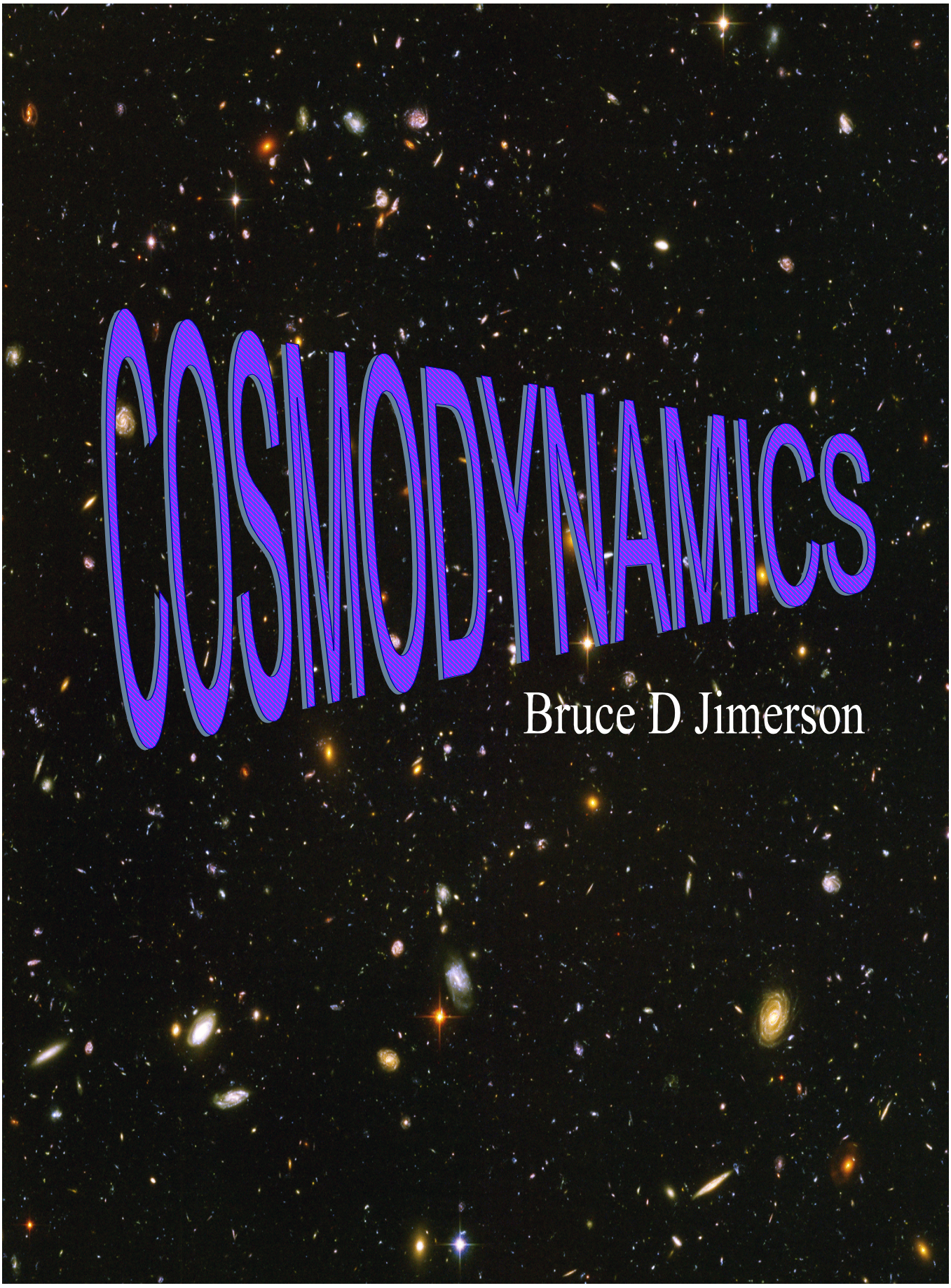
COSMODYNAMICS
Bruce D Jimerson

AUTHOR'S PRECIS

The science student of today learns that forces are transmitted through empty space by virtual entities proclaimed by the architects of the standard model to transfer momentum quantum(s) between point particles at the speed of light. As an young eager-beaver undergrad, the failure of such theories to predict the origin and strength of nature's fundamental processes was a disturbing letdown. The consummate engineering textbook of my day was at least honest in offering an agnostic disposition of gravity.[1] Like others, I wondered if some simple mechanism lie waiting to be found.[2] As a young child, my Father demonstrated his power to create artificial gravity by swinging a bucket of water. I looked on with wonderment. Was the earth's rotation responsible for what held us down. As later learned, inertial forces depend from motion, but not gravity–or did it?

How separated objects act and react upon one another has always been a mystery. Newtonian physics provided formulas, but the mechanism was missing. Exposure to Einstein's theories came unexpectedly by way of a post-grad seminar, a refreshing diversion from classroom grate.[3] Relativity revealed a new world founded upon a single constant, yet it raised questions. Serious deliberation of these topics, however, would await the end of formal study, and the fulfillment of two careers. The first straddled the space race of the 1960s. It was a time of stimulating opportunities for the fortunate few positioned to contribute. At TRW's Space Technology Laboratories, the task of designing the descent electronics for the Lunar Excursion Module (LEM) had fallen upon me. The small part played in the success of the landings is now a later life pride.

The challenges imposed by the dictates of the Apollo program spawned a wealth of new technology, and my first exposure to Patent Law. From a distance, the profession appeared to offer security at the cutting edge of science. That notion would be dispelled after entering the field four years hence. As later discovered, intellectual property is often not intellectual, the work is seldom glamorous, and the details tedious. As Corporate Patent Counsel, identifying with Einstein's discontent in his first job as a Clerk in the Swiss Patent Office, posed no difficulty.

Skip ahead to an early retirement, and a cold winter's night in the mountains of Utah. The family vacation home had become a congenial abode for airing ideas among friends. The fire had died low, the hour was late, the colloquy had drifted to the enigma of "Gravity." Conjectures provoked comments, and more conjectures, including my own naive characterization of gravitation as inertial reaction. At first glance, the idea of the void as a dynamic source seemed absurd...but cosmological expansion was a fact, the plausibility of space-mass reactance gained favor in afterthought.[4] In the days following, long unused math and physics texts were dusted off, applying classical dynamics to empty space became a consuming priority

Newton had no reason to suspect a spatial kinetic, but Einstein had amended his theory by introducing a balancing force $\mathbf{\Lambda}$ to prevent gravitational collapse. As invoked, the cosmological constant $\mathbf{\Lambda}$ was an equilibrium stabilizing function, it did not predict the **G** field or explain its cause.

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[1]Sears, Francis: *Mechanics Heat and Sound*. Addison-Wesley Press, Cambridge Mass. 1950. at page 285: **"***We know by experiment that a gravitational force of attraction ....is exerted on a body B by a body A, even though both bodies are in a vacuum and not connected in any way. How is this possible? No one knows. That is the way the world is made.***"**

[2]"God hath chosen the most foolish things of the world to confound the wise." (1st Corinthians I, vs. 27).

[3]"It is little short of a miracle that modern methods of instruction have not already completely strangled the holy curiosity of inquiry." (Albert Einstein, circa 1953)

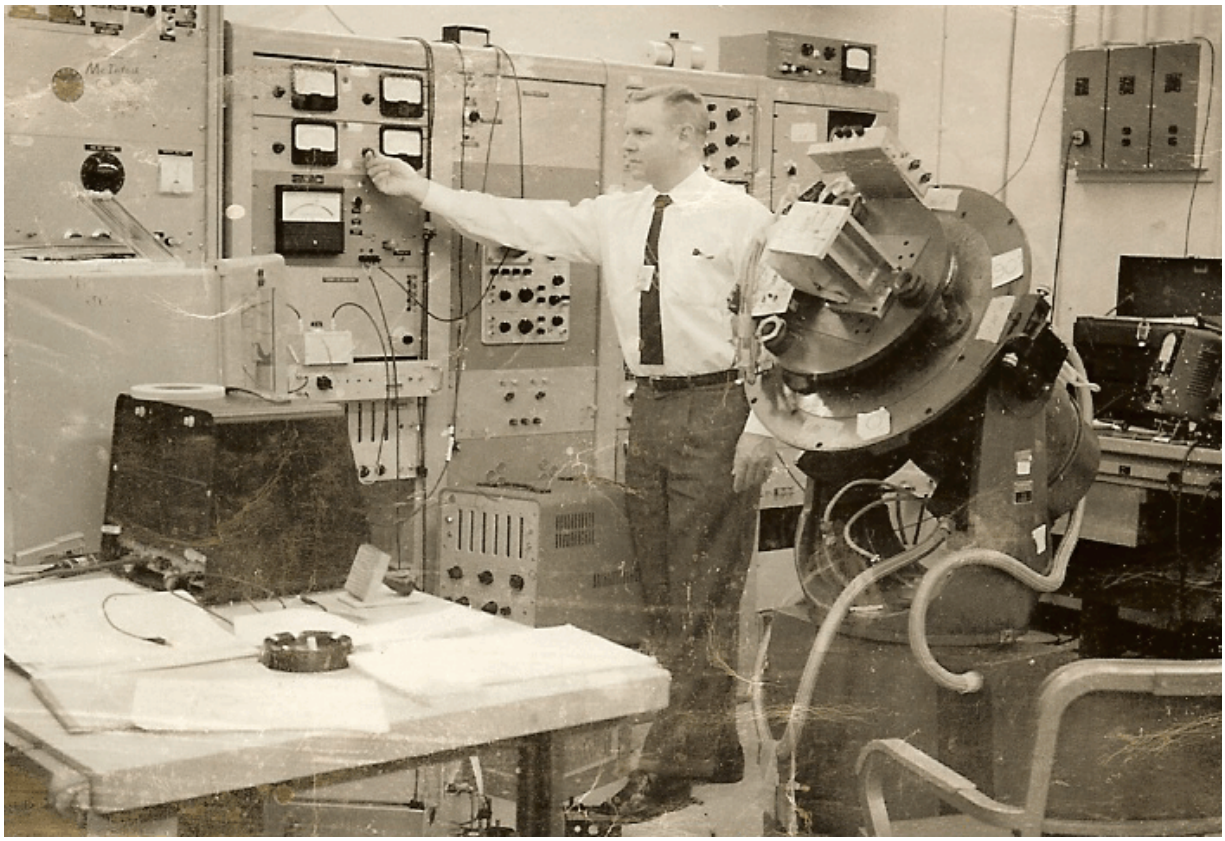
[4]Einstein turned the problem into a postulate by equating the curvature of space and time to inertial matter. If inert matter distorts static space as postulated by Einstein, the gravitational effect is not a force per se, but rather the observed path of objects following geodesics in curved spacetime.

The discovery of cosmic background radiation (CBR) in 1966 re-invigorated the idea of a genesis while sealing the fate of theories based upon past eternal existence (at least with respect to the creation of matter). The Einstein-de Sitter universe became the defacto standard, cosmologists adopted the proposition galactic recessional velocities instantiated from an explosive "big bang" followed by some 14 billion years of gravitational deceleration. That all changed in1998 with the Lawrence Berkeley **1a** supernova studies. The model of the universe was turned upside down. For the author, it was welcome news for a personal conviction that gravity could be best explained as accelerating expansion. Within these pages, the reader will find the rest of the story.

In giving audience to a young physicist seeking advice, Einstein counseled it would be better to earn a living in some unrelated labor that did not involve constant academic scrutiny, or as he put it: "Get a cobbler's job that you may have the liberty to ponder your ideas and make mistakes in private." So it is with Cosmodynamics, for in its revisions there has been no didactic compromise, no preceptors to appease, no schedules to meet, not even a reason that it be made public, save for the chance it may stimulate some rethinking of cherished beliefs. The author has made many mistakes in private, and now offers these pages to the reproval of its critics.

It may seem strange that a "legal cobbler" would profess to craft a shoe to fit the universe. Stranger still would be the acceptance of some part of this accord as a credible thesis. Improbable yes, but not impossible—at least as a matter of Law:

California Civil Code §1597: *Everything is deemed possible except that which is deemed impossible in the nature of things.*



The Author, TRW Inertial Guidance Lab, Circa 1965

COSMODYNAMICS

The Origin of the Forces and The Accent of Mass

Bruce D. Jimerson

The Cover: For eleven days in 1995 the Hubble Space Telescope (HST) was fixed upon a dark area of the celestial sky. From the beginning, the project was a risk for the scientists who had proposed the experiment. Demand for the HST was high, staring at empty space criticized as a waste of time. The processed photos revealed a picture of the universe from a time near the beginning of time, each faint dot an early galactic system with billions of individual stars. The Hubble Deep Field and Ultra Deep Field (2003) are now regarded as the apices of astronomical montagery.

FORWARD

The riddle of Universe is integrally tied to the taxonomy of space and time. The peculiarities of these abstractions determine both the mannerisms of matter, and the influence of physically separated objects upon one another. Although reader familiarity with mathematical methods is presumed, much of this work can be appreciated by those qualified only with a desire to pursue such ultimate questions.* The overture taken here depends neither from ad hoc suppositions nor hypothetical particles—natures forces derive from a single operative, an intrinsic, but hitherto overlooked apotheosis of space.

Dedications

To My Mother Carol and My Uncle Roy

The author wishes to express his thanks to the following persons whose interest, help and faith in this endeavor have been most appreciated.

Robert and Gloria Potter
Robert F. Bennion
Bonna J. Stevens
Jennifer La Bar
James J. Brennan
Richard K. Rozelle

And My Wife Astrid Lindholm

Revision 16

*** For a brief review of the mathematical methods, notation, and terminology, the reader is referred to Appendix X**

Introductory Note

"In questions of science the authority of a thousand is not worth the humble reasoning of a single individual"

Galileo Galilei

The universe is constructed along simple lines, comprehensible to some extent by human minds. Nature's recurring patterns are forged from principles applicable at all times and in all places. From this spatiotemporal consistency, theories have emerged to explain behavior and reality. Those that survive experimental scrutiny become the laws of physics. Those that do not are usually cast aside. But surprisingly, unproven ideas sometimes ripen into creeds, to be later taught as fundamental truth. Once embraced by the stewards of a specialized discipline, they are not easily undone by logical assault upon their validity. Still, as history shows, scientific reforms do occur, often being brought about by an interloper—some "*upstart crow*" from another "field" with the temerity to interrogate treasured doctrines. Near the end of his life, Albert Einstein said of his own great legacy and all that had gone before:

"The present position of science can have no lasting significance."

This work challenges contemporary thought. It is not a *Theory Of Everything* (TOE), but rather, it is a *Theory Of Nothing* (TON)—and how it ordains gravitational, electrical and nuclear forces. In this undertaking, the evolution of inertial matter depends solely upon spaciotemporal dynamics. This reformative leads to a holistic epistemology wherein all things are immanent within one another; the way things are on the global scale decrees the behavior of the quantum world, and vice versa.

Much of our story is composed in the linguistics of algebraic symbols. These conventions provide the transcendental gateway to the expression of ideas in a form that retains its elegance in all languages and every culture. Any attempt to describe the world in a less perfect dialogue would only detract from the suasion of its governing law(s); symbolic algebra is necessary to support and evidence what cannot be certified otherwise. Herein though, rigorous formalism is conspicuously absent, and likely all this will be judged as simplistic and even dystopian by the career cosmologist. It is not expected that such authorities will, in any event, be disposed to render audience or approval to an exposition prejudiced upon conventional proclivity. For those who dare to taste of this new wine from old bottles, here is a celebration of the void and how it brings about the material world.

A Brief History of the Classical Forces

For more than 200 years, electrical and gravitational effects were distilled by classical methods. The descriptor(s), however, failed to explain how forces were communicated through empty space. Something essential was missing—but what?

In the early part of the twentieth century, the morphology of the scientific manuscript was challenged by unexpected discoveries; *Relativity*, *Quantified Energy*, *Cosmic Expansion* and *Uncertainty* would ultimately depose the preconception of a well ordered static continuum founded upon determinism. These new revelations led to theories as to how gravitational and electrical forces might arise, but each said something different from the others. While there is at present no known canonical syntax for unifying such diverse recipes, they can be made relational within the applicative(s) of spatiotemporal mechanics. Here now is a partial cast of characters and the parts played in giving to the world the tools upon which we now rely.

