CHAPTER 9

SUMMARY

Relative and absolute motion, an overview

The true Universe?

Building blocks of Nature

Nature is an interplay between mass, charge, time and length. It produces acceleration and velocity generating the most precious commodity of all, namely energy, which can be stored (potential energy) or used (power). Stored energy is the product of mass (m) and tension (ϕ). Spent energy or power always involves radiation Charge (q) and mass (m) are related through the constants ε_0 and μ_0. The change in energy with time (power) is nature's gift of life. Without change in energy nothing would ever happen.

9.1 Relative and Absolute Motion, an overview

Isaac Newton, the ground breaker of modern physics and mechanics, summarized physics in three laws of motion which are still in broad use today. He believed the Earth was orbiting the Sun through a fixed space or ether so that our frame of reference, the Earth, would have an absolute velocity with respect to stationary space. If Earth in its orbit is moving around in stationary space, which acts as a medium for force fields and the propagation of light waves, then space must have some physical properties. It should be possible to perform an experiment that could detect the Earth's motion through stationary space or the so called "ether". Michelson and Morley (1887) were first to attempt such an experiment using sensitive optical interference methods. It was thought that the travel of light waves, from a light source to a mirror and back, would be different along the direction of the Earth's orbital motion through the ether than at right angles to it. The result was that no difference in travel time was detected. Ritz explained the null result by suggesting that *c,* the speed of light, is always constant with respect to the light source, but other scientists at the time favored the idea that our Earth is dragging the ether along in its motion. This is perhaps closer to the truth since the gravitational tension of all matter in the Universe is what constitutes the ether and serves as a medium for force fields and electromagnetic waves. **As long as the gravitational tension is constant the speed of light stays constant**. There is no change in the gravitational tension ϕ_{univ} at the surface of the Earth, regardless of its orbital motion around the Sun, that will change the speed of light in any direction along the Earth's surface except in the vertical direction where the Earth's own gravitational tension changes with altitude. The change in the Earth's gravitational tension with altitude (acceleration *g*) will change the speed of light, see Appendix C. Fitzgerald (1889) and, independently, Lorenz (1892), on the other hand, believed that the null result could be explained if one assumed that the length of the measuring instrument shortened in the direction of motion. This turned out to be an appealing approach and it had its origin in the discovery, at that time, that matter could not accelerate to exceed the speed of light *c*. It had been observed that velocity v, ($v = distance$ per *time*) did not increase proportionally to the square root of kinetic energy as envisaged by Newton but seemed to shrink at high values, never to reach the speed of light *c*. This behavior was attributed to the shrinkage of *distance* and was assumed to affect anything moving at high velocity. The proposed shortening in the length of objects, including instruments and measuring rods in the direction of velocity v relative to the ether, was attributed to a factor β which limits the velocity to the speed of light

$$\beta = \sqrt{1-(v^2/c^2)}\,. \qquad (none) \quad (128)$$

This shortening of length is known as the Lorenz-Fitzgerald contraction and the idea has been widely used in situations where energy and velocity are transferred from coordinates in one frame of reference to another, which are moving with a velocity of v relative to each other. However, instead of changing length of coordinates in moving frames by β it is just as easy to modify the rate at which time flows by β or to change both. This variation of the Lorentz-Fitzgerald idea is exactly what Einstein (1905) had in mind when he introduced his Theory of Special Relativity which led to the concept of space-time

$$E_0 + E = E_0 / \beta \qquad (ml^2/t^2) \quad (129)$$

or

$$v = c\sqrt{1 - \frac{1}{\left[1 + (E/E_0)\right]^2}} = c\sqrt{1-\beta^2}\,, \qquad (l/t) \quad (130)$$

where E is the kinetic energy of a mass m due to its relative velocity v and $E_0 = mc^2$ is the rest mass energy of an object. The interesting but perhaps troublesome outcome of Einstein's theory is that it eliminates the use of length when transforming velocities from one coordinate to another thus abolishing the concept of a fixed space and the existence of an ether. Einstein's velocity equation (130) improved Newton's law of motion to the point where it can precisely describe the behavior of particles with high relative velocities such as found in high energy particle accelerators. In fact, Einstein's equation is only accurate in situations where matter has gained velocity due to gain in energy. The diagram in Fig. 17 shows how Einstein's relativistic formula differs from Newton's law of motion when used to calculate velocities of high energy electrons. Einstein's energy-velocity formula has been verified numerous times in particle accelerators where matter has gained energy and is perhaps one of the greatest successes in physics of the 20th century. But one problem still remains, namely that neither Newton's law of motion nor Einstein's relativistic equations work satisfactorily for the high relative velocities found in atomic orbits, where velocities are created by loss of rest mass energy. In fact, Newton's laws of motion offers a slightly better fit for the energy-velocity relationship of atomic energy spectra than does

