Chapter VII. Relativity and the Wave Property of Matter

A. Electrodynamics and Relativity

In this book we have assumed a universe of identical elastic spherical particles which particles make up a gaseous ether and make up all matter and radiation. Further, we assume the gaseous ether is in a three dimensional space with a separate absolute time. The particles are very small with a radius in the order of the Planck length $\doteq 10^{-35}\ m$ and with a mass billions and billions times smaller than the electron. The particle number density is very large $\doteq 10^{83}\ m^{-3}$ and the mean free path is on the order of nuclear particle diameters.

A photon is assumed to be a stable assemblage of a large number of these ether particles translating at the speed of light, of course. Each fundamental matter particle at rest such as a proton, is assumed to be a neutrino which is a very small stable assemblage (again made up of very many basic particles) moving at the speed of light in a circular path with a very small diameter.

From these above assumptions we immediately have the result that the energy of a matter particle at rest is the matter particle mass M_0 (which is the background particle mass times the number of particles making up the matter particle) times the square of the speed of light. Defining energy as mass times the square of the velocity of the mass then

$$E_0 = M_0 c^2 \tag{7.1}$$

which is the famous Einstein formula for the *equivalence* of mass and energy.

In order to accelerate matter, a series of photons bombard the matter, and each photon is partly scattered and partly captured. The captured parts of the photons are the mass that is added to the matter as it accelerates. When a force does work on a particle of mass m and accelerates m from zero velocity to v, the work done is $\frac{1}{2}mv^2$ so that $\frac{1}{2}mv^2$ is the particle's *kinetic energy*. The average energy of the accelerated mass during this process is the kinetic energy.[1] If a mass moving at velocity v (having energy mv^2) is absorbed by another mass moving at the same magnitude and direction of velocity v then the energy change of the increased mass particle is mv^2. Consider now a photon of energy $e_\gamma=m_\gamma c^2$. This can be written in terms of its linear momentum p_γ as $e_\gamma=(p_\gamma/c)c^2 = mc^2$. Consider the acceleration of a matter particle due to the result of scattering photons. Let M_0 be the mass of the matter particle at rest and let M_v be the mass when moving at velocity v. The matter particle energy when moving is M_vc^2 and the linear momentum is $P_m=M_vv$. The linear momentum P_γ of the photons (assuming many photons were used) is $P_\gamma=M_\gamma c$, where M_γ is the sum of the photon *masses*. Let the scattered photon total mass be $M_s=kM_\gamma$ so that the captured mass is $M_c=(1\text{-}k)M_\gamma$. The momentum transferred by the captured mass of each photon is $m_\gamma(1\text{-}k)c$, where m_γ is the mass of one photon. The momentum transferred by the scattered portion of each photon is $m_\gamma kc$ since the scattering is spherically symmetric with the maximum back scatter momentum being $2m_\gamma kc$ and the minimum forward scatter being zero for an average of $m_\gamma kc$. Thus, the momentum transferred to the matter particle is all of each photon's momentum. The total momentum imparted then is the sum of the initial momentum of each photon. Let us denote the total momentum as P. The differential energy change for the matter particle is the force times the distance so

$$dE_v=Fdx \qquad (7.2)$$

where E_v is the energy of the moving matter particle and F is the force applied. The force is the time rate of momentum change of the

1 Appendix B presents a discussion of energy and kinetic energy.

matter particle which, also, is the time rate of momentum change of the group of impacting photons.

$$F=dP/dt \tag{7.3}$$

Now

$$dE_v=Fdx=(dP/dt)dx=vdP \tag{7.4}$$

We also have

$$dP=d(M_v v)=M_v dv+vdM_v \tag{7.5}$$

and

$$dE_v=vdP=v(M_v dv+vdM_v) \tag{7.6}$$

further

$$dE_v=d(M_v c^2)=c^2 dM_v \tag{7.7}$$

Thus

$$c^2 dM_v=v(M_v dv + vdM_v) \tag{7.8}$$

Simplifying

$$(dM_v)/M_v=vdv/(c^2-v^2) \tag{7.9}$$

Integrating M_v from M_o to M_v and v from o to v gives

$$\ln\frac{M_v}{M_o} = -\frac{1}{2}\ln\frac{c^2-v^2}{c^2}=\frac{1}{2}\ln(1-\beta^2) \tag{7.10}$$

where $\beta = v/c$. Now

$$\frac{M_v}{M_o} = \frac{1}{\sqrt{1-\beta^2}} \tag{7.11}$$

We see that this is the well-known mass growth equation and note it has been derived from classical Newtonian mechanics which uses an absolute space with a separate absolute time system.[2]