Gravity / Inertia

Aristarchus of Samos appears to be the first of the Ancient Greeks to expound the schema of a sun centered universe. As with other credo's denigrative of terrestrial importance, it would be later condemned as heretical by Christian authorities who embraced Ptolemies' "geocentric system" as providential. But in 1543, the Polish Astronomer, Nicolaus Copernicus, proposed a new heliocentric theory that elegantly de-mystified retrograde motion. The conflicting ideologies sparked a controversy that remained unresolved until the invention of the telescope. In 1610 Galileo Galilei turns this new instrument toward the night sky and sees the moons of Jupiter; his courageous pronouncement that: "everything does not revolve about the earth" earns him a trip to the Inquisition. Galileo's most important emendation to physics, however, received less reproach. By showing that gravity accelerates all weights equally, he disproved Aristotle's "tenants of motion" and laid the cornerstone for the development of classical mechanics.

Born posthumously on Christmas day in the year that Galileo died, the only child of an illiterate yeoman in Woolsthorpe England, Isaac Newton would survive premature birth and physical frailty to become the mental giant who discovered the relationship between accelerating motion and inertial reaction. He also identified the local impetus which caused "apples to fall" with the force that coerced planets to follow elliptical paths around the Sun. Newton's "Law of Inertia" and his "Law of Gravity" were regarded as separate and distinct forces for 25 decades. But that would change in the early years of the 20th century with the publication of several remarkable papers authored by an obscure clerk working in the Swiss Patent Office.

Albert Einstein, once thought by his parents to be retarded, ignited a scientific reformation based upon the counterintuitive proposition that light speed is the same for all observers. The novel theory called "Special Relativity" provided a new exposition of space and time. The aether was rendered superfluous, temporal intervals subjective, and "simultaneity" frame dependent. The perception of motion and physical reality awaited even further dismantling from what was soon to follow.

In 1907 Einstein applied his theory to develop the now famed $\boldsymbol{E = mc^2}$ *relationship of energy and mass while his former instructor, Herman Minkowski, was at work dissecting the same equations to discover a startling connection between space and time. Both works would have significant impact upon the direction of physics, but neither resolved the puzzle of why all weights fell at the same rate. That nexus would be answered years later in a single inspirational moment when Einstein realized "inertial" and "gravitational" mass to be one-in-the-same. The Equivalence Principle at once demolished the idea of a separate gravitational force per se; only one kind of mass existed, and it acted to curve Minkowski Spacetime. With the publication of General Relativity in 1916, the paths of falling apples and orbiting planets were reduced to a single equation. After two centuries, Newton's "Law of Gravity" was exposed as an artifact of his "Law of Inertia."*

In 1917, Dutch Astronomer, Willem de Sitter, discovered that General Relativity admitted an expanding solution. Having neither matter nor pressure, de Sitter's exponentially dilating void would likely have been ignored as a curiosity except it appeared to shed light upon the mysterious red shifts observed in the light spectrum of distant galaxies. In 1923, the Russian mathematician, Alexander Friedmann, derived a density dependent expansion equation also consistent with the General Theory. Although Friedmann's work went largely unnoticed at the time, the same kinetic relationship would be later re-discovered by Belgian Priest, George Lemaitre (resulting in the Pope's pronouncement that Science had proved Genesis). While the ontology fell far short of validating biblical doctrine, de Sitter, Friedmann and Lemaitre, did establish expansion as a plausibility—a reality later confirmed by an American who would forsake his legal career to study the stars.

Edwin Hubble, the lawyer turned astronomer, is appropriately hailed as "the man who measured the Universe." Using the 100-inch Hooker Reflector on Mount Wilson, Hubble and his assistant, Milton Humason, collected the galactic red shift and luminosity data that led to the velocity-distance relationship $\boldsymbol{v = rH}$ *(commonly but improperly called "Hubble's Law"). In genesis cosmologies, the Hubble parameter* $\boldsymbol{H}$ *determines the scale of space and the span of time.*

Electrical and Magnetic

By the early part of the Nineteenth Century, many of the principles of electromagnetism had been established. Charles Augustin de Coulomb determined the inverse square law between charges in 1784 using a torsion balance of the type employed 13 years later by Henry Cavendish to measure the gravitational constant; in 1820 the Danish physicist Hans Oersted discovered that moving charges produce magnetic fields; in 1825 Andre Ampere published a theory relating the magnetic field around a closed path to the sum of the currents crossing the area bounded by the path, and 7 years later Michael Faraday developed a qualitative form for his law of induction by demonstrating the proportionality between electromotive force and the rate at which magnetic field lines are cut.

This was the state of the art in 1856 when Scottish theorist James Clerk Maxwell published the first of his insightful papers dealing with electromagnetism. Maxwell envisioned the magnetic field as a space filled with vortex tubes—and he considered space itself as having the characteristics of an elastic medium which could be distorted by electric fields, and thereby bring about the mechanical connections between known magnetic phenomena. In a later paper in 1864 he developed the whole theory on a totally abstract bases devoid of any assumptions as to the properties of the medium other than its permeability and permittivity.

In 1896 German physicist, Max Planck, found an "algebraic fit" for the spectral curve of a Black Body radiator by making the bold assertion that radiating sources emit energy in discrete increments having a definite angular momentum ***h*** *(action) content. The hypothesis led to the quantum theories of modern physics, the symbol* ***h*** *being known thereafter as Planck's Constant.*

Working on his doctorate in 1909, a young French aristocrat, Prince Louis-Victor de Broglie, discovered a mathematical relationship between Planck's Constant and a yet to be observed wavelike property of moving masses. His examiners were of a mind to reject the paper, and wanting an outside opinion, sent a copy to Einstein who replied:"He has lifted the corner of a great veil." The dissertation was accepted—fifteen years later it earned de Broglie a Nobel Prize—the first ever awarded for an academic thesis.

Comes then German physicist, Warner Heisenberg, with a revelation that certain interdependent pair quantities cannot both be determined with a precision greater than Planck's constant. This manifesto, known as the Uncertainty Principle, has been given various philosophical interpretations. First published in 1927, the restriction is not subject to the accuracy of the observing instrument—rather, it is a mathematical embargo that imposes both a limitation and a consequence upon the information obtainable in a sampling process.

The first anti-particle was predicted when Lucasian mathematical Professorate, Paul Dirac, applied Special Relativity to Quantum Wave Theory. The subsequent discovery of positively charged particles with electron mass authenticated Dirac's opus, and established the ratio between the electrical and gravitational force of attraction as approximately $\mathbf{10^{42}}$. Reasoning that the near equality between the "electro/gravitational" force ratio and "cosmic/subatomic" size ratio, must be more than a coincidence, Dirac suggested that these ratios will maintain the same proportions at all times. Published in 1937 as the **L**arge **N**umber **H**ypothesis (**LNH**), it led to the important implication that at least one of the fundamental constants (most likely **G**) must change as the universe expands.

From these endowments, we begin our quest. The Path to the origin and interdependence of gravity and inertia will twists its way to the quantum world and the exposition of electrical and nuclear forces as spatial angular momentum(s)

CONTENTS

EINSTEIN'S PERPLEXITY

"***What really interests me is whether God had any choice in the creation of the world"***

Albert Einstein

The improbability that the physical constants should exhibit the precise values which permit the universe to exist in a manner conducive to the development of life is a never ending source of philosophical speculation. The so-called *fine tuning* that appears necessary for long term global stability finds expression in what has come to be termed the "anthropic principle." This evocative doctrine rests upon the premise that, if things were slightly different, neither humans nor any other form of life would exist to take note of the world, and therefore we, as well as all else, are either "a-lucky-roll-of-the-dice" or everything is specially rigged to make life possible.[1] As the late astrophysicist, Sir Fred Hoyle, once quipped:

"***The universe looks like a put up job.***"

Yet between "pure chance" and "fine tuning" resides a plethora of fanciful diversions. One imaginative school of thought foretells of many universes–the concept being that only a few of an incalculable number of possible cosmic systems contain the right ingredients to grow living organisms, and that ours happens to be one (perhaps the only one) where the stuff of life abides. At the other extreme, the multiplicity of possibilities gives way to the "*principle of necessity*" wherein all universes (whether there be one or many) are proclaimed to be governed by the same physical laws. This ideology rests upon the premise that unity and consistency within a functional cosmos demand that things be the way they are; apparent alternatives are illusory.

What then determines the nature of the laws that govern our World? Such ultimate questions apparently cannot be resolved by physics—for it is the very essence of science that these limitations exist. Should we then forever despair of finding meaningful understanding of the cosmos? Perhaps this seemingly empty rhetoric will gain content if we turn it around and ask: *At what times and places can life exist, and what interrelationships are determinative?*

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[1] Stephen Hawking once lamented: "We have both a '*Newtonian Formulation'* and '*General Relativity'* to describe gravity, yet neither can predict its strength.... nor do we at present have a theory to explain the magnitude of the electron charge." Said Hawking:

"These are arbitrary elements, discoverable only by observation...they seem minutely adjusted to make possible the development of life as we know it."

In what follows, the classical forces are shown to depend upon certain primal properties that arise as an adjunct of cosmological expansion. The governing physical constants are interdependent, each entwined with the others through a common global dynamic. That which brings about change is also the correspondent of the change.[2]

The idea that everything may come down to something so incredibly simple seems absurd, yet this view is neither new nor far-fetched. Shortly after Hubble's results were made public, the brilliant English physicist, Sir Arthur Eddington, wrote:

> ***"The conception of the expanding universe seems to crown the edifice of physical science like a lofty pinnacle...A few years ago I became strongly convinced that in these astronomical discoveries in the remoteness of space, we had picked up the key to the mysteries of the proton and electron. All that I have since been able to work out confirms my conviction."***

Some years later, America's preeminent theorist, The Late, John Archibald Wheeler, proffered these words:[3]

> ***"Behind it all,***
> ***Is surely an idea so simple,***
> ***So beautiful,***
> ***So Compelling,***
> ***That when we grasp it,***
> ***We will all say to each other,***
> ***How could it have been otherwise?***
> ***How could we have been so stupid for so long?"***

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[2] In 1961, Princeton cosmologist, Robert Dicke, proposed a limiting form of the Anthropic Principle based upon the idea that the age of a life spawning universe cannot be random–biological factors constrain the cosmic system to be more or less in a goldilocks era, neither too hot nor too cold. Living entities could not have existed before sufficient levels of heavy elements (most notably carbon) had synthesized during several generations of stars. If the universe were 10 times older, most of the stars will have turned into white dwarfs and their stable planetary systems long since ended. Dicke also reasoned that the density of the universe must be almost exactly equal to the critical value to avoid an immediate big crunch or long term runaway inflation. Aside from the many versions of the Anthropic Principle (Weak, Strong, Modified, Self Sampling etc), the idea of free parameters becomes moot if the fundamental constants are interdependent.

[3] *"The years of searching in the dark for a truth that one feels, but cannot express, the intense desire and the alternations of confidence and misgivings, until one breaks through to clarity and understanding, are only known to him who has himself experienced them"* - Albert Einstein

THE QUEST FOR UNIFICATION

The precepts of physics are replete with symptoms that betray an underlying communion between electromagnetism and gravity. Initial attempts to relate this hidden aspect of nature go back to the early Greeks. Despite centuries of thought, neither has been derived, one from the other, nor has a common root been found from which they might be synthesized; the 'tie that binds' has evaded discovery.

The challenge is a seductive one—luring many great minds to its intrigue. More than a half century before Einstein took-up his theoretical quest, Michael Faraday sought enlightenment in the laboratory. In l849 he scribbled these words in his notebook:

> ***"Gravity: Surely this force must be capable of an experimental relation to electricity, magnetism, and other forces, so as to bind it up with them in reciprocal action and equivalent effect.***"

After many unsuccessful experiments he concluded:

> ***"Here end my trials for the present. The results are negative. They do not shake my strong feeling of the existence of a relationship between gravity and electricity, though they give me no proof that such a relationship exists." (Encyclopedia Britannica, l97l, pp. 670, 673).***

The absence of an underlying causal theory to explain either phenomena was consternation for both Faraday and Einstein.[4] But from their efforts, together with Minkowski unification and Hubble expansion, a yet to be appreciated dynamic is revealed. The construal of gravitational and electrical fields as spatiotemporal action and reaction is contrary to the complexities modern theoretical physics has bestowed upon it's disciples. As mused by Victorian Essayist, Thomas Carlyle:[5]

"Men understand not what is among their hands"

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[4]Having succeeded in identifying gravity as a manifestation of space-time curvature, Einstein endeavored to relate electrical phenomena to a similar geometric effect. In this effort, to which he devoted most of his later years, he is considered to have failed. (Editorial comment - McGraw-Hill Scientific Encyclopedia, 1992).

[5]On the subject of life on other worlds throughout the cosmos, Carlyle had this to say: "A sad spectacle. If they are inhabited, what a scope for misery and folly. If they are not, what a waste of space."

CHAPTER I

SPATIAL MECHANICS

"Why are the equations that describe such different physical phenomena so similar? We might say: It is the underlying unity of nature. But what does that mean? What one thing is there that is common?" Nobel Laureate Richard Feynman answered his own rhetorical: "....it is the *space*, the framework into which the physics is put."

Global Acceleration

"All is space. The forms of energy are the distortions of space and nothing more." J.D. Ross

Spacetime is the operative framework of the physical world. Coupling between spacetime, matter and motion portray as classical forces—gravity, inertia, electrostatic and magnetic. Each field is a different expression of the expansion dynamic consentient with the forms thereof. Action-at-distance is a predictable manifestation of venerable physics principles.

Our quest begins with gravity. Ironically, the connection between Einsteinian gravity and Newtonian inertia is fully contained in Newton's 2nd Law, as valid today as ever since rate of change of momentum involves the temporal variance of mass as well as well as velocity. As the reader may anticipate, gravity cannot be separated from inertia or acceleration, nor can it be isolated from the universe and the expansion thereof. How then can mutual attraction between masses be understood in terms of mass and acceleration acting autonomously? To put the question is to answer it. Gravity is the natural result of cosmological expansion. Space under static stress is meaningless, dynamic spatial stress is tantamount to acceleration.

The Cosmic Acceleration Parameter

According to the "*cosmological principle*," the universe has neither a center nor an edge; it appears functionally the same in all directions from any point of surveillance.[6] Every observer will have a subjective view of the Hubble complex as isotropic expansion centered upon their own location. This leads to shifted but equivalent perspectives of the cosmos as accelerating volume. The problem posed is that of relating gravitational force to global expansion. Because the *cosmological principle* offers a constitutional guarantee "that all free space locations are created equal," our task is greatly reduced.[7] If the expansion rate of the void is determined anywhere, it is known everywhere.

To set the stage for what follows, the hypothesized distortion of static space by inert matter is replaced by the concept of accelerating space. This teaches away from the Einsteinian view of gravity as static spacetime curvature, offering in its

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[6]This proposition has profound implications. It is the basis of modern cosmology—yet the idea is ancient. "God is a circle whose center is everywhere and whose circumference is nowhere" (Empedocles, Fifth Century B.C.). "Whatever spot anyone may occupy, the universe stretches away from him just the same in all directions without limit" (Lucretius, First Century B.C.).

[7] We take as the communicable universe "*the now operative volume* encompassed *by a sphere of uniform synchronous expansion concentric with an observer.* Examiners at different places will interpret the cosmos as that contained within the Hubble horizon centered on their own situs, and each will derive identical properties in accord therewith. But a single **3-D** sphere cannot satisfy the cosmological principle as a complete universe. For a spatially closed finite volume, the common analogy is an inflating balloon with an extra dimension, i.e, a unbounded expanding 3 space neither embedded in a surrounding fourth spatial dimension nor enveloping an interior space–all existence is concentrated in the dimensions of a circum-navigable **3-D** surface

stead a dynamic derived from global expansion. Substitution of acceleration for static curvature recovers **G** without further postulation.

In the cosmic landscape, the Hubble scale defines a sphere of radius $\mathbf{R_H}$ consistent with linear velocity distance law $\mathbf{v = rH}$.[8] Each complex delimited thereby is determined by the maximum distance from which information can be received if communicated at the speed of light ($\mathbf{v = c}$); the maximum radius of a sphere causally connected to our place in space. All Hubble spheres are taken as equivalent, but each is unique in the sense that every attestant will avouch his position to be central.