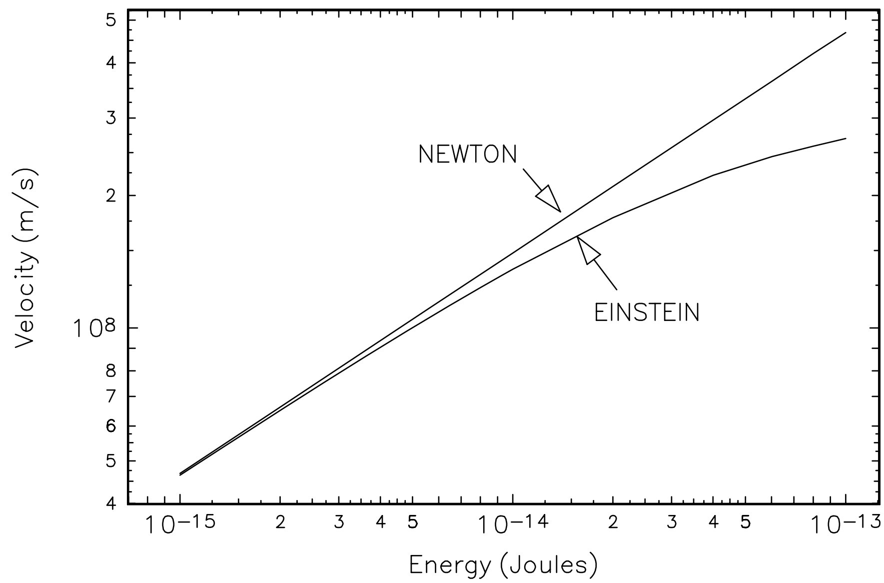

Fig. 17. Velocity of high energy electrons as a function of Energy according to Newton and Einstein.

Einstein's theory, see Fig. 12, Chapter 6.

The reason why both Newton's law of motion and Einstein's theory of relativity do not work for atomic orbits has to do with the fact that both theories consider us at rest (thus the term rest mass energy) and therefore ignore the influence of our own motion with respect to the rest of the Universe. Einstein's theory goes as far as to state that everything is relative and that no observer occupies a privileged position in the Universe because there is no absolute space or ether to reference our position or velocity to. Although our Earth, the solar system and our galaxy, are moving relative to other astronomical objects the theory claims that it is just as valid to say that other astronomical objects are moving relative to us and that we, therefore, can consider our frame of reference here on Earth to be at rest. By the same token an observer at any other galaxy can consider her or himself to be at the center of the Universe and at rest. Herein lies the snarl with Einstein's relativity theory since it essentially places ourselves as stationary observers in a mathematically centralized position. As previously explained it creates the same difficulty that haunted our predecessors for thousand of years when they firmly believed that our Earth was at the center of heaven and at rest and how an impossible task it was to understand any mathematical equation describing the planets including our Sun orbiting the Earth. It is for this same reason that both the Lorentz-Fitzgerald transformation of velocities and Einstein's relativity theories are difficult to understand and why they have always been a subject of debate. Even though the mathematical equations, in some cases, provide correct numerical answers there is still a small number of investigators who cannot accept a mathematical theory unless it makes physical sense; while many mainstream scientists of today seem to feel that a mathematical equation, which gives a correct numerical answer, constitutes a physical law. Even if Lorenz-Fitzgerald and Einstein's equations give correct answers, it is the interpretation of the physics that is amiss because it does not take into account our absolute motion in the Universe and, therefore, breaks down when applied to atomic and astrophysical orbits where velocities relative to us are generated by loss of potential energy (see Appendix C). To illustrate the importance of absolute motion consider, for example, the Earth's orbital velocity v_0 around the Sun using standard Newtonian mechanics

$$v_0 = \sqrt{GM_{sun} / R_{orb.}} = 30\text{km/s}. \qquad (l/t) \quad (131)$$

Adding energy in the amount of ΔE to the Earth's orbit would sling the Earth out to a higher orbital radius but slower orbital velocity of

$$v_0 - \Delta v = \sqrt{\frac{2(E_{orb} - \Delta E)}{M_{earth}}} \qquad (l/t) \quad (132)$$

where Δv is the change in orbital velocity due to the added energy ΔE. However, should the Earth's orbit on the other hand, experience a loss in potential energy it would fall closer to the Sun, but with an increase in orbital velocity of

$$v_0 + \nabla v = \sqrt{\frac{2(E_{orb} + \nabla E)}{M_{earth}}}, \qquad (l/t) \qquad (133)$$

where ∇v is the change in orbital velocity due to ∇E, the loss in energy, see Fig. 18.

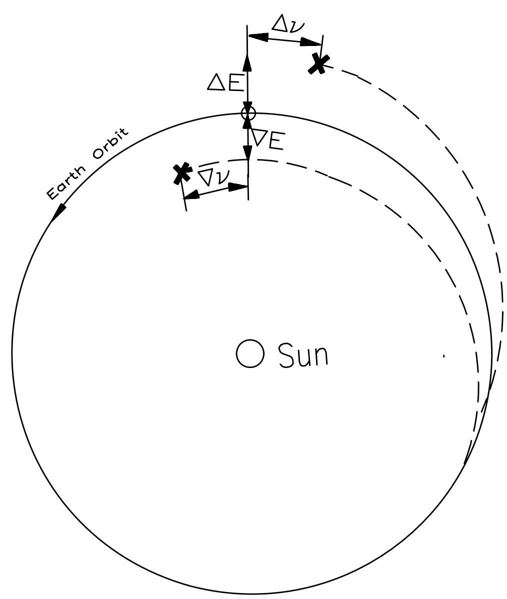

Fig 18. Diagram illustrating change in Earth's orbital velocity and frequency $\Delta \nu$ and $\nabla \nu$ as a function of change in orbital energy ΔE and ∇E respectively.