Let us determine the portion of the photon mass that is captured and that which is scattered. The captured mass is

$$M_c = M_v - M_o = M_o\,(1 - \sqrt{1-\beta^2}\,)/\sqrt{1-\beta^2} \tag{7.12}$$

The momentum balance relates the scattered and captured mass by the equation[3]

$$(M_s + M_c\,)c = (M_c + M_0\,)v \tag{7.13}$$

Thus

$$M_s = (M_c + M_0)\beta - M_c = M_0\,[\beta - 1 + \sqrt{1-\beta^2} \div \sqrt{1-\beta^2} \tag{7.14}$$

Now

$$M_s/M_c = \beta/(1 - \sqrt{1-\beta^2}\,) - 1 \;\; M_s/M_c = \beta/(1 - \sqrt{1-\beta^2}\,) \tag{7.15}$$

Some values of M_s/M_c verses β are now obtained.

β	0.01	0.02	0.1	0.5	0.8	0.9	0.99
M_s/M_c	199	99.0	18.9	2.73	1.0	0.595	0.153

2 This analysis was developed for this theory by Dr. Darrel B. Harmon, Jr.

3 This results since the average scattered mass has its velocity at 90° to the impacting velocity.

From this table we note that at small velocities practically all the mass is scattered, while at large velocities practically all the mass is captured.

The fact that the velocity of matter can never exceed the speed of light results simply from the fact that the accelerating agent (i.e. the photon) is moving at the speed of light.

When a photon interacts with matter at rest the circular path becomes a planar coil path as seen from a rest frame. However, in a frame moving at the translational velocity v of the particle the planar coil is seen as a closed path and since angular momentum is constant

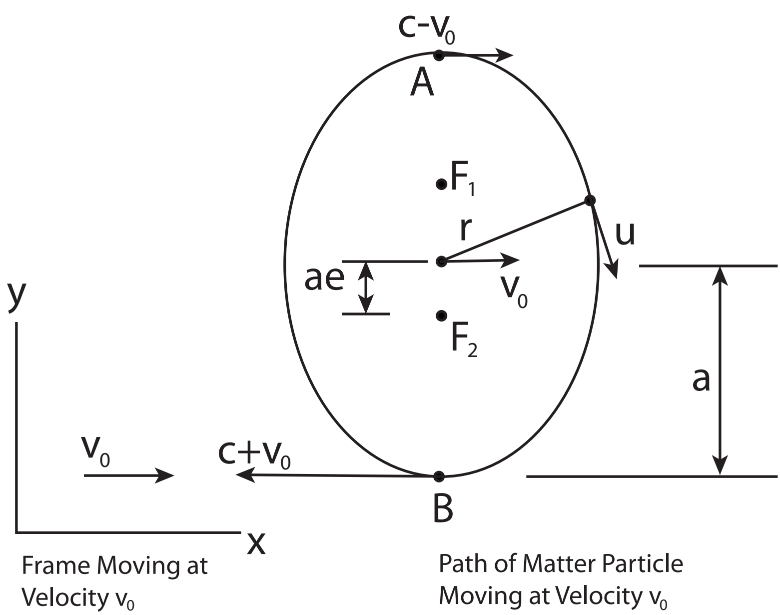


Figure 7.1 Matter Particle Moving at Velocity v_o

along the path, the closed path is an ellipse. Figure 7.1 shows the elliptic path of a matter particle moving to the right at velocity v_0.

The two foci F_1 and F_2 are shown. The mass "*m*" takes the path shown by the ellipse in the reference frame moving at velocity v_0.

Since the mass always moves at velocity *c* (the speed of light) the mass at point A moves at velocity $c—v_0$ in this frame and the mass at B moves at velocity $c+v_0$. Angular momentum conservation requires that the mass at A times ($c—v_0$) times the distance A to F_2 be the same as the same mass at B times ($c+v_0$) times the distance F_2 to B. The major semi-axis is "*a*" and the eccentricity is "*e*", as shown in Figure 7.1. Angular momentum conservation gives

$$(a+ae)(c—v_0)=(a—ae)(c+v_0) \qquad (7.16)$$

Solving for *e* gives

$$e=v_0/\mathrm{c}=\beta \qquad (7.17)$$

Thus, the eccentricity is the particle translational velocity in speed of light units.

We will now determine the relation between the orbit shape and the particle velocity. Figure 7.2 shows an elliptic orbit of a particle moving to the right at velocity v_0 . An ellipse is the locus of points where the distance from the point of a fixed focus (i.e. distance $\overline{AF_1}$) added to the distance from that same point to the other focus (i.e. distance $\overline{AF_2}$) is constant. For example, if a string of length $\overline{F_1A}$ plus $\overline{AF_2}$ is fixed at F_1 and F_2 and a pencil is placed inside the string then the trace will be an ellipse.