Any point adopted as a Hubble center will have its own range of influence. This distance of communicability is not, in general, synonymous with the observable universe, (which is frequently used to mean the 'now" distance of luminous objects from which photons presently reaching earth were emitted). Nor is it always used to express concurrence with the recessional velocity of the photon horizon (the growing scale of the Hubble sphere). Herein "communicable distance" is taken as the particle horizon measured in the observer's space at the time "now" and in that sense the observable universe corresponds to the communicable distance defined by the idealized reception of photons having infinite redshift. The particle horizon thus recedes, but for our purposes, a snapshot in cosmological time is all that is required to identify a communicable length $\mathbf{R_H = (c)T_o}$ where '$\mathbf{T_o}$' is the Hubble time (that required to shrink a Hubble sphere to a point at speed of light '**c**'). The '*now*' value of the Hubble constant is denoted $\mathbf{H_o = 1/T_o}$ (the reciprocal of Hubble time)**.**[9] In what follows, the limit of communicability $\mathbf{R_H}$ and its rate of change $\mathbf{dR_H/dt}$ are used to derive the dynamic characteristics of space and its affect upon an inertial mass in an otherwise empty universe. From these findings, we derive an expression for the gravitational constant **G.** As later developed, matter and its distribution are seen also as factors that matter (excuse the play on words) in the context of cosmic evolution.

Using Newton's notation, the volumetric growth of space $\dot{\mathbf{V}}$ within the Hubble sphere and its derivative $\ddot{\mathbf{V}}$ (volumetric acceleration) is related to the spatial flux $\mathbf{dR/dt}$ and its rate of change $\mathbf{d^2R/dt^2}$. To find the internal production rate of space, we construct an imaginary Gaussian surface **S** of radius $\mathbf{R_S}$ to encompass the Hubble volume as shown in **Figure 1**. Accordingly the following relations (1.1) hold:[10]

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[8] In 1929, Edwin Hubble made the astounding claim that extragalactic redshifts increase with distance, yet he expressed reservation about the cause. A year earlier, Howard Robertson had used the same data to derive a redshift distance relationship of the form $\mathbf{zc = HL}$ where **z** is the fractional increase in wavelength $\mathbf{(\lambda_o - \lambda)/\lambda}$ and **L** is the distance. From this, Robertson made the assumption that **cz** could be roughly approximated as a velocity, and therefore, $\mathbf{v = HL}$**.** As it turned out, this analogy lead to a change in thinking**--**the observed redshifts could be attributed to spatial expansion rather than recessional Doppler velocity. Robertson not only derived the velocity distance law prior to Hubble's announcement, he correctly interpreted the redshifts as cosmological expansion.

[9] Although not directly measured, the speed of gravitational affects are prophesied as equal to that of light. If collapse of a gravitational field is possible, it would be noticed simultaneously with the arrival of light heralding the event. But the residue of destroyed matter has the same gravitational mass as the object destroyed, and its inertial center is unchanged. The same is true for accelerated matter—conservation of momentum requires the gravitational center of action-reaction be unchanged.

[10] In Newtonian notation, the single and double superior point denote the first and second time derivatives respectively [Appendix A-I].

$$\mathbf{V} = (4/3)\pi \mathbf{R}_{\mathbf{H}}^{\,3} \quad ----------(1a)$$

$$\dot{\mathbf{V}} = 4\pi(\mathbf{R}_{\mathbf{H}})^{2}(\dot{\mathbf{R}}_{\mathbf{H}}) \quad ----------(1b)$$

$$\ddot{\mathbf{V}} = 8\pi \mathbf{R}_{\mathbf{H}}(\dot{\mathbf{R}}_{\mathbf{H}})^{2} + 4\pi \mathbf{R}_{\mathbf{H}}^{\,2}(\ddot{\mathbf{R}}_{\mathbf{H}}) \quad -----(1c)$$

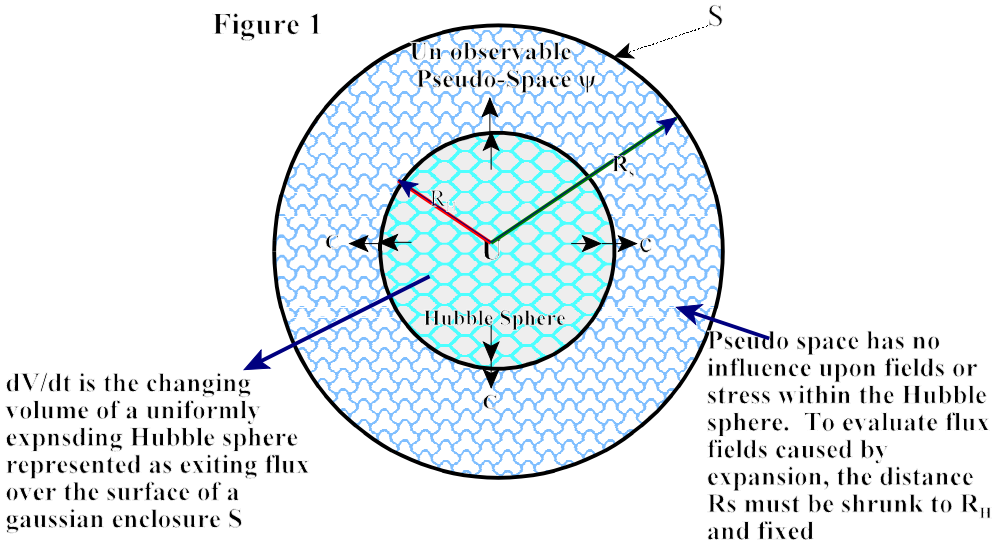

Figure l. <u>Spatial Expansion Modeled as Changing Volume</u>

A Hubble sphere of radius R_H will contain a volume $V_H = (4/3)\pi(R_H)^3$. For uniform radial dilation at velocity 'c' the volumetric acceleration of the Hubble sphere is $[8\pi(R_H)(c^2)]$. If R_S represents the radius of a spherical Gaussian enclosure having a fixed surface area $4\pi(R_S)^2$, the rate of change of spatial volume dV/dt will equal $4\pi R_H^2 c$ as indicated by the arrow dV/dt denoting spatial volume per second exiting across the fixed Gaussian surface. In a slowing universe, the Hubble dilates at greater velocity than the recessional flow of internally expanding space; in an accelerating universe, the opposite is true. To evaluate the present state of the universe, it is necessary to know whether the second term of (1c) is zero, positive or negative. When the radius of the Gaussian surface S is shrunk to $R_S = R_H$ (or conversely when the Hubble has expanded to R_S) the Gaussian surface takes a snapshot of the exiting flow as measured by the metering orifice area $4\pi R_s^2$. The conceptual significance of spatial flux exiting across the Gaussian surface is that it reveals the dynamic state of the universe within the Hubble sphere. All space beyond R_H can be ignored since only changes within the Hubble sphere contribute to acceleration.

If the Hubble sphere expands at constant radial velocity '**c**' the production of spatial volume is given by the first term of (1.2):

$$\ddot{\mathbf{V}} = \mathbf{8}\pi(\mathbf{R}_H)(\dot{\mathbf{R}}_\mathbf{H})^2 + \mathbf{4}\pi(\mathbf{R}_H)^2(\ddot{\mathbf{R}}_H) \qquad (1.2)$$

In the '**mks**' or **si** {systême international} units, volumetric acceleration is expressed as cubic meters per second squared {$\mathbf{m^3/sec^2}$}. The dimensional units of **G** are defined in terms of volumetric acceleration per unit mass [$\mathbf{m^3/sec^2}$]**/kgm** where '**kgm**' is used throughout this treatise to mean "*kilogram of mass*" as distinguished from '**kg**' which represents "*kilogram force*."

Dilation at the speed of light **'c'** thus corresponds to a Hubble volume accelerating at ($\mathbf{8\pi Rc^2}$). While the Hubble limit is not a physical thing, and has no mechanistic influence upon the strength of the gravitational field per se, the manifold will prove a useful analytical concept for mensuration. A Gaussian surround '**S**' contiguous with the surface defined by **R** is an adaptation of a volume to surface transformation first elaborated by the 18th century mathematician, Carl Gauss.[11]

Different expansion models lead to different formalisms. In the **stretching space** scenario, the universe is analogized to an elastic rubber sheet. Uniform stretch rate ($\mathbf{c\Delta t = \Delta R}$) is dubbed **Minkowskian Expansion**. The Hubble sphere expands at constant radial rate "**c**" and so does its internal space. Galaxies diverge at a speed proportional to their separation distance, but recessional velocities never change (interstitial space increases but velocity is constant). Because each of the three spatial dimensions augment as $\mathbf{c(\Delta t)}$ the Hubble volume accelerates in proportion to the cube of the radius $\mathbf{[c(\Delta t)]^3}$. In **de Sitter's Universe**, expansion is viewed in one sense, as self creating space; the growth of new space depends upon the existing dimensions, so the velocity of co-moving galaxies increase exponentially and the scale of the Hubble sphere corresponds to the distance where the Hubble recessional velocity is '**c**.' In the **Standard Model**, expansion is based upon the Friedmann equation(s) which postulates a big bang beginning modified to account for different forms of energy densities thought to exist at different eras. The model conforms closely to the observational data for the present, but it depends from a high initial velocity prerequisite (to overcome the high density of the beginning volume where the entire mass of the universe is theorized to have been brought into existence in a 'big bang' genesis or some form of inflation). Velocity is deemed to decelerate to a minimum in about 7 billion years and for no presently verifiable reason, begins to increase. **Einstein-De Sitter** expansion was the defacto favorite during most of the 20th century. This variant of the standard model appealed to many theorists because of its mathematical elegance. If the universe had critical density, gravitation would exponentially decelerate the rate of expansion to zero at infinite distance .

While expansion formalisms can be adapted (with some finagling) to fit much of the observational data., there is no one theory befitting all eras. Conveniently, for our purpose of calculating **t**he **'***now***'** value of **G** based upon the present rate of expansion, only a good estimate of the Hubble constant $\mathbf{H_o}$ is required.

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[11] **Johann Carl Friedrich Gauss** (1777 — 1855) sometimes referred to as the *Princeps mathematicorum* (The Prince of Mathematicians)..

To apply a Guassian surface to measure expansion, the universe is assumed homogeneous on the large scale, in form a composition of identical small volumes each growing equally in the three coordinate directions **X**, **Y** and **Z** that make up **3-D** space. Mathematically, this is identified as the vector divergence field of expanding space, more specifically the fractional change in volume per unit time as volume shrinks to zero. All locations are assumed devoid of mass and gravitational fields, only space is considered, and in this expose, it is the accelerating rate of volume that powers the universe. The divergence theorem relates the integral over the volume of the surface containing these infinitesimal divergences to the sum of the flux exiting across the surface that contains the volume. To apply the Theorem, it is only necessary to integrate over the volume and divide by the surface area, which in the case of the Hubble sphere, is simply $\mathbf{4\pi(R_H)^2}$. For uniform radial dilation, the volume will be accelerating ($\mathbf{m^3/sec^2}$). When the Hubble expands at radial velocity **c**, the exit flux across the area $\mathbf{4\pi(R_S)^2}$ reveals a fundamental characteristic of the universe.[12] Per (1.1):

$$\mathbf{A_v} = \frac{[\mathbf{8\pi(R_H)(\dot{R}_H)^2 + 4\pi(R_H)^2(\ddot{R})}]}{\mathbf{4\pi(R_S)^2}} \tag{1.3}$$

For a snapshot when $\mathbf{R_H = R_S = R}$, (1.3) reduces to:

$$\mathbf{A_v} = \frac{\mathbf{2\dot{R}^2}}{\mathbf{R}} + \mathbf{\ddot{R}} \tag{1.4}$$

In terms of the paradigmatic deceleration parameter. $\mathbf{q} = (-)\frac{\ddot{\mathbf{R}}\mathbf{R}}{\dot{\mathbf{R}}^2}$

(1.4) becomes:[13]

$$\mathbf{A_v} = \frac{(\dot{\mathbf{R}})^2}{\mathbf{R}}\left[\mathbf{A_H - q}\right] \tag{1.5}$$

---

[12]The divergence theorem states: *The volume integral of the divergence of a vector field taken throughout a bounded domain equals the surface integral of the normal component of the vector field taken over the boundary.* Symbolically:

$$\int\int\int \mathbf{div\ F}\ dV = \int\int \mathbf{A_n}\ dS$$

where div $\mathbf{F} = \lim(V\rightarrow 0)\mathbf{[(1/V)(dV/dt)}$. The divergence of a vector field is a scalar field that represents at each point of the field the extent to which the field diverges from the point. Thus for vector field **F**, the divergence is the scalar field obtained by performing the following operation:

$$\mathbf{F} = F_x\mathbf{i} + F_y\mathbf{j} + F_z\mathbf{k} \qquad \text{div } \mathbf{F} = [\partial F_x/\partial x + \partial F_y/\partial y + \partial F_z/\partial z]$$

[13]The deceleration parameter **q** is a dimension-less factor devised to express the dynamic properties of the universe in terms of the scale factor **R**. Its name is a carryover from a time when most authorities were convinced expansion was being slowed by gravity.

Equation (1.5) expresses volumetric expansion per unit area as a composite of two factors. $\mathbf{A_H}$ has a value of **2** for space co-expanding with the Hubble sphere, in which case $\mathbf{q = 0}$. We termed this Minkowski expansion, herein our vote for the *equation of state* that prevailed during the first "half life" of the Hubble. If the '*now*' state of expansion is accelerating, then $\mathbf{q = -1}$, and the current state of affairs is:

$$\mathbf{A}_v = \frac{(\dot{\mathbf{R}})^2}{\mathbf{R}}\left[\mathbf{A_H} - \mathbf{q}\right] = \frac{\mathbf{3c^2}}{\mathbf{R}} = \mathbf{3H^2R} \qquad (1.6a)$$

The $\mathbf{A_v}$ parameter has far reaching significance; it transmutes a facet of empty space to a dynamic operative. As will be later developed [equation (2.25) infra], the factor $\mathbf{3H^2}$ corresponds to Einstein's *cosmological constant* $\mathbf{\Lambda}$. Volumetric acceleration per unit area can thus also be written as $\mathbf{\Lambda R}$.

Resolving $\mathbf{A_v}$ along any normal drawn to the Hubble surface defines the directional acceleration:

$$\mathbf{A_n = A_v/3 = c^2/R}. \qquad (1.6b)$$

which is **1/3** the volumetric acceleration per unit area for **3-D** space. The acceleration in the direction of the normal, however, is the same as the acceleration in the direction of any radial, which, in the case of de Sitter expansion, corresponds to a radial acceleration defined by $\mathbf{q = -1}$. And since $\mathbf{q = - c^2/R}$, we arrive at the same value for the directional acceleration $\mathbf{A_n}$ by simply considering **q**. In other words. When $\mathbf{q = -1}$, the radius is accelerating at $\mathbf{c^2/R}$ and therefore volumetric acceleration per unit area is $\mathbf{3c^2/R}$.

That the experimental data conforms closely with a uniform expansion rate **'c'** for the first half life of the universe proves convenient for defining a Hubble time constant $\mathbf{T_o = 1/H_o}$ in terms of a distance $\mathbf{c(T_o)}$ as previously discussed. All matter will be subjected to the isotropic acceleration intensity $\mathbf{A_v}$. It is encoded within the mathematical emolument of the expanding universe.

