressing it in terms of E_1 using (7.25) we get

$$Z^3 = \frac{E_1(2\sigma-1)^{\beta}}{24}\frac{h^3c^3}{b^4}\frac{(1-2\alpha)(3-2\alpha)}{1-4\alpha}(2\sigma-1) \qquad 0 \le \alpha < ¼ \qquad (17.3)$$

Replacing b by E_1 as used in (16.7) and using the formula (7.4) for λ_1 we get

$$Z^3 = \frac{\lambda_1}{24}\frac{(1-2\alpha)(3-2\alpha)}{1-4\alpha}(2\sigma-1)^{1+\beta} \qquad 0 \le \alpha < ¼ \qquad (17.4)$$

Thus for the size of a particle, i.e. $2Z$, we have

$$2Z = \lambda_1\sqrt[3]{\frac{1}{3}\frac{(1-2\alpha)(3-2\alpha)}{1-4\alpha}(2\sigma-1)^{1+\beta}} \qquad 0 \le \alpha < ¼ \qquad (17.5)$$

Using the assumption (7.26)

$$2Z = \lambda_\sigma(2\sigma-1)^{\beta}\sqrt[3]{\frac{1}{3}\frac{(1-2\alpha)(3-2\alpha)}{1-4\alpha}(2\sigma-1)^{1+\beta}} \qquad 0 \le \alpha < ¼ \qquad (17.6)$$

For particles with $\sigma = 1$ we have

$$2Z_1 = \lambda_1\sqrt[3]{\frac{1}{3}\frac{(1-2\alpha)(3-2\alpha)}{1-4\alpha}} \qquad 0 \le \alpha < ¼ \qquad \sigma = 1 \qquad (17.7)$$

For particles with $\alpha = 0$ and $\sigma = 1$ we get formula $2Z_1 = \lambda_1$ as required, already obtained in formula (7.21). The formulas (17.6) and (17.7) above can be used to test experimentally the assumption (7.26) concerning the standing waves in a pipe with the shape of a particle with $\alpha > 0$.

18. Summary and conclusions

It has been shown by solving the Euler equations of motion for rotating bodies that the motion of a Vir can result in a circular wave, where the head chases its tail. Such a wave destroys itself after one precession if the head and tail are out of phase, but results in a stationary circular wave if they are in phase.

If a spinning top has a perfectly circular footprint then its spin axis precesses in a perfect circle. If the top has an elliptical footprint then its spin axis follows a wavy circular motion that the top never returns to its initial state. However, if the top is only slightly elliptical and its axis almost coincides with the total angular momentum vector then its motion can produce an almost standing circular wave.

The standing circular wave occurs if the ratio of the Vir moments of inertia Ix/Iz is an integer or half-integer. If the ratio is an integer then the top (almost) returns to its initial state after one precession and if it is a half-integer then after two precessions. This restricts particles to the spin that we observe. The standing circular wave causes a standing linear wave along the spin axis with such wavelength that the energy $E = h\nu$. This enables us to calculate the wave-length, the size and the energy density of particles.

Electric and magnetic fields for two inertial observers moving with relative velocity v are related by Lorentz transformations used in Special Relativity. These transformations can be expressed by hyperbolic functions of a real argument ω or by an imaginary argument $i\omega$ with trigonometric functions. Thus the transformations can be considered as rotations in zt plane, where axis z is aligned with the velocity of the moving observer. Thus the space rotation of a hurricane about its spin axis is caused by a spiral movement of the air, the rotation in a space-time plane is caused by a linear movement of the relativistic ether along Vir spin axis.

This completes the description of all Vir rotations in space and time and reveals the origin and nature of the electric charge in particles. If the rotation in zt plane is positive the ether flows out from the ends of the Vir and we have a positive particle. If the ether flows in through the ends of the Vir we have a negative particle. If the ether flows in from one end and out from the other then we have a neutral particle.

CPT is the most fundamental conservation law observed in particle physics, but there is no explanation for this in terms of quarks. The time transformation T reverses all motion and transforms a particle to an anti-particle. Using this concept of anti-particles Vir Theory shows that CPT transformation must be invariant.

Although there are anti-protons, anti-neutrons and anti-electrons (positrons) there are no stable anti-atoms, except for the anti-atoms with very few anti-protons and anti-neutrons. In this context the Vir theory also provides explanation of the origins of the strong force.

Black holes are described by only three quantities: mass, spin and electric charge. These are the essential properties also for particles. Like particles black holes have accretion disc and two opposite jets perpendicular to the disc. Thus the smallest and the bigest objects known to us may have the same nature.

The integrals for the mass and the moments of inertia for the Vir can be evaluated algebraically and using these expressions one can obtain a formula for the relationship between the spin and mass of Vir. It is a formula that allows several masses for a given spin and vice-versa. This formula has been tested very successfully using the existing particle data, as will be shown shortly in the paper entitled “Mendeleev-like Tables of Hadrons”.

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Sources of Figures

Figure 22. Image courtesy NASA 11 Sep 2003 *Hurricane Isabel*
http://www.hurricanetrackinfo.com/

Figure 23. Image courtesy NOAA/NASA 22 Aug 2005 *Hurricane Anatomy*
http://earthobservatory.nasa.gov/Library/Hurricanes/Images/hurricane_structure.jpg

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