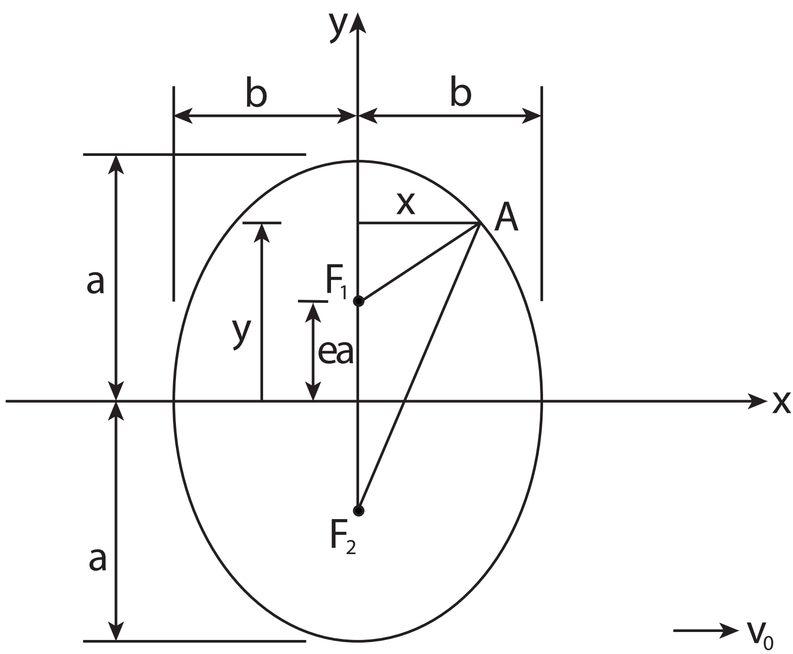


Figure 7.2 Elliptic Orbit Geometry

The length of the string is given by

$$\overline{F_2A}+\overline{AF_1}=\sqrt{(ea+y)^2+x^2}+\sqrt{(y-ea)^2+x^2}=2a \quad (7.18)$$

which simplifies to

$$(a^2-a^2e^2)(a^2-y^2)=a^2x^2 \quad (7.19)$$

or

$$(1-e^2)(a^2-y^2)=x^2 \quad (7.20)$$

When

$$y=0 \quad x=\pm b \quad (7.21)$$

then

$$a^2(1-e^2)=b^2 \quad (7.22)$$

Thus

$$b/a=\sqrt{1-e^2} \tag{7.23}$$

Since $e=v_o/c=\beta$, from (7.17), we have

$$b/a=\sqrt{1-\beta^2} \tag{7.24}$$

This is the ratio of the minor axis to the major axis and clearly shows the orbit size reduction. Every matter particle in a piece of matter, such as a bar of steel, experiences this shortening with velocity. Thus, the complete bar will be shortened in the direction of motion by the factor $\sqrt{1-\beta^2}$. We therefore have

$$\ell_v/\ell_o=\sqrt{1-\beta^2} \tag{7.25}$$

The velocity "u" of mass "m" on this elliptic path at radius r from F_2, as shown in Figure 7.1, is given in McClusky [7.1] by the equation

$$u^2=g[2/r-1/a] \tag{7.26}$$

where "g" is a constant (=GM by McClusky). The maximum velocity is when $r = a - ea = (1-e)a$ and has the value $c + v_o$. From this

$$(c+v_o)^2=g\left[\frac{2}{(1-e)a}-\frac{1}{a}\right]=\frac{g}{a}\;\frac{1+e}{1-e} \tag{7.27}$$

and

$$g=(c+v_o)^2\,a(1-e)/(1+e) \tag{7.28}$$

Let the time for an orbit, i.e. the period, be τ_v (from reference [7.1]), substituting the value of GM as g from the above, and using e as β gives

$$\tau_v = 2\pi a^{3/2} / \sqrt{g} = 2\pi a / (c\sqrt{1-\beta^2}\,) \qquad (7.29)$$

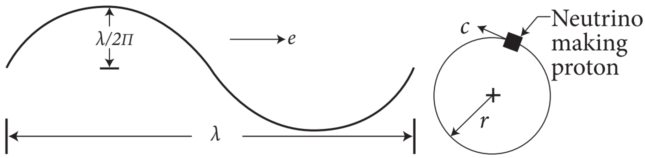
When v_o=0 (i.e. when β= 0) the period = $2\pi r/c$ – obviously the circumference of the circle divided by the speed of light. The period increases with motion and grows without bound as $\beta(=v_o/c)$ approaches unity, or as the velocity approaches the speed of light. Nuclear particles, which disintegrate and emit radiation and produce other matter particles, are observed to decay slower when moving – and governed by the law, $\tau_v / \tau_0 = 1/\sqrt{1-\beta^2}$ where τ_v is the decay time while moving at velocity v and τ_0 is the decay time while at rest. If it is presumed that decay takes an average number of orbits at rest and that the decay process depends upon the number of orbits (i.e. the number of trials at *breaking loose*) then it follows that