For flat space, the notion of **R** as a scaling factor for distances and velocities is preserved (The concept of the Hubble limit and its relation to the present distance of communicability is equally applicable to flat space).[14]

The velocity-distance law $\mathbf{v = Hr}$ specifies the rate of change of velocity with distance, i.e,

$$\mathbf{dv/dr = H} \qquad (1.7a)$$

The expression (1.7a) says nothing about whether the velocities of the nebula per se are increasing. To measure a velocity change for a particular galaxy, then

$$\dot{\mathbf{v}} = \mathbf{H\dot{r} + r\dot{H}} \qquad (1.7b)$$

[14] Einstein's schematic was founded upon the prospect of a static universe with positive curvature; The modifications introduced by Einstein in 1916 added a term $\mathbf{\Lambda}$ to prevent gravitational collapse, but Einstein offered no causal connection between **G** and $\mathbf{\Lambda}$

For a **q = (-1)** universe, **H** is constant, so the second term of (1.7b) is zero, and therefore radial acceleration **a = Hv.** In a **q = 0** universe, **v** does not change, and accordingly:

$$\mathbf{H\dot{R} = -R\dot{H}} \tag{1.7c}$$

One formalism appears to be in play during the first half-life of the universe, (1.7c) and another during the latter (1.7b). To explore the affections of our curious cosmos that lead to accelerating expansion, some new relationships will be needed. Of particular interest in the context of the **G** field chronicled in Chapter II is the state of positive matter density and how it is balanced by negative expansion pressure.[15]

There is much that interlocks the present state of cosmological theory with the work of its experimental inquisitors.[16] To deal with the universe, is to construct models that compliment the data. In Appendix I, accelerating space is depicted as a radial array extending beyond the Hubble limit to a vast unobservable universe forever lost from our poor power to comprehend.[17]

The velocity acquired by an accelerating object is:

$$\mathbf{v = \int a(dt)} \tag{1.8a}$$

Uniform radial acceleration $\mathbf{c^2/R}$ for a time $\mathbf{T_o}$ corresponds to a velocity:

$$\mathbf{v = (c^2/R)(1/H_o) = c} \tag{1.8b}$$

[15]Minkowskie expansion generates negative pressure which is greatest when **R** is small. As the universe expands, negative pressure reduces to the level of matter density at which point pressure and density balance to zero. As explained in Chapter III, this condition triggers de Sitter expansion.

[16]While widely separated nebula are observed to recede from one another at velocities greater than **c**, these objects are comoving with the recessional flow of space rather than with respect to space; ergo, Special Relativity does not impose a speed limit for recessional drift.

[17]If instead of a sphere we select a cube of space for our expansion model, then for a volume **V** having three equal sides **X = Y = Z** = 1 expanding at **c**:

$$\mathbf{dV/dt = 3Y^2[c]}$$

And the acceleration is:

$$\mathbf{d^2V/dt^2 = 6Y[c^2] + 3Y^2(\ddot{Y})}$$

Applying the volume to surface divergence transform, we divide by the area $\mathbf{6Y^2}$ so the effective volumetric acceleration per unit area of the cube is

$$\mathbf{A_c = ([c^2]/Y + \ddot{Y}/2)/3}$$

"Ill tell you what's beyond the observable universe -- lots and lots of unobservable universe."

GRAVITY

Sir Isaac Newton derived the gravitational force between masses; Albert Einstein interpreted the influence of one mass upon another as space-time deformity. But neither could explain the nature of the interaction between matter and medium, nor could their theories predict the value of the gravitational constant G.

The Gravitational Constant

"No machinery has ever been invented that explains gravity without also predicting some other phenomena that does not exist."

Richard Feynman

Newton's recognition that falling objects and planetary motion are governed by the same physical law was perhaps his most far sighted—and controversial contribution to the scientific world. That masses could reach out across empty space and exert attractive forces upon one another was regarded by many as voodoo physics. Newton himself refused to hazard a guess as to the "*modus operandi*" yet he was profoundly bothered as to the origin of this perplexing "action-at-a-distance" and, like others, sought some further explanation. In "Principia" he states:

"We have explained the phenomena ...but I have not been able to discover the cause...and I frame no hypothesis...metaphysical or physical...occult or mechanical..."

Years later in a letter to Richard Bently he would write:

"That one body may act upon another at a distance through a vacuum, without the mediation of anything else, by and through which their action and force may be conveyed from one to another, is to me so great an absurdity, that I believe no man who has in philosophical matters a competent faculty of thinking, can ever fall into it. Gravity must be caused by an agent acting constantly according to certain laws, but whether this agent be material or immaterial I have left to the consideration of my readers"

More than two centuries would pass before the world received a tenable explanation of gravitational attraction. Like Newton, Einstein asserted that gravity involved continuous action, but he went further by developing a geometric construct wherein the contents of the cosmic container determine its size and shape. In rejecting the notion that physically separated bodies act directly and instantaneously upon one-another, *General Relativity* postulates the conditioning of space-time by local matter and the influence thereof being propagated to other parts of the universe at the speed of light. The theory has quantitative significance when dealing with relativistic velocities and large masses—and it correctly predicts the slowing of clocks, the perihelion motion of Mercury, and the deviation of light—yet it leaves certain ultimate questions unanswered—namely, "what" determines the value of the gravitational coefficient **G**, and "why" does mass alter space and time? In this sense we are still left with Newton's dilemma: How is it possible?

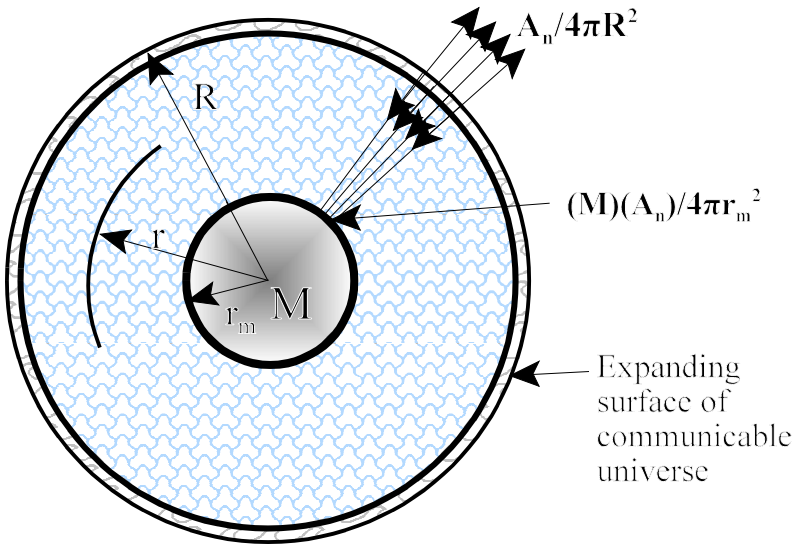


Figure 2. A uniform spherical mass "M" concentric as to its velocity field will be subjected to an isotropic cosmic flux A_n.[18] The inertial reaction of "M" to this acceleration is $M(-A_n)$. The equal and opposite force exerted upon space will be distributed uniformly over the manifold with intensity $M(A_n)/4\pi R^2$. Since the same number of force lines converge upon "M" through all closed encompassing surfaces, the field intensity I_m (# of force lines per unit area) at any other distance "r" greater than r_m will be:[19]

$$I_m = \text{Force/meter}^2 = (M)(A_n)/4\pi(r^2)$$

[18]As discussed previously, the measurement of velocities and forces in relation to spherical shells centered on our position does not prejudice the mathematical model since all points in the universe are equivalent. The commonly used cosmological allegory of the two dimensional surface of an inflating balloon has each observer judging his position to be central to what appears to be an expanding flat space. In this simile, all spectators share the same curved surface, but they are unaware of the curvature. In a like manner, every observer in our three dimensional world will view their situs as central to an expanding volume. This perspective of the universe as a **3-D** surface cannot be drawn or visualized because the Cosmological Principle appears to require global geometry be hyperspherical The advantage of the metric ground-form avoids the necessity of having to conjure a **4-D** space within which to embed **3-D** curvature.

[19]Fields are an intellectual construct first put forth by Faraday to explicate action at a distance. As is usually understood, a field is an assignment of values (such as magnitudes in a scalar field, or magnitude and direction in a vector or tensor field) to points in space. To relate the strength of a source to the area over which the influence is operative, Faraday hypothesized an array of continuous lines radiating outwardly from the source. This leads to the familiar "inverse square" law wherein force intensity (number of continuous lines per unit area) diminishes geometrically as the square of the radial distance from the point of origin.

The Interaction Between Space and Mass

One of the significant recognitions of modern cosmology is that space has *properties*.[20] Being non-material, its attributes are *sui generis,* yet recognizable and measurable. General Relativity predicts it can be twisted, dragged, stretched, bent and rotated.[21,22] Its permeability and permittivity determine both the impedance and velocity of electromagnetic waves. And out of the *Equivalence Principle*, a new reciprocity has arisen between forum and mass that betrays inertial and gravitational forces to be but different sides of the same coin; each the result of shared connection with the global dynamic.[23]

The idea of interaction between space and matter is by no account new. Newton concluded that inertial reaction did not depend upon other objects, and must therefore be related to space itself. He invented the concept of '*absolute space*' as a reference frame by which acceleration could be measured. But Einstein averred that both velocity and acceleration were relative. Symmetry is a common fundament implicit in natural law; it is immaterial whether mass accelerates with respect to the universe, or vice versa.[24] While the Newtonian proposition is grounded upon the perception of force as the agent responsible for producing velocity change, Einstein concluded that gravitationally attracted objects were following curved space-time geodesics created by the distorting influence of mass upon static space. In our paradigm, divergent spatial flow is a property of the void, it defines the reference frame of the universe by which all acceleration is measured. For a uniform spherical mass **M** immersed in the global isotropic acceleration flux, the reactionary force along any line of action is by Newton's Second Law and (1.6a):

$$A_n M = \frac{c^2}{3R}(A_H - q)\, M \tag{1.9}$$

---

[20]Quoting Stephen Hawking: "*Empty space isn't empty*...."

[21] Einstein described space as a medium: "being at every place conditioned by the presence of matter at a particular location and in neighboring places."

[22]In 1918 the Austrian physicists, Josef Lense and Hans Thirring, predicted the magnitude of spatial drag induced by rotating mass.

[23]In Einstein's elevator thought experiment, the passenger inside a closed container cannot detect whether the force is due to a gravitational field or the acceleration of the container relative to the universe, or vice versa. It makes no difference whether a mass is accelerated relative to the rest frame of the universe, or whether the universe is accelerated relative to a static mass; the resultant force is the same. Newton's "Second law "likewise makes no distinction between the *acceleration of mass relative to space* or the *acceleration of space relative to mass.* But if acceleration of the universe produces instantaneous forces on a local matter throughout the universe, is not the acceleration field a global condition of space continuously linked to all forms of mass at all times?

Figure 2 shows the inertial reactionary field for an exemplary section of a two-sphere universe of mass $\mathbf{M_u}$ distributed as a surface density $\boldsymbol{\sigma} = (\mathbf{M_u}/4\pi\mathbf{r}^2)$. The introduction of a new mass **M** at the geo-center depicts as a bundle of convergent lines terminating normal to its surface of radius $\mathbf{r_m}$.[25] Each bundle of lines is associated with a unit of area on the two-sphere manifold of radius **R**—and since every line in the bundle passes through all imaginary closed concentric shells encompassing **M**, the '*force-line*' density at a lesser distance **r** will be greater in proportion to the ratio of the squares of the distances $\mathbf{(R/r)^2}$. The reactionary force intensity at any point measured from the center of mass thus follows directly from the convergence of the field (same number of lines passing through all closed Gaussian surfaces encompassing **M**). Mass **M** renders a uniform counter force $[(-\mathbf{A_n})(\mathbf{M})]$ upon the $\mathbf{M_u}$—this translates to an added force line density $\mathbf{[(A_n)(M)]/4\pi R^2}$ at **R**. The field intensity at any other imaginary shell of radius **r** centered on **M**, is therefore $[(\mathbf{A_n})(\mathbf{M})]/\mathbf{4\pi r^2}]$. If force is measured in newtons and area in square meters, intensity will have **mks** units of stress ($\mathbf{ntn/meter^2}$). From (1.5) and (1.9) the field intensity $\mathbf{I_m}$ on the spherical shell of mass **M** is:

$$I_m = \frac{\text{Force}}{\text{meter}^2} = \frac{Mc^2}{3R}\left[\frac{(A_H - q)}{4\pi(r)^2}\right] \tag{1.10}$$

The gravitational field $\mathbf{E_G}$ is defined as force per unit mass. Our derivation outputs the intensity in units of $\mathbf{ntn/(meter)^2}$. But this is to be expected inasmuch as the set-up was rigged by spreading $\mathbf{M_u}$ over an area coextensive with the Hubble surface to take advantage of Faraday's concept of field convergence. To recover the stress intensity $\mathbf{I_m}$ given in (1.10) in terms of a **kgm** of mass, multiply both sides by ($\mathbf{meter^2}$) and divide by **kgm**. The resulting force density per unit mass $\mathbf{E_G}$ [equation (1.11)] will have units of **ntns** force divided by **kgm(s)** mass, i.e., the gravitational field is:

$$E_G = (I_m)\left\{\frac{\text{meters}^2}{\text{kgm}}\right\} = \frac{Mc^2}{3R}\left[\frac{(A_H - q)}{4\pi(r)^2}\right]\left\{\frac{\text{meters}^2}{\text{kgm}}\right\} \tag{1.11}$$

The bracketed multiplier term carries the captured dimensional units generated by transformation of the field from $\mathbf{ntn/m^2}$ to **ntn/kgm**.[26]

---

[25]Spatial acceleration is the alter-identity of dynamic stress. The density $\boldsymbol{\sigma} = (\mathbf{M_u}/4\pi\mathbf{r}^2)$ can just as well be replaced with the expansion acceleration factor. The total force on a real or imagined matter surface enclosing a volume is calculated by integrating the stress over the containing surface. When related to the volume, this can then be transformed by using the divergence theorem in reverse, to output the intensity in units of **ntn/kgm**

[26]"Tag-along" units are implicit in the formulation of any affect inversely diluted over a spherical surface In equation (8), **E** has units of $\mathbf{ntn/m^2}$. Transformation from $\mathbf{ntn/m^2}$ to **ntn/kgm** relates the totality of the spatial reactionary force distributed over the Hubble manifold to the Newtonian inertial force produced by the isotropic acceleration field acting upon mass **M**.

The dimensionality of the field follows from the fact $4\pi R^2$ contains the mass of the universe in surface density form $\sigma = M_u/4\pi R^2$ so the force can be represented as the interaction between **M** and M_u, wherein the latter enters as a surface density $(4\pi R^2)[kgm/m^2]$. The directional field intensity $(c^2/R)(1/4\pi)(m^2/kgm)$ is thus 'auto-dimensioned with the same units as **G**, i.e., as volumetric acceleration per unit mass. However, it is the acceleration of space that is primary, the coefficient **G** simply expresses the inertial reaction of matter subjected to global isotropic acceleration.[27]

Historically, positive **q** was attributed to gravitational slowing. If density and pressure are both ignored, (or if equal and opposite) cosmic evolution is determined by Λ. Here we provisionally adopt the **q = -1** accelerating universe as the *now* state of expansion, hence for the two sphere model we label **G** as G_2 and **R** as R_2:

$$G_2 = \frac{c^2}{4\pi R_2}\left\{\frac{meters^2}{kgm}\right\} \tag{1.12}$$

Our ambition for a theory interrelating the physical constants within the dictates of a zero energy platform embarks with (1.12).[28] **G** is ordained by global expansion, subject to the model employed to account for the distribution of matter. The acceleration parameter for our two-sphere $A_n = H_2(c) = c^2/R_2$ conforms to the velocity distance law, and the G_2 parameter derived therefrom is consistent with expansion algorithms compliant with the standard model. The generic form is retained in (1.9) - (1.11) both for historical reasons and because different values of **q** and A_H may be applicable to other eras and other models. Of particular interest is the set $\{A_H = 2,\ q = 0\}$ from which our present accelerating universe may have succeeded. From estimates based on the '*Standard Model'* the Hubble distance is approx **13.7 Gly** = $[(13.7)x10^9)][(9.46)x10^{15}$**meters/light-year]**, or 1.29×10^{26} meters. For the two-sphere model then:[29]

$$G_2 = [c^2/4\pi R]\{meters^2/kgm\} = 5.55 \times 10^{-11}(m^3/sec^2)/kgm \tag{1.13}$$

---

[27]The relationship between surface density and volumetric density is $4\pi r^2/(4/3)\pi r^3 = 3/r$. The Hubble density can be thus be expressed as $(3/R)kgm/m^2$. Whether the reactionary force of matter is due to the quantum characteristics of space or an organic property of the universe as a whole, the mechanism does not require gravitons or any other form of information traveling between masses.