The diagram in Fig. 19 shows a curve labeled "Energy gained", which is constructed from Equation (132) and a curve labeled "Energy lost" which is constructed from Equation (133). The two curves, "Energy gained" and "Energy lost" demonstrate that for an equal change in energy $\Delta E = \nabla E$ the velocity Δv does not equal ∇v or

$$\frac{\Delta E}{\nabla E} \neq \left(\frac{\Delta v}{\nabla v}\right)^2, \qquad (none) \qquad (134)$$

which informs us that two different equations must be used depending on whether energy is lost or gained, for the simple reason that our frame of reference, the Earth, is not at rest. The same is true for objects seen from our point of reference relative to the rest of the Universe, a reality which has been neglected and explains why existing theories fall short in accurately predicting velocities of atomic orbits where electrons have lost energy to radiation. Therefore, it cannot be ignored

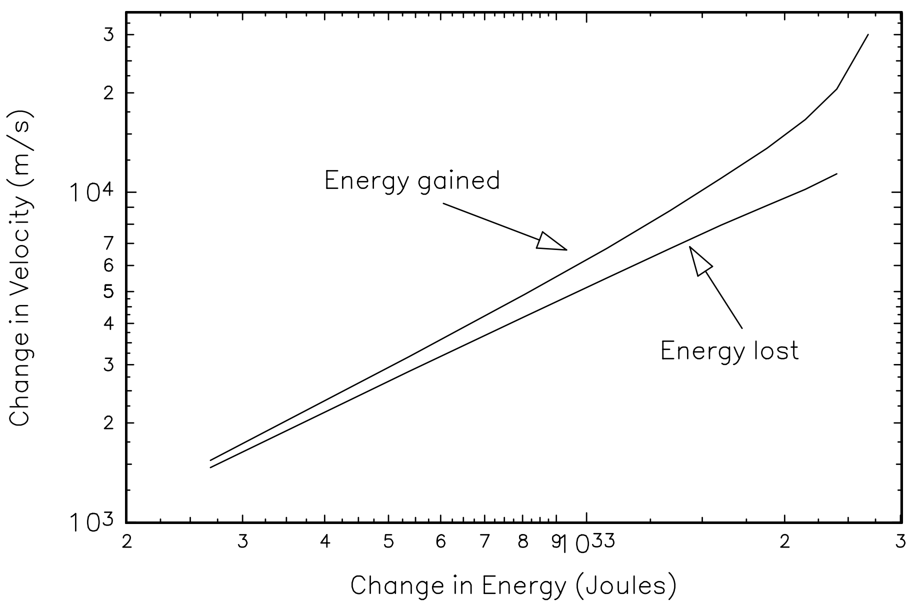

Fig. 19. Change in the Earth's orbital velocity as a function of change in energy.

that we ourselves are in motion when trying to determine motion of matter relative to us. We have to abandon the doctrine of both Einstein’s relativity and Newton’s concept and accept the fact that we are part of a Universe in which all matter has its own peculiar position and absolute velocity with respect to the center of mass of the system. The intention of this book has been to show that it is possible to construct equations of motion that are both conceptually clear and physically sound, and that will work for both energy gained and energy lost, as well as for absolute and relative velocities. For example, if we use Newton’s Equation (131), that was used to describes the Earth's orbit around the Sun, but change the mass and radius to that of the whole Universe we obain

$$v_{abs} = \sqrt{GM_{Univ.} / R_{Univ.}} = c\,, \qquad (l/t) \quad (135)$$

where $v_{abs} = c$ can be considered our absolute velocity relative to the rest of the Universe. At our frame of reference in the Universe, the potential energy of matter equals $E_0 = mc^2$. The absolute velocity as a function of gain in potential energy is therefore

$$v_{abs} = c\frac{E_0}{E_0 + \Delta E} \;. \qquad (l/t) \quad (136)$$

As previously shown relative velocities of bodies in the Universe, that have gained kinetic energy relative to our frame of reference, are obtained from the vector sum

$$\Delta v = \sqrt{c^2 - v_{abs}^2} = \sqrt{c^2 - \left(c\frac{E_0}{E_0 + \Delta E}\right)^2}\,, \qquad (l/t) \quad (137)$$

which can be reduced to Einstein's relativistic Equation (130)

$$v = c\sqrt{1 - \frac{1}{\left[1 + (E / E_0)\right]^2}} = c\sqrt{1 - \beta^2} \;. \qquad (l/t) \quad (138)$$

On the other hand, when energy is dissipated relative to our frame of reference, such as when electrons or astronomical bodies are captured in orbits and where potential energy is lost relative to us , the above Equations (137) and (138) are invalid. The correct equation for velocities relative to us that are produced by loss in potential energy is therefore

$$\nabla v = \sqrt{c^2 - \left(c\frac{E_0 - \nabla E}{E_0}\right)^2} \;. \qquad (l/t) \quad (139)$$

The curves in Fig. 20 show the velocity of an electron relative to our frame of reference as a function of energy gained and energy lost. The straight line represents Newton's law. The curve labeled "energy gained" is constructed from Equation (137) and which also conforms with Einstein's Equation (138). The curve labeled "energy lost" is constructed from Equation (139) and fits perfectly situations where absolute energy has been lost such as in atomic orbits, see detailed description in Chapter 6, section 6.3. The energy-velocity Equations (138) and (139), identical to Equations (5) and (10) in Chapter 3, which were developed from the cosmic harmonic model pictured in Fig. 4, Chapter 2.