$$\tau_v / \tau_0 = 1/\sqrt{1-\beta^2} \qquad (7.30)$$

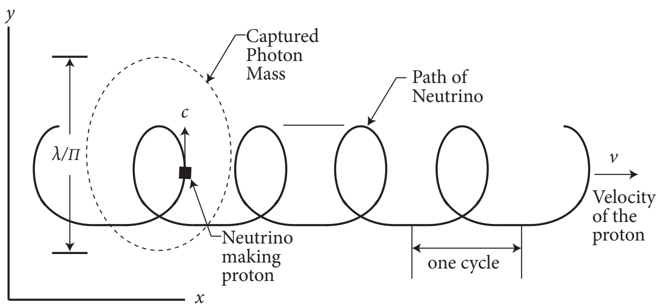
This gives the time dilation effect produced by the special theory of relativity but here derived from a classical Newtonian basis.

Let us illustrate the kinematics of the acceleration of a proton. Figure 7.3a shows a photon approaching a proton. The proton, of course, is made up of a neutrino orbiting at the speed of light and with a mass equal the proton mass. Figure 7.3b shows the subsequent path of the proton neutrino after impact as seen by an observer at rest relative to the pre-impact proton. Figure 7.3c shows the proton as seen by the observer moving at the post-impact velocity. This moving observer sees its path as an ellipse.

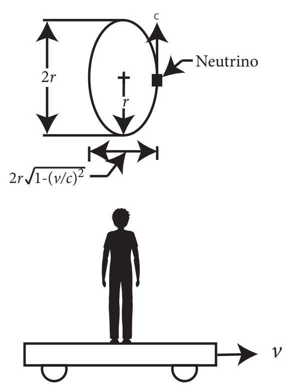
We note that the proton orbit horizontal width has reduced to $2r\sqrt{1-(r/c)^2}$ and that the time to orbit is increased as given by the equation $T_v = T_o / \sqrt{1-(v/c)^2}$.



a. Before Impact



b. After Impact



b. After Impact Collision by Observer Moving at Velocity *v*

Figure 7.3. Acceleration of a Proton by a Photon

B. Compton Scattering

The experiment known as Compton Scattering where high energy radiation was applied to an electron indicated several significant things:

1. When radiation impacts a stationary electron, the electron is accelerated.
2. The electron mass increases.
3. The scattered radiation wave length is larger than that of the impacting photon which indicates that radiation could consist of particles.
4. Since the energy of a radiation particle decreases and the mass of the electron increases, if Einstein's theory of relativity had not been *en vogue*, the obvious conclusion would be that radiation, like other gases, consists of smaller particles. In the kinetic particle theory of physics, radiation, of course, must consists of the brutino gas particles making up the ether — and all other constituents of the universe.

In a Compton scattering experiment a photon impacts an electron at rest. The electron scatters off at some angle and a photon at another angle. See Figure 7.4.

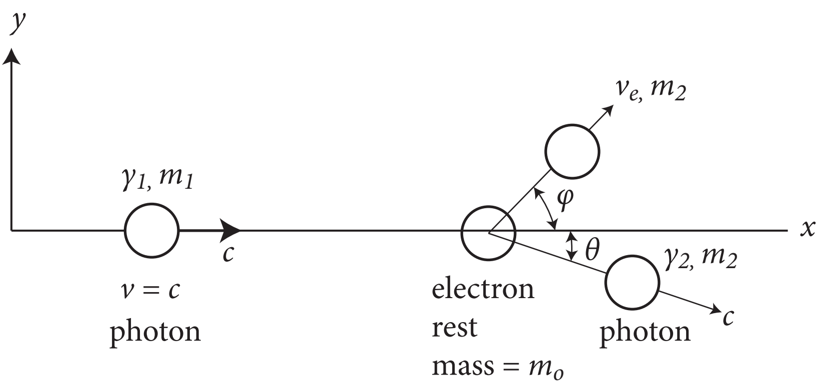


Figure 7.4. Photon Impacting an Electron

In this figure γ_1 is the impacting photon with mass *m* and velocity *c*, of course; m_o is the rest mass of the electron, v_e is the recoil electron velocity at angle *φ*, and its mass m_2 is $m_o/\sqrt{1-\beta^2}$; and γ_2 is the scattered photon of mass m_2 scattered at angle *θ*.