[28] The Hubble sphere contains all galaxies receding at less than the speed of light. Those at the edge exit with co-moving space at velocity **c**. As discussed in Appendix I, the Hubble dilates at velocity $U_H = d(R_H/dt) = c(1+q)$. In a slowing universe the Hubble distance overtakes the recessional flow at relative velocity $U_H - c = cq$. For **q = 0**, the Hubble sphere grows at velocity **c** and the distance R_H coincides with the distance to the surface **R.** For an accelerating universe, **q = –1**, so $U_H = 0$.

[29]In most literature, **H** is expressed as the ratio of recessional rate measured in **km/sec** per unit of distance measured as mega parsecs (**mpc**). One **mpc = 3.09 x 10^{19} km**. The empirical value of **G = 6.67 x 10^{-11} (m^3/sec^2)/kgm**, H_o corresponds to **[71(km/sec)/mpc].** To convert **[(km/sec)/mpc]** to mks units, first divide by **3.09 x 10^{19} km/mpc**. Thus if H_o is **71 (km/sec)/mpc** division by (**3.09 x 10^{19} km/mpc**) = **2.3 x 10^{-18}/sec**. The Hubble time T_o is then **1/(2.3 x 10^{-18}/sec) = 4.3 x 10^{17} sec**, and the scale **R** is $c/H_o = (3 \times 10^8 m/sec)/(2.3 \times 10^{-18} sec^{-1})$ or approximately **1.3 x 10^{26} meters. S**ince one year equals **3.16 x 10^7 seconds**, the age in giga years is **(4.34 x 10^{17} sec)/(3.16 x10^7) = 13.7 Gy.** One light year equals **9.46 x 10^{15} meters**, so since the Hubble dilation rate has been constant over the lifetime of the universe, our two sphere gravitational constant $G_2 = 5.55 \times 10^{-11}$ (m^3/sec^2)/kgm

The Now Value of the Hubble constant for a Homogenous 3 Sphere

Modeling the universe as a two-sphere simplified the derivation, but the $\mathbf{G_2}$, value obtained in (1.13) misses the mark by about 8%. The gravitational coefficient of a two-sphere universe will be less than a three-sphere universe having the same energy and scale. When the matter content $\mathbf{M_u}$ is distributed over the Hubble surface, the energy $\mathbf{U_{2D}}$ is $\mathbf{(M_u)^2G_2/2R_2}$ whereas the same mass homogenized throughout the Hubble volume (per Appendix VII) will have energy $\mathbf{U_{3D} = 3(M_u)^2G_3/5R_3}$. Therefore:

$$\mathbf{G_2/R_2 = 2U_2/M_u^2} \qquad \text{And} \qquad \mathbf{G_3/R_3 = 5U_3/3M_u^2} \qquad (1.14)$$

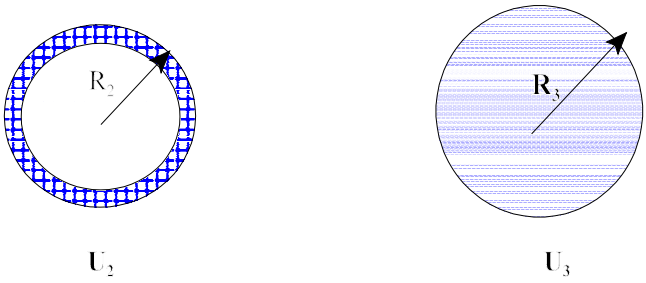
To compare $\mathbf{G_2}$, to $\mathbf{G_3}$, we equate the energy/mass ratios, that is:

$$\mathbf{[U_2/M_u^2] = [U_3/M_u^2]}$$

In which case

$$\mathbf{G_2/2R_2 = 3G_3/5R_3} \qquad (1.15)$$

For $\mathbf{G_2}$ to equal $\mathbf{G_3}$, then $\mathbf{5/3R_3 = 2R_2}$, and therefore $\mathbf{R_2 = (5/6)R_3}$. Because $\mathbf{G_2}$ was calculated using the $\mathbf{R_3}$ scale $\mathbf{1.29 \times 10^{26}}$ meters that corresponds to the three spatial dimensions of the real world, the gravitational coefficient computed in (1.13) will be in error by a factor of **5/6**. For the **2-D** theory to correctly predict the value of **G** in our **3-D** world, (1.12) must be multiplied by (**6/5**). The $\mathbf{G_3}$ value from the numerology of the standard model is thus $\mathbf{(6/5)(c^2/4\pi R)\{m^2/kgm\} = 6.7 \times 10^{-11}\ (m^3/sec^2)/kgm}$



Above, both universes have the same energy, but $\mathbf{R_3}$ must be larger that $\mathbf{R_2}$ by a factor of **6/5** if the two-sphere gravitational constant is to equal the 3-sphere gravitational constant. To transform (1.12) to **3-D** multiply by **6/5**.

$$\mathbf{G_{(three\ sphere)} = [3c^2/10\pi R]\{meters^2/kgm\}} \qquad (1.16)$$

NOTE: It is convenient to preserve the (1.12) form of the **G** equation as it expresses the result in terms of the factor $\mathbf{4\pi}$ (useful in deriving relationships that involve surface areas. Accordingly, (1.12) will be used with the understanding that **R** with no subscript corresponds to the adjusted value of Hubble radius $\mathbf{R = 5/6R_2}$. The last word on the dependence of gravity upon expansion is yet to be written.

The Deposition of Gravity

The expansion theory of gravity is at this juncture incomplete—for we have not addressed the origin of matter nor has it been shown how expanding space couples to mass. A model has been advanced and the **(q = – 1)** variant thereof commandeered to explain the diminishing magnitude of the **G** field as the Hubble scale distends. If true, the inertial property of particles must increases as **G** weakens. Not surprisingly, this also is prerequisite to the continuity of the zero energy universe which requires the total negative energy contained in the volume of each local **g** field be always in balance with the positive $\mathbf{mc^2}$ energy of matter. Since negative energy of **g** fields increase as the universe expands, the universe can be synthesized from a zero energy state; the fiction of initial singularities ends here.

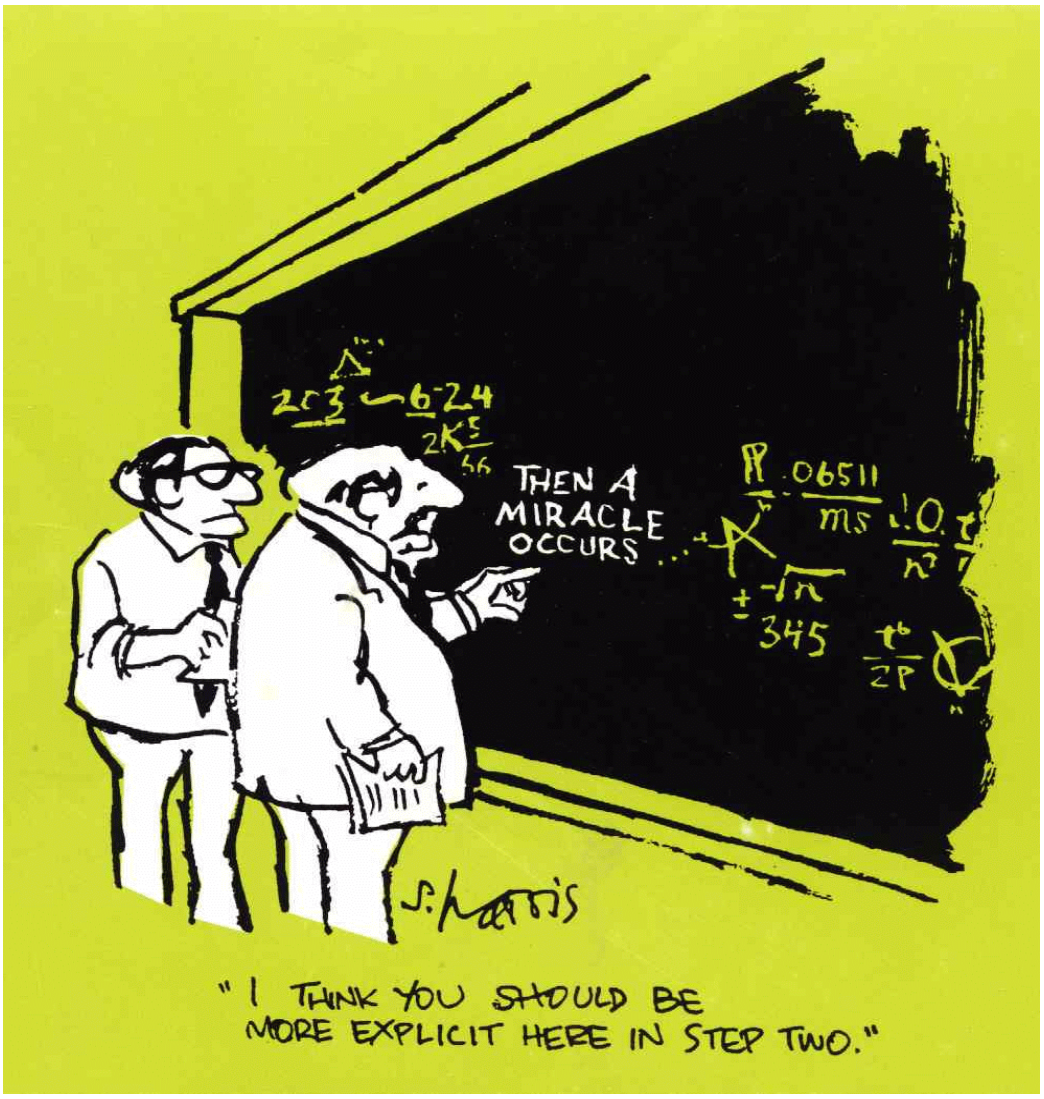
In the Cosmodynamic paradigm, Einstein's static distortion is replaced by spatial acceleration. The root cause of gravity is subsumed within the action of Newton's second law. With this realization comes the answer to the great cosmic profundity—the ultimate fate of the universe. Without expansion, there is no gravity and without gravity there is no gravitational collapse. In the end, there is no end!

How now should the sacred *Constant of Gravitation* be viewed? The stature of **G** as a finely tuned fundament of the universe can no longer be maintained. Its once exalted status is relegated to Newtonian reaction; the attraction between masses is the distortion of dynamic space by inertial matter.

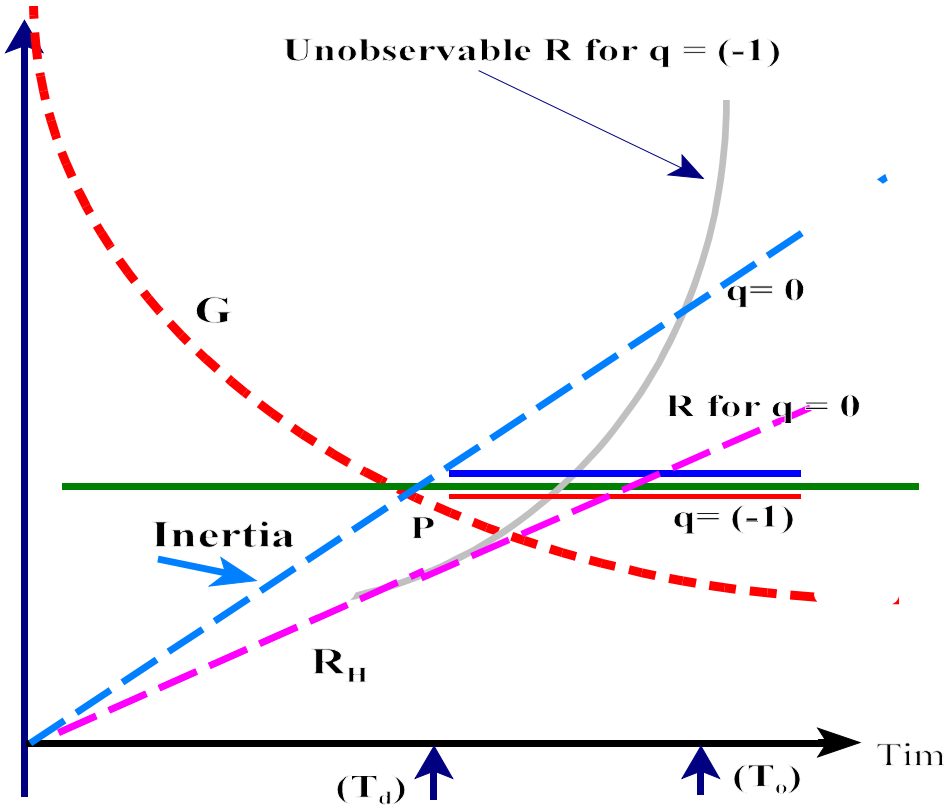
In the standard model, **v, R** and **H** are expected to change as the universe grows. Theories based upon variable **G**, however, are suspect; the many attempts to measure long term changes in planetary lunar orbits have proved unsuccessful. But these experiments only confirm the invariance of the **MG** product; they do not measure **M** or **G** as separate factors. Even though particles exhibit enhanced inertial reaction when accelerated to high velocities, the idea of expansion acquired inertia and its variable **G** corollary is difficult for most readers to accept. Take heart, it was hard for the author also, but that is where the physics leads.

We began our search for the gravitational constant with a quote from Newton. It is fitting this Chapter be ended likewise:

> ***"I derive from the celestial phenomena the forces of gravity with which bodies trend to the sun and the several planets. Then from these forces, by other propositions which are also mathematical, I deduce the motions of the planets, the comets, the moon, and the sea. I wish we could derive the rest of the phenomena of Nature by the same kind of reasoning from mechanical principles, for I am induced by many reasons to suspect that they may all depend upon certain forces by which the particles of bodies, by some causes hitherto unknown, are either mutually impelled towards one another, and cohere in regular figures, or are repelled and recede from one another. These forces being unknown, philosophers have hitherto attempted the search of Nature in vain; but I hope the principles here laid down will afford some light either to this or some truer method of philosophy."***
>
> Is. Newton, 1686


THEN A MIRACLE OCCURS...
S. Harris
"I THINK YOU SHOULD BE MORE EXPLICIT HERE IN STEP TWO."

POSTSCRIPT NOTES:



Time History of Inertial Acquisition and the Diminution of G

The **MG** product (Solid Green Line) for both individual particles and the Hubble mass as a whole is invariant with time. In a **(q = 0)** universe, inertial mass (dotted blue line) increases as **G** (dotted red Line) diminishes. If the universe transitions to exponential expansion at **P**, both inertia (solid blue line) and **G** (solid red line) remain constant thereafter Beyond **P**, the scale of the unobservable de Sitter universe (solid gray line) grows at an accelerating rate which would presently be approx **3x** greater than the Hubble scale $\mathbf{R_H}$ (dotted magenta line). The transition time **P** is indicated by $\mathbf{(T_d)}$ and the'*now*' time by the arrow $\mathbf{(T_o)}$.

While the standard model descends from Friedmann's hypothesis of fixed inertial mass created during a brief genesis phase, it has been re-modeled over the years to accommodate new discoveries and the theories invented to explain the discoveries. In particular, the forms of matter and their relative densities at different eras are adjusted to create a velocity profile consistent with luminosity-distance data gathered over many years of observation. In that effort, much has been refined to correctly estimate the Hubble age, and it is this factor we have borrowed from the standard model to develop a *variable **G**/variable **M*** theory of cosmic evolution consistent with the expansion of empty space.

Chapter II

Vacuum Stress

What I cannot create, I do not understand

Written by Richard Feynman in the corner of his office blackboard at Caltech—where it remained for eight years

Its Turtles All The Way Down[1]

Richard Feynman's deliberations on the conflicting physiognomies of General Relativity and Quantum Gravity were brought to the fore in a series of lectures given at Caltech in 1962, subsequently published as "Feynman's Lectures On Gravity." He had hoped that in teaching the course, his own diversions on quantum gravity would develop into a consonant theory. Yet the notion that gravity might be a disguised form of some known classical phenomena was always with him.[2] For Feynman, the provocative ideas of Mach, de Sitter and McCrea were of singular intrigue.[3] His attitude toward the problem is reflected in his own words:

1) Gravitation is a new field of its own, unlike anything else, or

2) Gravity is a consequence of something already known, but incorrectly perceived

It was Feynman's philosophy that nothing should be overlooked or dismissed until exhaustively analyzed in terms of known principles. New physics required strong evidence. The empirical support for a theory of gravitons congruent with the successful predictions of Einstein's geometric was then, and is today, still missing.