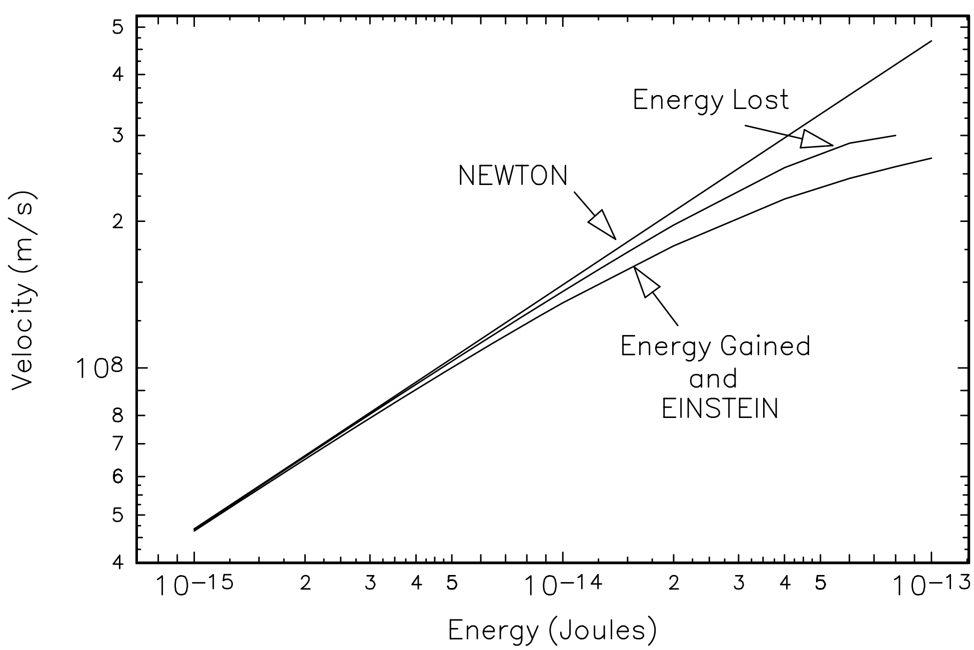

Fig. 20. Change in energy of an electron as a function of its change in velocity.

In summation, consider two observers, one at Earth and one outside the Universe. The outside observer will see our galaxy and Earth fall with an absolute velocity of c toward the center of the Universe. The outside observer will also see our galaxy being accelerated at a rate of

a_0 toward the center of mass of the system. Contrary to the cosmic observer, the observer on Earth tends to see himself at rest relative to the bulk Universe. Both observers however, will find that potential energy of matter at Earth equals $E_0 = mc^2$.

9.2 The true Universe ?

What has been described so far is a Universe based on the harmonic model shown in Fig. 4, Chapter 2. This model is basically a mathematical model which appears to works well for a stationary observer here on Earth using standard physical units for energy, time, velocity and mass *etc.* However, these units are not the same everywhere in the Universe but will change drastically with location. Time flows slower at the Sun's surface than here on Earth and faster on the planet Pluto. This means that fundamental constants such as the gravitational constant *G* and Planck's radiation constant *h*, which both have physical dimensions involving time, are not the same everywhere and as a result the relationship between energy and velocity can not be the same at different locations in the Universe. The reason for this is that the cosmic gravitational tension $\phi_{univ} = GM_{univ} / R_{univ}$, which determines the energy of matter, varies with the cosmic radius and can therefore not be the same everywhere. At our position x_0 in the Universe $\phi_{univ} = c^2$ and the potential energy of matter is $E_0 = m_0\phi_{univ}$.

The fact that energy per mass , inertia of mass and consequently time (see section Chapter 2, section 2.4), change proportionally with tension makes it difficult to exactly evaluate physical events at other localities in the Universe, using the same standards for physical constants as here on Earth.

Although the harmonic model of the Universe presented in this book, seems to function satisfactorily there are some questionable features which need to be addressed. For example, should we not be able to add velocities linearly in the same direction as we are accustomed to rather than by vector summation and is the edge or the end of the Universe really at exactly 1.6674×10^{28} m as predicted by the harmonic model in Chapter 2?

Absolute velocity and potential energy per mass of matter as a function cosmic radius predicted by the harmonic model are shown in Fig. 21. Absolute velocity and energy and absolute radius were obtained from the Equations in Fig. 4, Chapter 2. The diagrams also

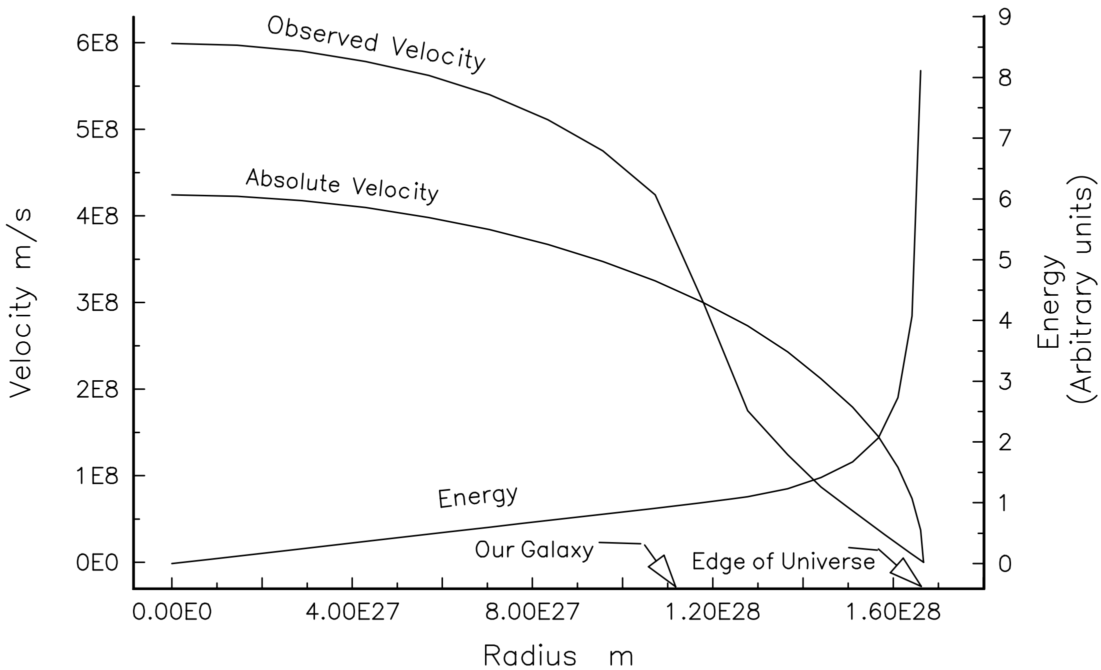

Fig. 21. Calculated absolute velocity, observed velocity and energy per mass as a function of Cosmic radius using the standard mathematical model presented in previous chapters.