Let $\underset{\sim}{p}$ and $\underset{\sim}{p}^1$ be the photon momenta before and after the collision and $\underset{\sim}{q}$ be the momentum of the electron after the collision. The momentum balance gives

$$\underset{\sim}{p} = \underset{\sim}{p}' + \underset{\sim}{q} \qquad (7.31)$$

Using the photon energy as *hv* the energy balance gives

$$hv + m_o c^2 = hv' + \sqrt{q^2c^2 + m_o{}^2c^4} \qquad (7.32)$$

where the last term in (7.32) is the energy of the electron (at high velocity), see Appendix B for the Newtonian derivation of this term.

From the momentum vector equation, the variable ϕ is eliminated, giving the equation

$$q^2 = (\underset{\sim}{p} - \underset{\sim}{p}')^2 = (p)^2 + (p')^2 - 2\,\underset{\sim}{p} \cdot p'$$

$$= \left(\frac{hv}{c}\right)^2 + \left(\frac{hv^1}{c}\right)^2 - 2\left(\frac{hv}{c}\right)\left(\frac{hv^1}{c}\right)\cos\theta \qquad (7.33)$$

where θ is the photon scatter angle.

Rearranging the energy equation and squaring it gives

$$\begin{aligned} q^2c^2 + m_o{}^2c^4 &= (hv)^2 + (hv)m_oc^2 - (hv)(hv') \\ &+ hvm_oc^2 + m_o{}^2c^4 - m_oc^2hv' \\ &- hvhv' - hvm_oc^2 + (hv')^2 \\ &= (hv)^2 + (hv')^2 - 2(hv)(hv') \\ &+ 2m_oc^2\,(hv - hv') + m_o{}^2c^4 \end{aligned} \qquad (7.34)$$

Dividing by c^2 gives

$$q^2 = \left(\frac{hv}{c}\right)^2 + \left(\frac{hv^1}{c}\right)^2 - 2\left(\frac{hv}{c}\right)\left(\frac{hv^1}{c}\right) + 2m_o\left(hv - hv^1\right) \qquad (7.35)$$

Now substituting q^2 from (7.33) into (7.35) gives

$$\left(\frac{hv}{c}\right)^2 + \left(\frac{hv^1}{c}\right)^2 - 2\left(\frac{hv}{c}\right)\left(\frac{hv^1}{c}\right)\cos\theta$$

$$= \left(\frac{hv}{c}\right)^2 + \left(\frac{hv^1}{c}\right)^2 - 2\left(\frac{hv}{c}\right)\left(\frac{hv^1}{c}\right) + 2m_o\left(hv - hv^1\right) \qquad (7.36)$$

or

$$2\left(\frac{h\nu}{c}\right)\left(\frac{h\nu^1}{c}\right)(1-\cos\theta) = 2m_o\left(h\nu - h\nu^1\right) = 2m_oc\left(\frac{h\nu}{c} - \frac{h\nu^1}{c}\right) \quad (7.37)$$

Using

$$\nu = c/\lambda \qquad \text{and} \qquad \nu' = c/\lambda' \quad (7.38)$$

gives

$$\frac{h^2}{\lambda\lambda^1}(1-\cos\theta) = 2m_och\left(\frac{1}{\lambda} - \frac{1}{\lambda^1}\right) = 2m_och\frac{\lambda^1 - \lambda}{\lambda\lambda^1} \quad (7.39)$$

Rearranging gives

$$\lambda^1 - \lambda = \frac{h}{2m_oc}(1-\cos\theta) \quad (7.40)$$

This is the usable form of equation since wave lengths are measured in the experiment.

Equation (7.40) is the Compton scattering equation which relates the change in photon wave length to the target rest mass and the scattering angle. This is the same equation derived on Pages 1136-9 by Halliday [7.2] using the special relativity approach. We again emphasize that Equation (7.40) was derived from Newtonian mechanics. The experiments performed by Dr. Compton verified this equation, see 1136-9 of [7.2].

C. Matter Waves

When any matter particle translates from one place to another along a nominal straight path, it always undulates from one side to the other as it moves. All matter at rest consists of elementary matter particles which consist of mass moving at the speed of light in circular paths. Ordinary matter, such as a bar of steel, is accelerated from rest by photons being transferred, usually from other matter (such as during impact by another bar). In the previous paragraphs we discussed how these photons interact with the flow fields produced by matter to accelerate the matter particles. When a small (low energy-long wavelength) photon interacts with a matter particle the distance from the particle center of mass to the coupling position must be in the order of the wavelength of the photon. Angular momentum considerations require that small impacts be at large distances from the center of the matter particles. Thus, the smaller the interacting photon energy (and the longer the wavelength) and the smaller the resulting matter particle velocity, the greater the eccentricity of the coupled mass. Now consider a free wheel in space rotating with a small unbalanced mass placed at a large radius. The axis of the wheel will undulate as it translates to keep the center of mass following an exact straight line. As a result the center of the wheel will take a sinusoidal path to the left and right of the center of mass straight path. Let us now calculate the wavelength of the moving matter geometric center path.