In what follows we take notice of a cosmological agent unknown to Einstein and unresolved by Feynman[4] To make sense of gravity as a reactive force induced by expansion, space must in some way be both insular and continuum, operatively discernable when accelerating, and then only when acting upon inertial matter. The reactance thereof must manifest as spatial stress, what is commonly observed and measured as a local '**g**' field, treated herein as synonymous with negative pressure. The reactionary force created by mass accelerated relative to space is called 'inertia.' Space accelerated by mass also has a special name, Newton termed it: 'gravity.'

---

[1]"The Sun's gravity holds the earth in its orbital plane." Such a statement provokes further questions as to the cause of gravity and why it has a particular value. Ultimately we are led to an endless quest for the cause of the cause of the cause.... In ancient culture, the earth was projected as a flat plate supported on the back of a giant tortoise. As to what held-up the tortoise, another tortoise was invoked to bear the first, and so on. When pressed by a reporter to explain the root cause of magnetism, Feynman joked: "its turtles all the way down."

[2]"One very important feature of pseudo forces is that they are always proportional to the masses. The same is true of gravity. The possibility exists therefore, *that gravity itself is a pseudo force*. Is it not possible that perhaps gravitation is due simply to the fact we do not have the right coordinate system?" [Feynman - Lectures On Physics at 12-11]

[3]"Another spectacular coincidence relating **G** to the size of the universe comes in considering total energy...**GMM/R** where $\mathbf{R = (T_o)c}$, with $\mathbf{T_o}$ being the Hubble time. If we now compare this number to the total rest mass energy of the universe $\mathbf{M_uc^2}$ lo and behold we get the amazing result that $\mathbf{GM^2/R = M_uc^2}$ so that the total energy of the universe is zero...It is exciting to think that it costs nothing to create a new particle since we can create it at the center of the universe (which is any place) where it will have negative gravitational energy equal to $\mathbf{mc^2}$." [Feynman, Lectures on Gravitation]

[4]The isotropic acceleration field is the missing coordinate system per Footnote 2 above.

Gravity as a Consequence

"When one tugs at a single thing in nature, he finds it attached to the rest of the world " John Muir

In deriving the cosmic acceleration parameter $\mathbf{A_n}$, the hyperbole was crafted to facilitate measurement at the temporal coincidence of the Hubble radius $\mathbf{R_H}$ with the fixed Gaussian surface of radius $\mathbf{R_S}$. The acceleration flux does not depend upon interaction; the fictitious Gaussian surface $\mathbf{S_U}$ will mathematically conform to enclose any representative Hubble surface volume defined by $\mathbf{S_R}$. In **Figure 3A** the curved surface areas ($\mathbf{S_R}$ and $\mathbf{S_U}$) are projected as flat circles, the changing rate of diverging flux being replaced by an equivalent parallel transport apropos of velocity **v** with volumetric displacement:

$$\mathbf{dV/dt = 4\pi R^2[v]} \tag{2.1}$$

Unidirectional expansion can be analogized to withdrawing a piston from an already evacuated cylinder as shown in **Figure 3B**. If the non-expandable mass **M** inside the cylinder is to experience a pressure field less that zero, the piston and cylinder must be impervious to leakage, or the volume of the false vacuum must continuously accelerate at a rate greater than the leakage rate. While negative pressure inside the cylinder is directionally equalized, it is not uniform. Pascal's law for negative pressure differs from the rules for positive pressure created by the kinetic action of molecules. Local pressure will be a negative maximum at the surface of **M** and diminish with distance, ergo, the acceleration gradient of the **G** field reaches a maximum at the surface of **M**. For the cosmos, the negative pressure field is created by volumetric acceleration. Energy is balanced to zero, the negative pressure field surrounding **M** being equal to that exerted by expansion upon the imaginary manifold (the equivalent of exiting momentum flow).

The object of this imaginary experiment, is to distinguish the reality of the void as a communicative medium when accelerating. Acceleration of nothing is negative pressure. Figure **3B** illustrates the difference between negative and positive pressure, the former ceases to exist when the accelerating potential is removed, whereas for a cylinder filled with gas compressed by a piston, positive pressure remains after the piston is brought to rest. Herein we will, from time-to-time, call negative pressure by its alter identity, "dynamic stress." For the unidirectional universe of **Figure 3A**, volumetric acceleration per unit area is $\mathbf{c^2/R}$ so pressure $\mathbf{P_M}$ at the surface of **M** will be:

$$\mathbf{P_M = [(c^2/R)M] /4\pi r^2} \tag{2.2}$$

where **r** is the radius of **M**. The calculation for the earth is set forth in Appendix II subject to the inclusion of the **6/5** factor expostulated in Chapter I.

As shown in Figure **3C**, an obvious but often overlooked convenience of uniform stress is that each shell of thickness **dr** will have the same density $\boldsymbol{\rho_u}$ and consequently an identical gravitational affect upon the Hubble center defined thereby.

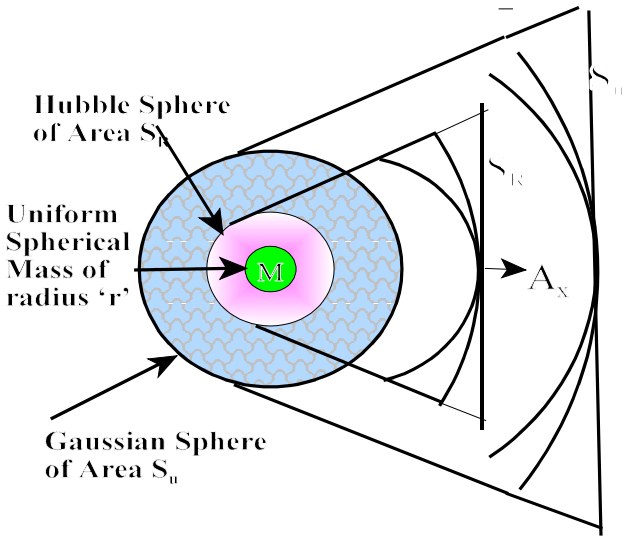


Figure 3A: The Hubble and Gaussian surfaces projected as "peeled off" flat areas. Acceleration is unidirectional but the resulting gravitational field of M is isotropic

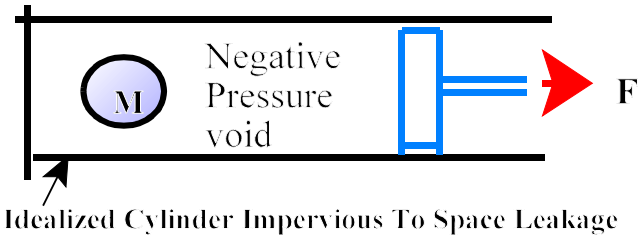


Figure 3B. When the Piston is accelerated by F, the internally created negative pressure will be isotropic as measured from the center of a uniform sphere of mass M. Negative pressure force obeys the inverse square law rather than Pascal's Law.

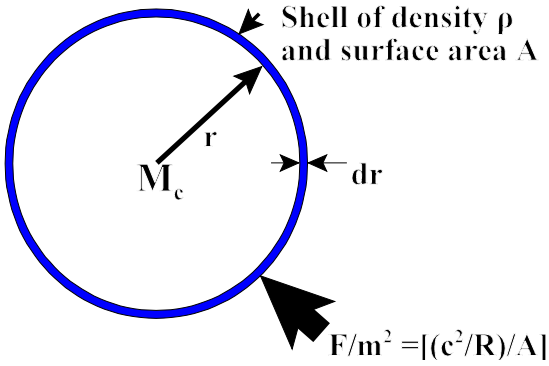


Figure 3C: In a spherical structure having large scale uniform density ρ_u, the net gravitational force exerted upon a co-centered point mass M_c by any elemental shell of thickness 'dr' is independent of its radial distance "r." While M_c exerts a net G force upon the elemental constituents that comprise the shell, there is no net force upon M_c irrespective of whether the shell is considered a fixed gravitational mass or a radially accelerating spatial flux. In both cases, the field acting upon M_c is isotropic and therefore net force is zero for all shells.

The discovery of cosmological expansion in the 1920's rejoined confounding questions raised by Einstein's presumption of space as static, but it fostered new affections about beginnings and endings. To unravel the implications, it proved fruitful to combine Einstein's *Theory of Gravity* with Friedmann's *Model of Expansion*. This allowed cosmologists to explore the universe in terms of the key parameters, curvature (**k**), density (ρ_u), and deceleration (**q**). Below we comment upon the most extensively studied models (**q = 0, +1/2, +1**, **-1**):

> For [**q = zero**], expansion is autonomous–the scale of space grows indefinitely in proportional to cosmic age. The invariant expansion pace is encoded in Minkowski's unification of space and time. This is the constant '**c** universe modeled in Chapter I, nothing disappears from view ..in the forever coasting universe there are no horizons, kinetic energy always equals potential energy.
>
> If [**q = +(½)**], density determines cosmic evolution. This is the mathematically elegant exponentially decelerating universe investigated by Einstein and de Sitter in 1932. Matter is deemed to originate abruptly, and the expansion rate is initially many times the velocity of light, being thereafter slowed by gravity, ultimately reaching zero velocity at eternity. The initial matter content must be finely tuned to bring about the precise rate of deceleration. Curvature $\mathbf{k \rightarrow 0}$ at eternity.
>
> In the [**q = +1**] universe, geometry is closed, **k = +1**, pressure and curvature are positive, expansion slows to zero, then reverses to contraction and eventual collapse. When Einstein's cosmological term **Λ** is included to balance gravity, the universe can be modeled as static, cylindrical in space and time as first proposed by Einstein.
>
> When [**q = -1**], pressure is negative, expansion is exponential and independent of ordinary matter density. Space is flat or open, curvature **k = -1**. The de Sitter universe accelerates indefinitely.

Different values of **q** thus lead to radically different phylogenesis. Without better data, theory must fill-in as best can. The expectation is that unrealistic models will be cast out as better information is acquired. At this juncture, however, it is imprudent to rule out modes that might fit earlier conditions. For example, the **q = 0** state looks to be a good fit for an earlier era even though it deviates from what cosmologists have adopted as the present **ΛCDM** standard model. While **q = (–1)** appears to be the correct descriptor for the '*now*' condition of the universe, that conclusion is based entirely upon the interpretation accorded **1a** supernova events. Other interpretations of the data lead to different conclusions.

For those uncomfortable with a 13.7 billion year age limit that barely accommodate the oldest (age adjusted to fit) astronomical structures, there is both hope and despair within the **q = -1** universe.[5,6] The notion of eternal exponential expansion avoids the creation dilemma but uninterrupted acceleration is inconsistent with the well established theoretics of nuclear synthesis which depend from hot dense thermionics. The testament for a violent beginning derives from extensive observational data supported by well developed models. The present state of affairs leads to the conclusion that no single function fits all epochs. The standard model attempts to tailor the Hubble history to the present reception of long ago emitted photons; its refinements are often more descriptive than predictive. The notion of variable expansion based upon gravitational slowing moderated by diminishing density provides a theory, but the exposition succeeds at the cost of failing to I.D. the root cause of gravity and mass.

Even if the universe is infinite in space and past eternal in age, an effective time $\mathbf{T_o}$ can nonetheless be defined for dating the first particles with the beginning of we observe as expansion. The Hubble time-constant $\mathbf{T_o}$ is roughly equal to the Hubble age for the standard model. Particle creation by"Big Bang" or "cosmological collapse can then regarded as a asymmetric event within an existing space-time structure.

Starting with the presumptions of constant **G** and constant inertia, the standard model concludes with the density factor of ordinary matter decreasing in proportion to the cosmic volume. According to current theory, the lifeline of the expansion phase starts with particles too closely packed to permit the escape of radiation, and proceeds toward a future horizon that includes only our own gravitationally bound local galactic group for future species to contemplate.[7] The light presently being received from the earliest galaxies were emitted when the separation distances were about 1/11 of their present value, the universe was about 470 million years old and these objects were 2.86 billion years from the stuff that eventually became the earth.

The sentiment of the physics community, is that space is granular at some scale, but the nature of the construct is unknown. Hubbles's data led Howard Robertson to

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[5] The acceleration that corresponds to a Hubble velocity **c = HR** is uniform throughout the universe; it is a local property of space. The local Hubble acceleration is the same as the cosmological acceleration, for any sized symmetrical container, the volumetric acceleration per unit area reduces to the square of the velocity of light **'c'** divided by a distance **r**. This simple relationship is the backbone of our thesis, repeated over and over in every chapter. It is the only formula the reader needs in order to understand how forces act at a distance. For gravity the denominator is **r = R** (radial divergence); for electric fields r = $\mathbf{r_o}$ (vortical circulation).

[6] While the Hubble parameter $\mathbf{H_0}$ has been down sized over the years, the most recent experiments have converged upon a value in the low seventies. Although there is uneasiness in fitting some data into the corresponding 13.7 billion year age limit, the "Super Sandage" values on the order of ($\mathbf{H_o = 42}$) would appear to be out of bounds unless some monumental systemic error were discovered. Such things have occurred in the past, however.

[7] The argument goes as follows: In decelerating universe(s) the Hubble sphere expands faster than the recessional flow, so the number of visible galaxies increases with time whereas in an accelerating universes the opposite is true. If the universe has only been accelerating during the last 7 billion years, photons emitted in our direction will have traveled a long distance toward the earth when the expansion became exponential, ergo we now see these photons from objects now invisible.

the velocity-distance law which can be analogized as a continuous membrane.[8] From Appendix VII, the positive energy density required to build a Hubble sized universe is twice the critical density of the Einstein-de Sitter universe**:**[9,10]

$$\rho_u = 3H^2/4\pi G \tag{2.3}$$

The dependence of density upon **H** and **G** leads to possibilities that range from variable inertia to self creating mass. Specifically from (1.12) and (2.3):

$$\rho_u = (3/R)[kgm/m^2] \tag{2.4}$$

For a given value of **H**, ordinary matter density is determined by (2.4).[14] For Minkowski expansion (**q = 0**), and (2.4) applies but **G, H** and $\mathbf{M_u}$ are variables.

A fine tuned density function is critical in the standard model because global acceleration is presumed to be driven by dark energy. But density need not diminish inversely with volume as commonly ordained, nor need matter have any particular average density if the **G** field is the source of inertial reaction. A net zero universe, will always unfurl as critical density because the **G** field increases with volume as does the inertia of matter. This would appear to favor (**q = 0**) expansion as the frontrunner for the job of orchestrating genesis and provocateur of matter. Significantly, this can come to pass without the aid of artificially implanted phenomenological parameters.

For a net zero universe, the positive $\mathbf{mc^2}$ energy must balance the negative stress energy of expanding space. Accordingly:

$$P_S = F/A = (M)(a)/A = (\rho V)(-c^2/R)(1/4\pi R^2) = -\rho_u c^2/3 \tag{2.5}$$

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[8] Hubble was not the first to relate redshifts to expansion, nor did he actually claim to have made such a discovery. The published data collected by himself and Humison showed an approximate linear relationship between distance and the Doppler interpretation of redshifts as velocity, but the correlation proved to be valid only for small redshifts. As previously mentioned, Howard Robertson used Hubble's results to formulate the velocity-distance law which is true at all distances.

[9] The expansion redshift(s) arises from the changing cosmological scale. This is sometimes attributed to spatial stretching, but the analogy is misleading because it hints of an external source rather than an internal cause that depends upon"what is" to create "what is to be." Exponential expansion is the natural result of self creation. When one end of an anchored elastic cloths line is pulled upon with a constant velocity, the cloths pins separate but their velocity wrt to one another does not change. This corresponds to a universe where **H** varies with time and the galactic velocities remain constant (or decrease due of **G**) as would be the case if they were initially put in motion by a single event. But in the supposed present state of our universe, **H** is constant, and the velocity of the Nebula wrt to one another increases with time; such a cosmology is easily formalized within a model built upon self creating space.