show the observed relativistic velocities Δv and ∇v as seen from our vantage point here on Earth, and which are also predicted by vector summation see Equations (137) and (139) and Einstein's Equation (138). However, it does not seem natural that there should be two types of velocities, absolute velocity as predicted by the harmonic model and relativistic velocity according to Equations (137, 138, and 139). In the authors opinion velocities should add linearly in the same direction and by vector summation only if they point in different directions. I therefore believe, that in the relativistic energy-velocity Equations (137) and (139) and Einstein's Equation (138) it is not the velocity but the energy that appears both as absolute and relative. In Chapter 3 section 3.1, it was shown that energies do not always add linearly as demonstrated by the examples of the tennis ball and rocket. Doubling the energy of a rocket at the launching pad does not make the rocket go twice as fast but increasing the energy in flight by two will double the velocity. Changing the diagram in Fig. 21 to reflect the idea that both relative and absolute energy can exist and how it will relate to the observed velocity is accomplished by mathematically replacing the components in Fig.21 and construct a new digram such as Fig. 22.

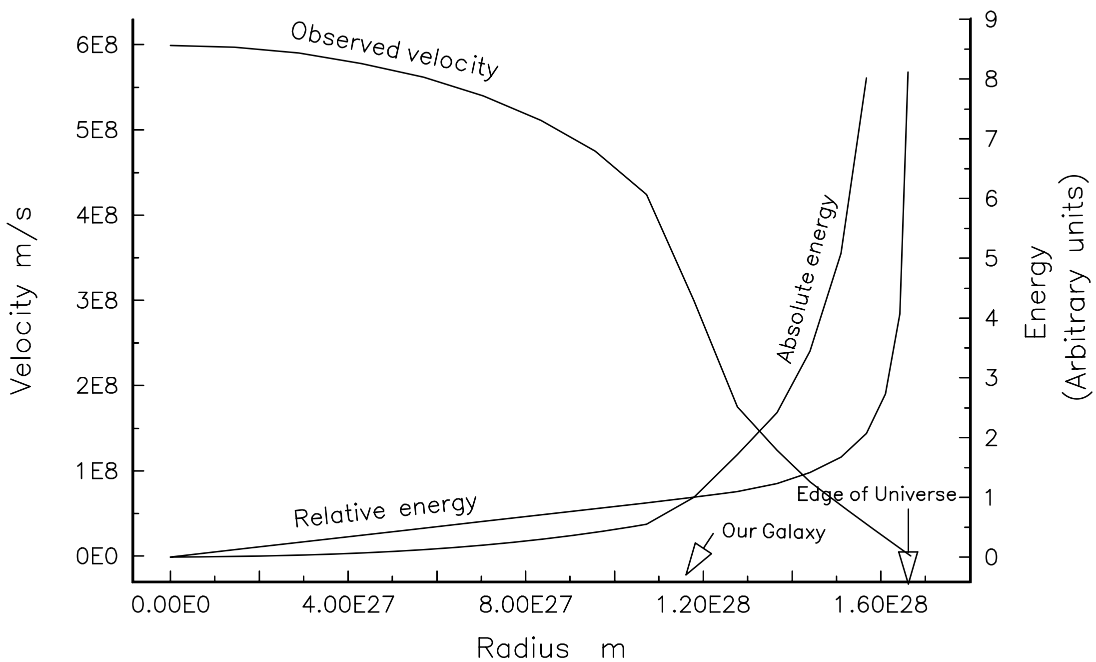

Fig. 22. The standard cosmic model modified to show both relative and absolute energy as related to observed velocity.

The Diagram in Fig. 22 presents a more sensible view of our Universe where relative energy is energy of matter as seen from our vantage point in space and absolute energy as seen from an observer outside the Universe. Both absolute and relative energy will equal E_0 at our galactic reference point x_0 in space. The observed velocity at x_0, or our velocity relative to the rest of the Universe, is c and increases or decreases by Δv or ∇v on either side of x_0. The increase and decrease in observed velocity as a function of cosmic distance is not linear as suggested by Hubble's law but follows a quadratic function.

The other problem with the harmonic model presented in Fig. 4 is that at maximum amplitude *A,* the radius is precisely 1.6674×10^{28} m where the gravitational tension; potential energy of mass; and length of time become infinite. This is purely a mathematical solution which stems from the fact that we only know the amount of mass in our Universe within our radius of x_0 and not how mass is distributed outside x_0. A close examination of the diagram in Fig. 22, shows that relative energy of matter increases linear with radius up to our galactic position at x_0. It seems likely then that relative energy should