Let r_c be the distance from the matter particle's center to the place where the momentum is captured, by both the captured mass and scattered mass. The linear momentum "P" times the capture radius is Pr_c - which is equal to $\hbar$. For low velocities (i.e. non-relativistic conditions) the momentum P is also M_0v, where M_0 is the matter particle rest mass. Now, we can write

$$\hbar = P r_c = M_0 \, v r_c, \qquad h = 2\pi\hbar = M_0 v 2\pi r_c = M_0 v \lambda \tag{7.41}$$

where λ is the wavelength. Thus

$$\lambda = h/(M_0 v) = h/P \tag{7.42}$$

This is the relation postulated by deBroglie and is called the *deBroglie wavelength*. For high speeds (i.e. for relativistic speeds) consideration must be given to matter particle mass growth, the center of gravity difference, and the matter particle contribution to the angular momentum.

The wavelength λ is measured in meters, the constant h is 6×10^{-34} kilogram-meter^2 per second (i.e. Planck's constant), M_0 is the matter particle rest mass in kilograms, and "v" is the particle translational velocity v meters per second. An electron with a mass of 10^{-30} *kg* and a velocity 1/3 the speed of light (i.e., 10^8 m/s) has a wavelength of

$$\lambda = \frac{6\times10^{-34}}{10^{-30}10^{8}} = 6\times10^{-12} \text{ meters} \tag{7.43}$$

– a very small wavelength. The amplitude of the oscillation is smaller than the wave length.

The observation of high speed mass growth with velocity is a significant part of high speed (relativity) physics and the observation of matter moving as a wave is a significant part of small item (quantum) physics. Both of these mechanisms come about simply from the interaction of a photon with matter – as shown by the mass growth formula and the wavelength formula just derived.

Throughout the 20th century many authors have stated the impossibility of deriving the special relativity results from classical (Newtonian) theory. We have shown that the three primary relativity observations (mass growth, matter shortening, and time dilation) are derived in a straightforward manner from a classical kinetic particle theory. Further, the mass-energy equivalence $E=M_0c^2$ is an obvious result of this theory. Finally, we have derived the wave properties of matter rather than postulating them – as done in contemporary physical theory. In summary, these results indicate that the universe is a classical based system.

D. Magnetism

Let us now determine the effect of motion on the electromagnetic force between two charged particles. An electron at rest, in the assumed kinetic particle universe, has an assemblage of kinetic particles orbiting at the speed of light in circular paths. In order to accelerate an electron, a photon with angular momentum $\hbar$ impacts the electron electrostatic field. The angular momentum of the combined assemblage (consisting of the electron and the captured portion of the photon) increases by $\hbar$ and the two entities combined translate at velocity v. The angular momentum then of the combined entities is $\hbar = m r_c v$, where m is the mass (of the two entities) and r_c is the half-amplitude of the center of the *charge*. The center of mass, of course, continues on a straight path. The undulation of the center of charge is the *electron wave*.

Consider now two like electric charges moving at velocity v parallel to each other and with a vector R starting at one charge and ending at the other and which vector is perpendicular to the particle velocities. In a reference frame moving at velocity v the two charges are seen to oscillate along the vector v. Assuming phasing is controlled by the twist component of the orbiting assemblage producing the charged particle, the maximum force of interaction between the two particles is given by the same form as the formulas for electrostatic charge. The difference is that a will be the deBroglie wave amplitude of the charge (which is $\lambda/(2\pi)$), and the period T_m will be $2\pi a/v = \lambda/v$. The force then due to motion will be

$$F_m = \rho_0 \frac{8\pi^2 a^4 \alpha^2}{T_e^{\,2} R^2} = \rho_0 \frac{8\pi^2 a^4 \left(\lambda/(2\pi)\right)^2}{\left(\lambda/v\right)^2 R^2} = \rho_0 \frac{2a^4 v^2}{R^2} \qquad (7.44)$$

Dividing the magnetic force by the electrostatic force gives

$$\frac{F_m}{F_e} = \frac{2\rho_o a^4 v^2 / R^2}{2\rho_o a^4 c^2 / R^2} = \left(\frac{v}{c}\right)^2 \tag{7.45}$$

for the special case of equal charges, equal and parallel velocities, and a charge separation vector initiating on one charge and ending on the other where the vector is perpendicular to both velocities. This ratio, of course, is the ratio of the magnetic force to the electrostatic force for this special case. Thus this mechanism models the magnetic force.

If the charges have the same sign then the force is attractive, if opposite, the force is repulsive. By the same mechanism, if the charge velocities are opposite, the repulsion/attraction is reversed due to the helicity of the charged particles.