General Relativity or Something Else

A question long pondered by cosmologists, is why the ratio $\mathbf{GM_u/Rc^2}$ should equal "one" within the limits of experimental error. In his search to find a scalar tensor alternative to General Relativity, Robert Dicke (introduced by footnote on page 2) would claim it the identity connective between inertial and gravitational mass, *vis a vis* Mach's Principle:[11]

$$\frac{\mathbf{M}_{Gravity}}{\mathbf{M}_{inertia}} = \frac{\mathbf{GM_u}}{\mathbf{Rc^2}} = \mathbf{1} \qquad (2.6)$$

To make merit of Dicke's theory, $\mathbf{Rc^2/G}$ must equal $\mathbf{M_u}$. The problem has been to find a way in which $\mathbf{Rc^2}$ determines the value of **G**, or alternatively to derive **G** in terms of **R** and **c** by independent means. As developed for the massless two sphere shell model in Chapter I, this relationship exists as equation (1.12). Therefore, since [$\mathbf{GM_u = Rc^2}$] is a valid experimental result per (2.6), then from (1.12):

$$\mathbf{M_u = Rc^2/G = [\ Rc^2/(c^2/4\pi R)](kgm/m^2) = 4\pi R^2(kgm/m^2)} \qquad (2.7)$$

The relationship between Hubble volume and its mass-energy content per Dicke's supposition is consistent with the derivation of **G** set forth in Chapter I. While based upon the expanding two sphere model, the result is applicable to any spherical volume when adjusted for the geometric(s) of three sphere reality. Dicke's premise is a major step toward a single accord, one that aligns inertia with gravity. The interdependence of one upon the other is key to demystifying critical density as a fine tuned constitutional feature or a miraculous providential consequence. Alas, there is no mystery, and no need to invoke deistic oversight. Gradual accretion of inertial-energy is the natural affectation of diminishing gravitational acceleration in our expanding universe. This is as it must be. Equations (2.3), (2.4) and (2.7) are the implicates of zero energy dynamic expansion.

The notion of negative pressure as the reactive emblement of gravity teaches away from the primacy of mass as an evolutionary factor. Lumps of matter perturb the cosmological expansion field passively (which is another way of saying reactively) by creating local '**g**' fields that come with negative pressure fields that exceed the void. The irony of particles is that these local '**g**' fields are the result of internal forces that prevent disassociation. Pascal's Law does not apply to negative pressure and therefore does not apply to an expanding non-uniform universe. Elevated negative pressure in the proximity matter is Newtonian reaction on the scale of the cosmos.[12]

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[11]Robert Dicke and others had predicted the wavelength of the CBR before its accidental discovery by Arno Penzias and Robert Wilson while attempting to eliminate spurious noise from a horn shaped antenna in 1965. For their fortuitous fluke they received the 1968 Nobel prize.

[12]Pascal's law: "*Pressure applied to an enclosed fluid is transmitted undiminished to every portion of the fluid and the walls of the containing vessel.*"

There are limits to what a theory explains and concomitantly to what it leaves as questions. Newton established that forces were the result of changing momentum, but neither Newton nor Einstein saw the void as vitality. Newton refused to guess, Einstein postulated spacetime curvature.[13] Contemporary theory hypothesis gravitons for **G** and massive, short lived, Higgs particles to account for **M**, but no physics to explain the coupling mechanism of either. In Cosmodynamics, all forces are related to motion, space and time. As Newton told us three centuries past, the mechanics of the universe are not governed by statics but by dynamics. Whether the change be in the velocity of a physical object wrt the universe, or a change in the velocity of local space relative to the object, force is proportional to rate of change of momentum. It is only the name that differentiates the action as inertia or gravity.[14] The constant '**c**' is the communal factor in the space-time landscape.[15] The nature of negative pressure and how it creates matter during the start-up era of Hubble expansion are subjects yet to be addressed.[16,17]

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[13]The failure of General Relativity to predict **G** and its inability to explain how inert matter curves spacetime has led theorists to seek alternatives. Most notable among these were those based upon the perfect cosmological principle (PCP). The premise is that, although expanding, the universe remains in a steady state, essentially unchanged in appearance. It's most well know proponents were Herman Bondi, Thomas Gold and Fred Hoyle. Hoyle showed how the General Theory could be modified to admit continuous creation, and although he found the same relationship for the critical density as Einstein and de Sitter, the specification did not predict the form nor the rate at which matter would be created. However, another cosmologist, William McCrea, had proposed a rationale based upon the supposition that cosmic tension $\mathbf{P}_s$ equaled the energy density (ρc^2). In such a universe, the energy released by expansion maintains cosmic density constant. The expanding false vacuum as causation of matter was revived by Alan Guth some 30 years later.

[14]While curvature is factual, it is a consequence of motion rather than statics. In the presence of matter, the reactive field is superposed. The measuring instruments are the indicators of gravitational reactance and not the reverse premised by the substitution of geometry for physics.

[15]The radius of the sphere r is determined by minimizing the sum of the ground state energy, the spherical surface energy, and the work done in forming the bubble against the liquid pressure. At zero pressure the sphere will have a radius r of approx 2 Angstroms. When the pressure is made negative, the sphere expands.

[16] To pose the question of cosmological acceleration, is to suggest a line of inquiry that depends from the question itself, namely self creating expansion. In negative pressure environments, cavitation and nucleation bubbles expand. The same is true when electrons are injected into liquid helium–the repulsion between the electron and helium atoms creates an empty spherical chamber surrounding the electron which expands as the helium pressure is made increasingly negative The same result is predicted for bubbles induced by quantized vortices. In empty space, energy and pressure are negative, ergo, spatially quantized vortices in the otherwise empty void translate to cosmological expansion. The origin of free space angular momentum quantization is the subject of chapter V and the origin of negative potential is discussed further in Chapter III

[17]Vacuum energy in modern physics is that which exists in space devoid of matter. It can be observed experimentally in such phenomena as the Casimir effect, spontaneous emission, Van der Waals bonds and the Lamb shift. Quantum Field Theory asserts that quantization must exist at each and every point in space. Metaphorically, space is visualized as filled with vibrating balls and/or springs. In short the theory considers space to have particle properties such as spin and polarization.

Dynamic Modulus And Longitudinal Wave Velocity

The region of proportionality between stress and strain is of fundamental significance in physics and engineering. The stress/strain ratio is a characteristic of a given material. For solids, gases and liquids, the adiabatic bulk modulus is the measure of the change in volume produced by external pressure as determined by the electrical and mechanical forces within. In the case of spatial distortion, a like relationship derives from inertial dynamics (rather than static compression or tension). The "Dynamic Bulk Modulus" $\boldsymbol{\beta_d}$ for a closed universe undergoing uniform isotropic acceleration relates inertial stress to fractional volumetric change, specifically:

$$\beta_d = (-)\frac{change\ in\ pressure}{fractional\ change\ in\ volume} = \frac{P}{\Delta V/Vo}$$

While the concept of a modulus in a boundless massless geometry cannot be visualized as a physical reality, a sample volume of space will suffice as a simile if treated as an ideal gas in the sense that a change in acceleration pressure will alter inertial reaction. For a universe in tension, the pressure $\mathbf{P_s = -\rho_u c^2/3}$ (equation 2.5), so the only variable affecting pressure is $\boldsymbol{\rho_u}$, specifically:

$$\beta_d = \frac{(\mathbf{d}\rho)\mathbf{c^2}}{\mathbf{3(dR/R)}} = \frac{\mathbf{-\,3R^{-2}(dR)R}(c^2)}{\mathbf{3(dR)}} = \frac{\mathbf{c^2}}{\mathbf{R}}\left[\frac{\mathbf{kgm}}{\mathbf{meter^2}}\right] \qquad (2.9)$$

The corresponding" stretch" modulus $\mathbf{Y_d}$ relates dimensional acceleration to stress

$$\mathbf{Y_d = \partial P/(\partial R/R) = 3c^2/R\ (kgm/m^2)} \qquad (2.10)$$

The modulus $\mathbf{Y_d}$ applies to axial deformation, analogous to a solid bar under tension.[18] For longitudinal sound waves in liquids and gasses, propagation velocity is determined by the Bulk modulus. But if longitudinal pressure waves can exist in a negative pressure void, the appropriate modulus is not $\mathbf{\beta_d = (c^2/R)}$ per (2.9) but rather $\mathbf{Y_d = 3c^2/R}$ per (2.10). In the void, pressure equals $\mathbf{(-)(\rho_u c^2/3)}$ so the velocity of propagation is $(\mathbf{Y_d/\rho_u})^{1/2}$ which is **"c"** for $\mathbf{\rho_u = 3/R}$. The same result obtains directly from the condition that $\mathbf{3P_s = -\rho_u c^2}$, which is requisite for negative pressure to cancel positive density in Einstein's equation [(2.22) infra].[19]

[18]When a solid bar is impacted with a blow stuck at one end, the propagation conditions that determine the velocity of the pressure wave are different from those of a fluid confined to a tube of constant cross section. Since the bar expands circumferentially when compressed longitudinally, the appropriate modulus is **Y** (named in honor of the 19th century theorist, Thomas Young).

[19]The ratio of dynamic Bulk Modulus to the dynamic Young's Modulus is 3 for an ideal medium such as space. In classical theory, the velocity **v** in an ideal gas is related to the average **rms** velocity of its particle constituents, that is, $\mathbf{v \approx (3P/\rho)^{1/2} = (-\rho_u c^2/\rho_u)^{1/2} = c}$.

Transverse Wave Propagation

Transverse wave propagation requires an elastic restoring force. In liquid mediums, there is in general, no shear component of resilience, and therefore transverse vibratory modes are not normally observed except along boundaries between physically dissimilar fluids. In surface water waves, for example, transverse restoration is supplied by gravitational pull upon the surface disturbance; in the plucked string, tension propels the wave by exerting a force that tries to reconstruct the string to its unperturbed condition. In connection with the latter, the velocity of propagation is:

$$\mathbf{v_t} = \sqrt{\mathbf{F}/\mu} \tag{2.13}$$

where **F** is the longitudinal tension and μ is the mass/unit length. To extend the applicability of equation (2.13) to the cosmos requires a '*stretch*' of the imagination (as well as the string). Practical problems aside, we select from the universe a filament of space having a length equal to the Hubble scale factor **R(t)**. We anchor one end to the center of the Hubble sphere and locate the other at the cosmic surface wherein tension is contrived by the cosmological acceleration ($\mathbf{c^2/R}$).[20] If the mass of the filament is $\mathbf{M_f}$, and its volume is $\mathbf{V_f}$, then for a density ρ_u, the force **F** is:

$$\mathbf{F} = \frac{\mathbf{c^2}}{\mathbf{R}}\left[\frac{\mathbf{M_f}}{\mathbf{1}}\right] = \frac{\mathbf{c^2}}{\mathbf{R}}(\rho_v)(\mathbf{V_f}) \tag{2.14}$$

The mass of the filament per unit length μ is $(\rho_u \mathbf{V_f})/\mathbf{R}$ and therefore:

$$\mathbf{v_t} = \sqrt{\frac{\mathbf{c^2}\rho_u \mathbf{V_f}}{\mathbf{R}\dfrac{\rho_u \mathbf{V_f}}{\mathbf{R}}}} = \mathbf{c} \tag{2.15}$$

More directly, from equation (2.5) the velocity of propagation of a transverse wave $\mathbf{v_t}$ in a medium is:[21]

$$\mathbf{v_t} = (3P/\rho)^{1/2} = [3(\rho c^2/3)/\rho]^{1/2} = \mathbf{c} \tag{2.16}$$

[20]The thought experiment presupposes congruence between a stressed or compressed filament, i.e., the numerical result is equally valid for a universe in tension or compression.

[21]Since $\mathbf{c^2} = (\mu_o \varepsilon_o)^{-1}$ then from (2.9), the ratio of the dynamic bulk modulus to the cosmic pressure is analogous to the free space electromagnetic impedance $\mathbf{Z} = (\mu_o/\varepsilon_o)^{1/2}$

Energy and Dimensionality

The energy in a particle of mass **M** equals the work required to remove it from the universe. Since "Force" can be expressed either as spatial rate of change in energy **dE/dS** or as inertial reaction **M(dv/dt),** then

$$\mathbf{dE/dS = M(dv/dt)} \tag{2.17}$$

The energy **dE** required to move **M** against the acceleration field a distance $\mathbf{R_H}$ is **M(dv/dt)**(**dS**). For **dv/dt** constant, the integral of **dS** from **r = 0** to **R**, totals the energy of the pilgrimage

$$\mathbf{E = \frac{Mc^2}{R}\int_{r=0}^{r=R} dr = Mc^2} \tag{2.18}$$

The potential of a mass $\mathbf{m_p}$ in the gravitational field of another mass $\mathbf{m_s}$ at a distance **r** from the center of $\mathbf{m_s}$ is $\mathbf{G(m_p)(m_s)/r}$ Equating this potential to $\mathbf{(m_p)c^2}$ gives:

$$\mathbf{G(m_s)(m_p) = m_p r c^2} \tag{2.19}$$

From (1.12) with $\mathbf{m_p}$ at a distance **r** equal to the black hole radius of $\mathbf{r_s}$, gives a value for $\mathbf{m_s}$ of:

$$\mathbf{m_s = 4\pi r_s R(kgm/m^2)} \tag{2.20}$$

The idea of natural units formed by combining the constants **q**, **c**, and **G** was first suggested by George Johnstone Stoney near the end of the 19th Century. A few years later, Max Planck derived a different set of dimensions using **G**, **h** and **c**. In spite of the fact that resulting magnitudes bear no resemblance to known constants, the Planck length and time have acquired sacrosanct status. As it turns out there are a number of constants that can be combined in ratios that reduce to a single dimension. For example if **G** and **c** are considered constant, they can be paired with known masses to create recognizable temporal and length dimensions. Specifically, if $\mathbf{(M_u)G}$ is the numerator and $\mathbf{c^2}$ the denominator, the ratio reduces to the scale **R** of Hubble radius ($\mathbf{10^{26}}$ meters). If the denominator is taken as $\mathbf{c^3}$, the expression reduces to the Hubble time $\mathbf{T_o}$ (about $\mathbf{10^{17}}$ seconds). When **G** and $\mathbf{c^2}$ are paired with the mass of the electron ($\mathbf{9.1 \times 10^{-31} kgm}$), the unit of space is roughly $\mathbf{10^{-57}}$ meters [on the order of what would be obtained using (2.20) to calculate the black hole radius of the electron].

Since the constancy of **G** is at issue, it is no surprise that the lengths and times created by the ratios $\mathbf{GM_u/c^2}$ and $\mathbf{GM_u/c^3}$ are also variables. Ratios incorporating **G** will, in general, not be constant. The special case of a single mass **M** is an exception where the increase in inertia **M** equals the decrease in **G**. $\mathbf{M_u}$ increases as the square of the Hubble scale per (2.7), so $\mathbf{M_u G/c^2}$ is a changing dimension. Dimensions have meaning in relation to other dimensions.

The Null Universe

Friedmann-Lemaitre-Robertson-Walker (**FLRW**) cosmologies proceed from beginnings that miraculously create the energy content of the universe in a momentary era of explosive violence or rapid expansion.[22] At the other end of the spectrum are the de Sitter and Steady State universes, which have neither abrupt beginnings nor finite endings. What is common to all genesis models is that they depend upon presumptive theories to sell some form of the 'matter happens' portfolio, i.e., a whole lot of something from nothing in a short span of time. The most widely heralded account was proposed in 1981 by Alan Guth. The early universe was hypothesized to undergo a period of rapid growth called "*Inflation*" The mass creating algorithm depended from a vaticination first put forward by William McCrea in 1951, namely that an expanding negative pressure would create positive energy. In Guth's scenario, exponential growth was postulated to terminate after a brief era comprising some 60 fold doubling(s). Thereafter, all forms of energy existed in a hot dense particle soup state from which no light escaped for about 400 million years. This was followed by the decoupling era, freed photons eventually became the comic background radiation (CBR) now observed after 13.7 billion years of expansion. By all indications, decoupling was marked by wild acoustical oscillations (First predicted by the Russian Astrophysicist Sakharov in 1960) which affected the cosmic matter distribution and its subsequent evolution into galaxies and groups of galaxies. All that is known comes from CBR photons and neutrino studies, neither of which provide information as to how the surrounding empty space is performing. At some point during the early history following decoupling, expansion of the luminous forms of matter appears to have slowed, and then later increased. The standard theory fills in the blanks with extrapolations from red-shift and luminosity data provided by photons emitted long ago by galaxies now receding at the speed of light at the Hubble limit. Our concern is with space and how it has moved in the past in comparison to the luminous sources.