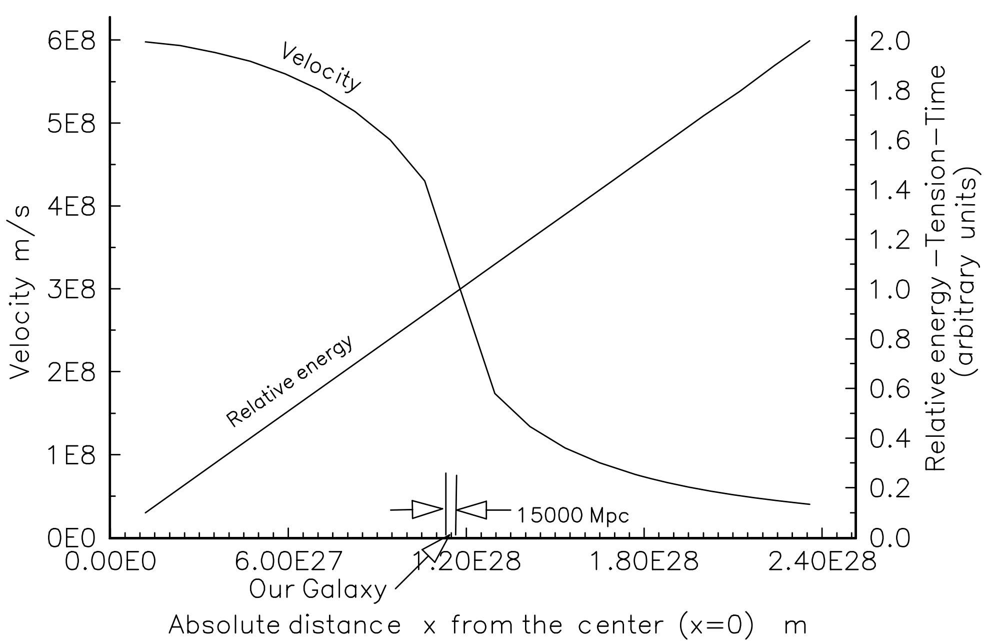

Fig. 23. A more realistic description of the Universe. Velocity and potential energy of matter shown as a function of cosmic radius seen from our vantage point in space and expressed in Earth units.

continue to increase in a linear fashion past our position x_0 to its maximum radius or amplitude A as shown by Fig. 23. Allowing the relative energy, or gravitational tension of the Universe, to increase linearly with its radius beyond x_0 means that the mass of the Universe must increase proportional to its radius squared ($M_U \propto R_U^2$) which is in exact agreement with the Large Number Hypotheses and the Virial Theorem described in Chapter 8, see page 116 and 120.

The increase in inertial mass as a function of radius squared hints to a Universe with a non-uniform mass density, unless pancake shaped, as suggested by several investigators. A pancake shaped or disk shaped Universe could possibly represent the ultimate structure of cosmos completing the hierarchical system from atoms, solar systems, galaxies, cluster of galaxies to a meta galaxy of near infinite size. The diagram in Fig. 23 portrays, in the author's opinion, such a Universe in a authentic way. It shows our distance from the cosmic center and for comparison a distance of 15,000 Mpc centered around our galaxy.

At the present time a distance of 15,000 Mpc is still far beyond the reach of our telescopes. The diagram in Fig. 24 zooms in on a small section of Fig. 23 spanning 400 Mpc along the cosmic radius in each direction of x_0. Note that the observed velocity of nearby galaxies appear linear with distance but then further deviates with distance. This explains why the illusive "linear" Hubble's law has never been established. In fact, several astronomers (A. Dressler (1987), (1994), Riess et al. (1996) and Perlmutter *et al.* (1998)) have recently discovered that Hubble's velocity-distance relationship is not linear but changes slightly with distance which they ascribe to a small amount of acceleration caused by some unknown force. The force is of course generated by the gravitational mass of the Universe and the observed acceleration is the cosmic acceleration a_0 (see Fig. 15. Chapter 7)

Does the radius of the Universe and the gravitational tension and potential energy of matter increase forever? There must be a limit to the size and mass of the Universe otherwise the laws of physics break down. But if there is a limit to the Universe how do we describe empty space beyond the boundaries of our Universe? Empty space contains nothing and we cannot assign properties to nothing or nothingness. This is a difficult subject since it is practically impossible for most of us imagine empty space as nothing or something that does not exist. We seem to understand that we cannot visit or live within the boundaries of a country that does not exist but yet we seem to find it possible to visualize a boundless void outside our Universe where nothing exists, a place filled with an infinite amount of nothing!