Let us now generalize the special case just developed. Consider a velocity v_1, of charge 1 which produces 100 oscillations in a given period of time. Starting with velocity v_2, of charge 2 with 100 oscillations, if the velocity is reduced say to 1 oscillation in the same time period then the force, clearly, would be reduced to 1/100th of the initial value. Thus, we can generalize the magnetic force equation to

$$F_m = (e^2/R^2)(v_1/c)(v_2/c) \tag{7.46}$$

where v_1 and v_2 can be any value, negative or positive.

The next generalization is for unlike charge magnitudes. We let N_1 be the number of elementary charges at one location and N_2 at the other and take

$$q_1 = N_1 e \quad \text{and} \quad q_2 = N_2 e \tag{7.47}$$

then

$$F_m = \frac{q_1 q_2}{R^2}\left(\frac{v_1}{c}\right)\left(\frac{v_2}{c}\right) \tag{7.48}$$

If v_1 and v_2 are perpendicular to each other then the force would be zero because of the phasing and should vary sinusoidally from zero when perpendicular to a maximum magnitude when parallel (or anti-parallel).

Finally, if the radius vector *R* for the general case starts at charge 1 and ends at charge 2 (no matter what the relative locations and directions that the charges have) we have the magnetic force given by

$$\underset{\sim}{F}_m = \frac{q_1 q_2}{c^2} \underset{\sim}{v}_2 \times \underset{\sim}{v}_1 \times \frac{\underset{\sim}{i}_R}{R^2} = \frac{q_1 q_1}{c^2 R^2} \times \underset{\sim}{v}_2 \times \underset{\sim}{v}_1 \times \underset{\sim}{i}_R \qquad (7.49)$$

In this expression q_1 and q_2 are the point charges with units of $kg^{1/2}$ $m^{3/2}$ s^{-1}, v_1 and v_2 are the charge velocities in *m/s,* $\underset{\sim}{i}_R$ is a unit vector from charge 1 to charge 2, *R* is the magnitude in meters of the vector from charge 1 to charge 2, *c* is the speed of light in *m/s*, and $\underset{\sim}{F}_m$ is the magnetic force in Newtons, which is attractive in the case where the velocities are parallel and equal and the charges are of like sign.

The above expression can be put in a more familiar form using the concept of the magnetic field. Let the magnetic field generated by charge 1 be

$$\underset{\sim}{B} = \frac{q_1}{c^2 R^2} \underset{\sim}{v}_1 \times \underset{\sim}{i}_R \qquad (7.50)$$

Now the magnetic force on charge 2 is

$$\underset{\sim}{F}_m = q_2 \underset{\sim}{v}_2 \times \underset{\sim}{B} \qquad (7.51)$$

The electromagnetic units also can be changed to Coulombs and Teslas, if desired.

Let us consider now the effect of relativity. All assemblages making matter, when at rest, orbit in circular paths. To accelerate a particle from rest, mass is added and the path is changed to a planar coil. If the planar coil is viewed from a frame moving with the center of mass of the moving particle then the path is elliptic. The time for an orbit is increased as given by the relation

$$\tau_v = \tau_0 / \left(\sqrt{1-(v/c)^2}\right) \tag{7.52}$$

where τ_v is the period while moving, τ_0 is the period while at rest.

For two charged particles of like charge moving parallel to each other at absolute velocity v and where the vector connecting the two particles is perpendicular to v then the electromagnetic force between them is a force of repulsion given by

$$F_{em} = \frac{q_1 q_2}{R^2}\left[1-\left(\frac{v}{c}\right)^2\right] \tag{7.53}$$

If these charges are viewed from a frame moving at the same velocity as the charges then the separating force must be the same as given above. However, when seen in this moving frame the charged particle response would appear to be that due to a force

$$F'_{em} = \frac{q_1 q_2}{R^2} \tag{7.54}$$

since the particle velocities in this frame would be zero.

The particle response is experienced only by the acceleration and in this moving frame it would be $d^2y/d\tau_v^{\,2}$, if the y-axis is taken to pass through the two particles. The response then as measured by a clock at rest would be

$$\frac{d^2y}{d\tau_v^2} = \frac{d^2y}{d\tau_0^2}\left(\sqrt{1-(v/c)^2}\right) = \frac{d^2y}{d\tau_0^2}\,[1-(v/c)^2\,] \tag{7.55}$$

Thus, the force would have to be reduced by the factor $[1-(v/c)^2]$. If the charges are of opposite sign then the electrostatic force is attractive but the magnetic force is repulsive so that the same factor

$[1-(v/c)^2]$ results.

Einstein did not understand how the observed acceleration between two parallel moving electrons could depend upon the observer's velocity. This motivated him to develop the special theory of relativity. The difference in the acceleration measured was due only to the clock running slower when moving.

E. The Speed of Light Appears the Same in All Reference Frames

One of the postulates of Einstein's special theory of relativity is that the speed of light experienced in any inertial system is the same as that experienced in any other inertial system. Let the $x'y'z'$ system move at a velocity of 0.866*c* directed to the right (where *c* is the speed of light) relative to the *xyz* system as shown in Figure 7.5. Body A is fixed to the *xyz* system, and body B is fixed to the $x'y'z'$ system.

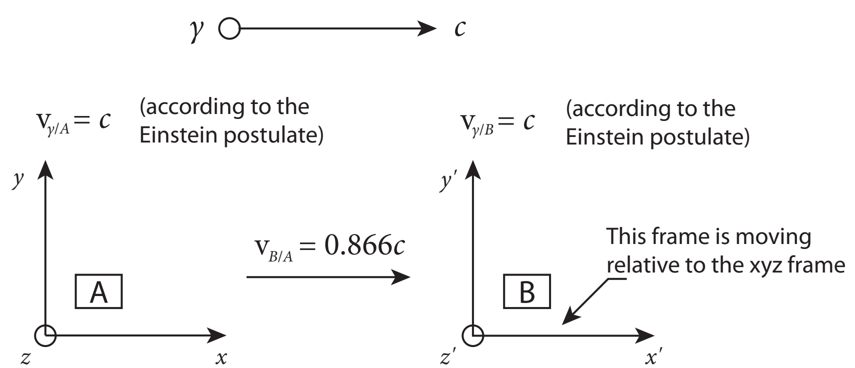


Fig 7.5. A Photon Observed in Two Frames

Let γ be a photon moving to the right at its velocity *c*. The velocity of B relative to A is 0.866*c* directed to the right. The velocity of the photon experienced by a person on the *xyz* frame, according to the Einstein postulate, is *c* to the right, and the velocity of the photon experienced by a person on the $x'y'z'$ frame is *c* to the right. Many scientists believe this postulate of Einstein represents the truth. The following paragraphs show how this fallacious result occurs.

The universe is filled with a gas of perfectly elastic particles which is an ether defining a fixed reference system. Matter emits photons, and every one travels at velocity *c* (3×10^8m/s) relative to the ether. This average speed is invariant throughout the universe except for the existence of ether *winds*. In case of a wind the photon velocity will be c with respect to the flowing ether.

Consider now an assemblage of matter attached to a reference system which is at (absolute) rest. We let body A and the xyz system in the above figure be at rest. Let the speed of light be measured using instruments on this frame. To measure speed, a distance measure is required, and a time measure is required, since v is change in location divided by an increment of time. Thus, we use a measuring rod and a clock. To make our calculations simple, let the distance change of the photon be 3×10^8 meters to the right while the clock ticked one second, as measured by A. Thus, the speed measured is

$$c = 3\times10^8 /1 = 3\times10^8 \text{m/s} \tag{7.56}$$

Now, consider an assemblage of matter (i.e., body B) attached to a reference frame moving to the right at an absolute velocity 0.866 times the speed of light ($v_B = 2.598\times10^8 m/s$). The observer on B now sees the same photon as the observer on A and measures the photon velocity. We know that the photon velocity relative to this frame is $c—0.866c = 0.134c$, since the xyz system is at absolute rest. Observer B uses the same type meter stick and same type clock as observer A, except B's meter stick and clock are moving to the right with an absolute velocity of $0.866c$. Observer B wants to compute the velocity of light relative to the $x'y'z'$ frame. To understand what happens we need to know the structure of meter sticks and time clocks. We explain these in the following paragraphs.

All matter is comprised of mass moving at the speed of light in an orbital path. For matter at absolute rest the mass travels in a circular path. In order for matter to translate, a photon must impact the matter and cause it to take a planar coil path, as viewed from a rest frame. The path viewed from a frame moving with the matter particle is an ellipse with a minor axis which is $\sqrt{1-\beta^2}$ ($\beta = v/c$) as large as the circular radius when at rest. Thus all matter shortens by this factor when moving. Further, the time for an orbit increases by the factor $1/\sqrt{1-\beta^2}$. In this case $\sqrt{1-\beta^2}$ $=\sqrt{1-0.866^2}$ =0.5 and while the photon passes, the measure stick would measure a distance of $3\times10^8/\sqrt{1-\beta^2}$ $=3\times10^8/0.5=6\times10^8$ meters while the clock ticked $1/\sqrt{1-\beta^2}$ =1/0.5=2 seconds. Thus, the observer on B computes the velocity as

$$c = 6\times10^8/2 = 3\times10^8 m/s \tag{7.57}$$

which is exactly the same as the rest observer's results. However, the photon absolute velocity relative to B is 0.134*c*. Sometimes the truth is hard to find!