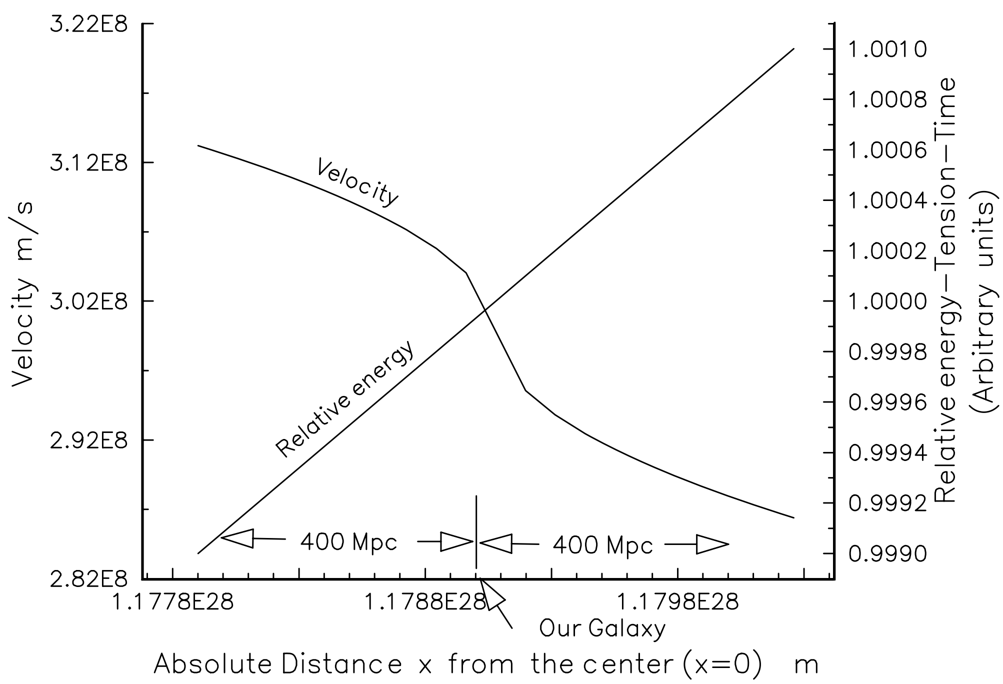

Fig. 24. A small section along the radius of the Universe centered around our Galaxy showing the change in velocity, tension, time and potential energy of matter as a function of cosmic radius.

One point of view is that since space outside the Universe is filled with its gravitational field which decreases to zero at infinity, one could argue that the Universe together with its gravitational field is infinite and boundless. Alternatively, if the energy of the gravitational field is quantized and divided into a finite amount of small energy/mass packets, like sand pebbles on the beach, then one could expect the number of energy packets to eventually run out before reaching infinity, thus favoring a finite Universe.

9.3 Building Blocks of Nature

Length: As mentioned in Chapter 1 the building blocks of nature are mass, charge, length and time or *m, q, l* and *t*. *Length* or distance is probably the one building block that is easiest to understand. *Length* however, has no physical significance unless joined by any of the other three building blocks. For example, *length* per *time* is velocity and *mass* per *length* determines the strength of gravitational tension ($\phi = Gm/r$). *Length* × *width* is surface area and is an important spatial dimension when dealing with pressure, temperature or radiation. Mass per unit surface area (m/l^2) is often used as a measure of pressure although a more sophisticated term for pressure is newton per unit surface area ($m/(t^2 l)$). The surface temperature of a body is determined by the power radiated per unit surface area of the body or $T^4 = L/A\sigma$ where σ is Stefan-Boltzmann's constant. *Length* × *width* × *height* is volume or space and is also quite meaningless unless filled with gravitational *tension*, *mass* or *charge*. We can imagine empty space but it is doubtful it can be detected. It was believed that gravity could warp space or bend world lines. I do believe that light rays will bend inside a volume filled with a non-uniform gravitational tension and that measuring sticks can shrink or expand, but I do not believe that the elements of space itself "*length* × *width* × *height*" can change. The fact that light bends near gravitating bodies is, therefore, not due to warped space or bent world lines but is caused by the same effect that bends light in glass, namely Snell's law. A peace of glass does not warp space or bend world lines, see Chapter 4, section 4.7.

Mass: If the units of *length, width* and *height* do not change what about *mass*? In scientific terms *mass* is often referred to as either *gravitational mass* or *inertial mass*. Many are of the opinion that both are equal, which is a subject of debate. Let us follow the historical progress that led to the concept of *inertial mass* which starts with Galileo Galilei 1564-1642. It is said that Galileo obtained his ideas for his famed experiments while attending a church service during which he also observed and timed the swing of a chandelier hanging from the ceiling. One experiment that followed is here described in Galileo's own words:

> I had one ball of lead and one of cork, the lead ball being more than hundred times heavier than the one of cork, and suspended them from two equally long strings, about four or five bracchia in length. Pulling each ball away and releasing them at the same instant from their vertical point of rest, they fell along the circumferences of their circles having the strings as radii swinging back to near the same vertical height of origin and then returned along the same path. This free pendulum motion, which repeated itself more than hundred times, showed clearly that the heavy body kept time with the light body so well that neither in hundred swings, nor in thousand, will the former pass the latter by even an instant, so perfectly do they keep step.

The experiment clearly showed that the pitch of a pendulum does not change with *mass* or weight even though gravity exerts a much stronger force on a heavier weight. The next test was to see whether a heavier weight would fall faster than a lighter weight. Galileo is said to have dropped different weights from the tower of Pisa, see Fig. 25, and found that they reached ground at the same time. In modern terms, two different weights are accelerated at exactly the same rate even if the Earth's pull is stronger on the heavier *mass*. It is often said that since inertia of *mass* is the same as resistance to acceleration, then although twice the *mass* means twice the pull by the Earth's gravitational field, the resistance to the pull will also double, thus canceling any effect of change in *mass* leaving the acceleration unchanged. This explanation is not quite right because the Earth's gravitational field does not care about the *mass* of an object but bestows the same rate of acceleration on any object immersed in its field. This is simply

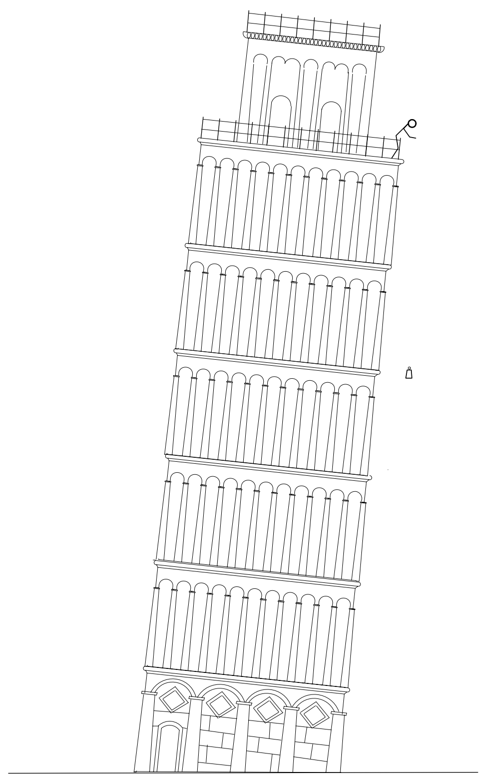

Fig. 25. Galileo's experiment and discovery of acceleration at the tower of Pisa.

explained by the fact that the Earth's acceleration g is solely determined by the gradient of the Earth's own gravitational tension or $g = \phi_{Earth} / R_{Earth}$ and not by the *mass* of the body being attracted to it. However, the view that the inertial force of a body (the force that resists acceleration) exactly balances the gravitational force that attracts it, did stick in the mind of scientists for a long time and has led to some questionable theories. One such theory concerns the "equivalence principle" which goes as far as to state that inertia of *mass* is the same as gravitational *mass,* since gravitational force cannot be distinguished from inertial force. The proof given is Einstein's famous example of an observer inside a windowless elevator. Two conditions are considered, one where the elevator is stationary suspended by a cable in the gravitational field of a gravitating body such as the Earth, and the other where the lift is being pulled by the cable at a steady rate of acceleration far outside any gravitating body. In both cases the observer will feel his feet pressed to the floor and inside his windowless elevator the observer would supposedly not be able to tell whether he is subject to a gravitational force or an inertial force, since they both are considered equivalent. This is not quite right, because for one thing, the lines of force inside the elevator, when subject to a gravitational force are not parallel but always converge to a point which coincides with the center of *mass* of the gravitating body. When pulled at a steady accelerating rate, the lines of force are always parallel. Also, a steady change in clock rate and a change in the velocity of light will take place in the latter case caused by the steady increase in velocity and tension $\Delta\phi \cong \Delta(v^2)$, see Appendix C. Another problem with the "equivalence principle" occurs when it is applied to the bending of light near gravitating bodies. Here the "equivalence principle", which assumes that any substance (including photons) will accelerate towards a gravitational center at an equal rate regardless of *mass* (whether zero or infinite), predicts that a massless beam of light will accelerate and bend in the same manner that the path of a massive projectile will accelerate and bend when passing near a gravitational source. The angle of deflection is determined by Newton's law of gravitation. In reality, massless light beams, contrary to massive objects, do not accelerate, they slow down and decelerate when entering a gravitational field and the bending of light in gravitational fields is better explained by Snell's law (Chapter 4, section 4.7).

Our concept of *mass* is not very clear. How is gravitational *mass* m_g related to inertial *mass* m_i? In our frame of reference at Earth we often define the *mass* of a body by its inertia or resistance to acceleration $m_i = F/a$ *i.e.* if a body accelerates by $a = 1$ meter per second per second when subject to a force F of one newton (nt) its *mass* is 1kg. We can, therefore, determine inertial *mass* from Newton's laws of motion

$$m_i = \frac{2E_k}{v^2}, \quad \text{Newton} \qquad (m) \quad (140)$$

where E_k is the kinetic energy involved in accelerating the body to a given velocity of v relative to us. There is one problem here, namely that at high relative velocities a relativistic increase in inertia of mass becomes notable. This relativistic mass increase, which was discovered by Einstein, makes Newton's law obsolete so Equation (140) needs to be changed to

$$m_i = \frac{E_k + E_0}{c^2}, \quad \text{Einstein} \qquad (m) \quad (141)$$

where $E_0 = m_0 c^2$ is the *mass* equivalent energy of the body at rest relative to our frame of reference. Since E_0 and c^2 are constants and E_k is a variable it means that m_i must increase proportionally with E_k. It is also important to remember that the rate of *time* in a system that has been accelerated changes proportionally with the energy of the system, see for example, Equation (1) and the "twin paradox" Chapter 2 section 2.4.

Gravitational *mass* on the other hand is determined by Newton's law of gravitation

$$m_g = \frac{E_g R}{GM} = \frac{E_g}{\phi}, \quad \text{Newton} \qquad (m) \qquad (142)$$

where R is the distance of m_g from the center of a gravitating *mass* M and E_g is the energy required to move m_g from R to infinity. The gravitational tension generated by M at R is ϕ. Since E_g is directly proportional to ϕ it means that the gravitational *mass* m_g will always remain constant. In contrast to inertial *mass* gravitational *mass* does not change with energy. However, the rate of *time* changes proportionally with gravitational tension. For example, we have seen that the rate of *time* is slower at the Sun's surface than here on Earth due to the Sun's higher gravitational tension. The result is that all physical processes on the Sun are slower, including processes involving acceleration. This slow-down of acceleration can be interpreted as an increase in inertia. This leads to the argument that the relativistic *mass* increase discussed above is really not an increase in *mass* but an increase in the length of *time* thus retarding or slowing down the rate of acceleration which we interpret as increase in inertia of mass. By the same token we can say that gravitational energy increases the length of time which is not reflected in Equation (142).

Conclusion: Whether the tension of *mass* (E/m) is raised by an increase in velocity relative to our frame of reference or by an increase in a surrounding gravitational field *mass* stays constant but inertia will change due to the change in rate of *time*.

Time: From the above it appears that out of the three main building blocks of nature *length, mass* and *time,* only *time* is a variable. A meter is always a meter and a kilogram is always a kilogram and will remain unchanged anywhere in Cosmos but the unit of *time*, the *second*, varies at different locations in the Universe. Most interestingly is that length of time is determined by the combination of *mass* and *length* (M/R) which is proportional to Tension and Energy. Time therefore must be related to Tension and Energy. The question is: Does tension or energy determine the rate of time or does the rate of time determine the amount of energy?