As a dis-associated independent event, *Inflation Theory* can be conveniently inserted into the evolutionary time-line without justification for its arbitrary start and end times, and without affecting the underlying expansion model whether it be accelerating, decelerating or constant. All versions of inflationary theory depend from the release of energy during false vacuum expansion, and indeed this mechanism is ecumenically merged into our own genesis scenario which follows naturally from Minkowski expansion and the (**q = 0**) creation parable.

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[22]The evolution of **FLRW** models depends sharply upon initial conditions. For **q** positive and greater than ½, the equations describe a hyperbolic space (infinite extent at the moment of the Big Bang like Athena springing full grown from the head of Zeus in ancient mythology). As an abstract mathematical model, negative curvature is conceptually useful but difficult to accept as a possible description of reality. If **q** is positive and less than **½,** the geometry is spherical (positively curved, finite but unbounded in both space and time). This too is acceptable as an abstract theory and while more palatable than negative curvature, needs bolstering from other theories regarding initial conditions. For **q = zero**, the expansion rate **c** is constant; the cosmos evolves from an undefined origin thereafter expanding forever without limit.

It is important the reader distinguish '*Gradually Acquired Inertia*' from the now discredited '*steady-state*' cosmology originally proposed in 1939 by the German physicist, Pascal Jordan as a scalar-tensor alternative to General Relativity. The basic premise of Jordan's Theory is that new particles are continuously created. The idea was later adopted by Hermann Bondi, Thomas Gold and Fred Hoyle. To its supporters, the argument for little-by-little assumed no more than what is claimed as having occurred in the instant of a Big Bang, and for many it offered esthetic appeal. McCrea's earlier work showing how positive energy would result from expanding negative pressure was applied to justify the hypothesized new particles. The Steady State theory, by its nature, did not depend from a beginning; regulation was by and through expansion-tension interdependence

Controversy between Big Bang genesis and Steady State theory persisted until the Cosmic Background Radiation (**CBR**) was discovered. With no mass creating algorithm in place, the theory succumbed to its critics. What the Steady State chronicle needed was an explanation of the **CBR** and a theoretic that maintains inertial density congruent. By contrast, the theory of '*gradually acquired inertia*' starts with a short, intense, particle creation phase from which all forms of matter descended. The inertial energy of the universe is enhanced as the universe ages.

While General Relativity was developed within the framework of static space, the same equations can be extracted from expanding Euclidean space. When Einstein's constant of cosmological acceleration $\mathbf{\Lambda}$ is combined with the proposition that positive energy density $\boldsymbol{\rho_u}$ equals negative pressure potential, de Sitter's solution is recovered from the Friedmann-Lemaitre equations.[23] Per Appendix IV:

$$\ddot{\mathbf{R}} = -\frac{\mathbf{4\pi G}}{\mathbf{3}}\left[\rho_{\mathbf{u}} + \frac{\mathbf{3P_s}}{\mathbf{c^2}}\right]\mathbf{R} + \frac{\mathbf{\Lambda R}}{\mathbf{3}} \tag{2.22}$$

$$\left[\frac{1}{R}\frac{dR}{dt}\right]^2 = \frac{\mathbf{8\pi G R^2}\rho_{\mathbf{u}}}{\mathbf{3}} + \frac{\mathbf{\Lambda R^2}}{\mathbf{3}} - \frac{kc^2}{R^2} \tag{2.23}$$

In a de Sitter universe where positive energy density $\boldsymbol{\rho_u}$ is balanced by negative gravitational pressure $\mathbf{3P_s/c^2}$ then (2.22) reduces to $\mathbf{\Lambda}$. Substitution for $\mathbf{P_s}$ and $\boldsymbol{\rho_u}$ from (2.2) and (2.3) respectively, then for a ($\mathbf{k = 0}$) universe, (2.22) and (2.23) give:

$$\ddot{\mathbf{R}} = \frac{\mathbf{c^2}}{\mathbf{R}} \tag{2.24}$$

And therefore:

$$\mathbf{\Lambda = 3H^2} \tag{2.25}$$

[23] Although de Sitter's 1917 synthesis was based solely $\mathbf{\Lambda}$, at the time of its debut it was not considered a feasible model since it appeared to be restricted a universe devoid of mass.

Equation (2.25) is Einstein's prescription for static space, specifically at the Hubble limit [$\mathbf{- 4\pi G\rho_u R + \Lambda R/3}$] will equal zero, which corresponds to $\mathbf{\Lambda = 3H^2}$. In Cosmodynamics, the two factors are always in balance because gravity is understood as a reaction brought forth by the cosmological constant $\mathbf{\Lambda}$. If the velocity-distance relationship had been originally construed as an ongoing process, the connective between $\mathbf{\Lambda}$ and G would likely have been recognized as Newton's second law operating on a cosmological scale per (2.24). Instead, Hubble's discovery was generally viewed prosaically as the manifest of accumulating separation distance between nebula that had been set in motion by a single explosive event. The impact of expansion as an ongoing process is yet to be fully appreciated. For $\mathbf{q = -1}$ then,

$$\mathbf{dr/r = H(dt)}$$

The de Sitter's solution is:

$$\mathbf{r = e^{Ht}} \qquad (2.26)$$

Figure 4A

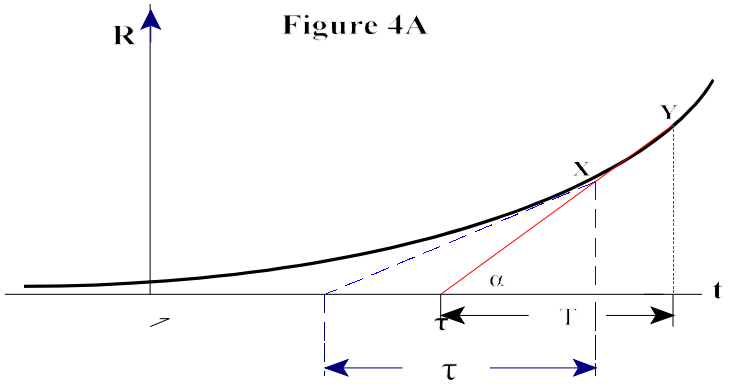


Figure 4A plots cosmic scale R against time for exponential expansion. In the idealized de Sitter universe, the present state of affairs comes inevitably into existence from a past eternal self perpetuating process. "Time" scales are defined in terms of the time constant (the chronological increment measured along the base from a point where the tangent intercepts the temporal axis). The time constant τ measured at any point X is equal to the time constant T measured at any other point Y. In such cosmologies the slope intercept is called the Hubble time, it is nigh equal to the cosmic age in the standard model. The elegant simplicity of the exponential cosmos is appealing. It lacks spatial and temporal intercepts, there are neither maximums nor minimums, no points of inflection, no discontinuities, singularities, nor inflationary interludes, no beginning and no ending. Because the derivative of an exponential function is proportional to the function itself, it is equal to its own derivative. This self similar feature makes it impossible to locate a temporal reference between antithetical infinities.

Exponential radial growth doesn't fit what we think we know about earlier epochs and while it is now generally endorsed as the correct descriptor of the present, the apparent lack of an energy source to power the acceleration needs to be addressed. An alternative to de Sitter's solution can be crafted by taking the volume as the base unit, whence the natural law of geometric progression follows from the existing volume. Still, there is no mechanism to explain why space is growing. The hunt for dark energy continues, and the reason why none is required reserved for Chapter III.

Any force proportional $\mathbf{G\rho r}$ will mimic $\mathbf{F_G}$, so it was logical in the 1916 edition of the General Theory that $\mathbf{\Lambda}$ would debut as a separate and distinct force equal to gravity.

$$\mathbf{F_G = GM/r^2 = 4\pi G\rho_u(r/3)} \tag{2.27}$$

General Relativity correctly predicted the deviation of light and the perihelion shift of Mercury's orbit. But it foretold not, how matter curved spacetime, nor did it offer a reason why $\mathbf{\Lambda R}$ would fortuitously balance $\mathbf{\rho_u G}$. Nonetheless, the cosmological constant and curved spacetime proved to be enduring landmarks even though Einstein's contemporaries were quick to recognize the instability of the delicately balanced universe. Surprisingly, the theory was unmodified until Hubble's work was published more than 10 years later. Einstein construed the discovery of expansion as mandate for doing-away with the cosmological constant. Expanding space explained why the universe had not collapsed, so why, Einstein reasoned, is $\mathbf{\Lambda}$ needed? But instead of self recrimination, celebration should have been the order. Sadly for greatest theorist the world has ever known, $\mathbf{\Lambda}$ would not be appreciated until long after his death in 1955. Einstein's *ad hoc* cosmological constant anticipates what is probably the greatest discovery of the 20th Century. To perfectly cancel gravity, the volume of the universe needed to accelerating at $\mathbf{3c^2/R}$.

$$\mathbf{F_\Lambda = \Lambda R/3 = 4\pi G\rho_u(R/3)} \tag{2.28}$$

From (2.4) and (1.12),

$$\mathbf{\Lambda R/3 = -(-1)3RH^2/3 = c^2/R} \tag{2.29}$$

And the volumetric acceleration is therefore

$$\mathbf{\Lambda R = 3c^2/R} \tag{2.30}$$

THE ACCELERATING UNIVERSE

Spontaneous creation has been a recurrent theme throughout scientific history. While an abrupt beginning of spatial expansion is plausible, it need not include the entire mass of the universe in a single or short term just as it does not include all of space. The sudden appearance of mass-energy out of nothing is discrepant with what is known about natural processes, like Zeus springing full grown from the head of Athena. Nonetheless, the general sentient of the twentieth Century had the more distant galaxies receiving a greater initial boost and therefore traveling farther since the beginning. The model was fortified by the belief recessional velocities were slowed by gravity, and for mainstream cosmology, exponential deceleration was the defacto standard for many years. The all at once matter myth requires the expansion rate to be fine tuned to avoid a quick crash or cosmic runaway.

The constant radial rate universe (**q = 0**) fulfils the requirement for a well behaved expansion algorithm. Based upon the unity of "space and time," the three spatial dimensions increase by **3 x 10^8 meters** each second, and consequently volume increases geometrically. Space is created at the same rate as the Hubble volume, and **G** is a variable per (1.12). The intensity of the negative pressure during the first few jiffies of expansion account for the hot dense particle creation era from which all forms of matter succeed. No special dispensation is needed by way of an inflationary interlude, in fact inertial mass is continuously enhanced by the same mechanism first proposed by William McCrea and later by Allen Guth and others. The (**q = 0**) universe embraces a form of acceleration (volumetric) as a long term proposition.

In 1998 a group of astrophysics, Saul Perlmutter, Brian Schmidt and Adam Riess, undertook to investigate type **1a** supernova data to determine how fast the universe was slowing. The study was based upon the proposition that these bursts could be used as standard candles–the exclamation of identical energies, and therefore of equal brightness and duration. To the surprise of the group, the intensity of the more distant events were fainter than expected; the universe appeared to be accelerating.

The gravitational pressure needed to trigger a supernova was derived in 1932 by the Indian physicist, Subrahmanyan Chandrasekhar, for which he later received the Nobel prize.[24] The critical energy $\mathbf{M_{limit}}$ (approximately 1.4 solar masses) depends upon the factor **(hc/4πG)**. If **G** diminished inversely with the scale **R**, the invariance of the **MG** product speaks directly to the question of whether supernova events were less energetic in the past. If that be so, the evidence for exponential expansion is

[24]A white dwarf star is kept stable by two opposing forces: 1) the electron degeneracy pressure created by nuclear fusion in the heart of the star (making lighter elements into heavier ones) pushing outwards from the core, and 2) gravity pulling inwards. When a white dwarf is locked in an orbit with a companion star, it sucks off matter over time. This increases the gravitational pressure until it overcomes the electron degeneracy pressure. The amount of mass in the core has a special significance called the Chandrasekhar Limit. When the core acquires a mass of approximately 1.4 solar masses, the electron degeneracy pressure is overcome by the pressure of gravity acting upon the core.

vanishes, and so also does the search for dark matter.[25] The irony is that the acceleration factor seems to be required in order to derive the correct value of **G** from (1.5). In other words, exponential cosmological expansion is the auspicate of the declining **G** theory, and its corollary, the doctrine of acquired inertia.

Minkowski expansion produces accelerating volumetric growth, and therefore no mysterious *Dark Energy* is required. We would like to have an experiment that shows **G** was greater in the past. The **1a** data does this, but at the expense of discarding radial acceleration upon which the present value of G is derived.[26]

A larger gravitational acceleration requires less mass to create the same force. Since electron degeneracy pressure is constant, less mass is required to trigger a **1a** supernova event in the early universe. If intensity diminution is the result of less mass rather than greater distance, the theory of accelerating universe is in trouble. But this apparently comes at the expense of our expansion model and having to buy back what was sold as an analytical derivation of **G** based upon **q = (-1)**. The operative word here is "apparently."The idea of spatial expansion uniformly driven by the passage time is compelling If we are to preserve our intuited opinion that expansion is governed by Minkowski space-time coupling through the constant '**c**,' we will be pressed to find a resolution. Interested readers are urged to stay tuned for Chapter III.

EXPANDING FOUR DIMENSIONAL SPACE—A TEMPORAL INTERLUDE

Time as a changing spatial dimension: In **4-D** expanding space, reality takes place in the three dimensions where we experience matter. Changes in an empty 4th dimension (e.g.,$\mathbf{R_4}$) will result in curvature during rapid expansion (expanding negative pressure creates reactionary mass-energy which can puckers flat space into a spherical geometry. The volume of the hyper-sphere $\mathbf{(1/2)\pi^2 R_4^4}$ and its area $\mathbf{2\pi^2 R_4^2}$, lead to the (2.31 and (2.32) for constant rate of expansion:

$$\mathbf{dV_4/dR_4 = (4/2)\pi^2 R^3 \text{ and } d^2V_4/(dR_4)^2 = 6\pi^2 R^2} \qquad (2.31)$$

$$\mathbf{[dV_4/dR_4]/2\pi^2 R_4^2 = 3/R_4} \qquad (2.32)$$

---

[25]As a side note, efforts to explain the present value of **G** in terms of **q = ½** led to much frustration for the author. The discovery of Cosmological Acceleration provided a good fit to the empirical value of **G** based upon standard model consensus $\mathbf{H_o = 71}$. The perception of uniformly expanding **3-D** space as 'time' can be appreciated as a consequence of a changing **4th** dimensionality.

[26]Because the **MG** product is constant, the weight of the mass required to overcome the degeneracy pressure is the same at all eras. When the weight overcomes the electron degeneracy pressure, the white dwarf star collapses with a violent luminous display. Since the electron degeneracy pressure does not change with time, the **MG** pressure required to trigger a supernova event will also be invariant irrespective of the individual contributions of **G** and **M.** A robust **G** during an earlier era translates to smaller **M**, and consequently less energetic events. For the present value of **G**, Chandrasekhar's equation predicts 1.4 solar mass as the critical value.

Let **c = 1** for comparative conversion. Then $\mathbf{c^2}$ also equals **ł**, and **3/R** corresponds to the temporal form $\mathbf{3c^2/R}$, which is recognized as volumetric acceleration divergence per unit area for an exponentially expanding three sphere per (1.6a).[27] In Appendix III, the spatial Bulk Modulus (2.9) was identified with cosmic curvature *a la* the excess radius calculated from General Relativity, specifically $\mathbf{M_uG = (3c^2)\delta R.}$ Therefore $\mathbf{\delta R = R/3}$.

In summary, expansion creates reactionary matter and reactionary matter creates spatial curvature per Einstein. However, it is the acceleration field acting upon the matter created by expansion that causes the inertial reactionary force which brings about the spatial curvature. The process is joint, without the operative action of the spatial acceleration field, there is no mechanism for creating spatial curvature. Assuming the **4-sphere** spatial geometry is adapted per (1.4) with an appropriate radius **(2/3)R**, then for constant expansion:

$$\mathbf{A}_{\mathbf{v}} = \frac{\mathbf{2\dot{R}}}{\mathbf{R} - (R/3)} = \frac{\mathbf{3c^2}}{\mathbf{R}} \qquad (2.33)$$

Uniform expansion of **4-D** space thus leads to the same value of volumetric acceleration as accelerating radial expansion in a **3-D** universe. But to arrive at the correct value for **G**, the 4th space cannot participate in the curvature, i.e., it must be devoid of mass. This would seem to fit the description of what we call "time."

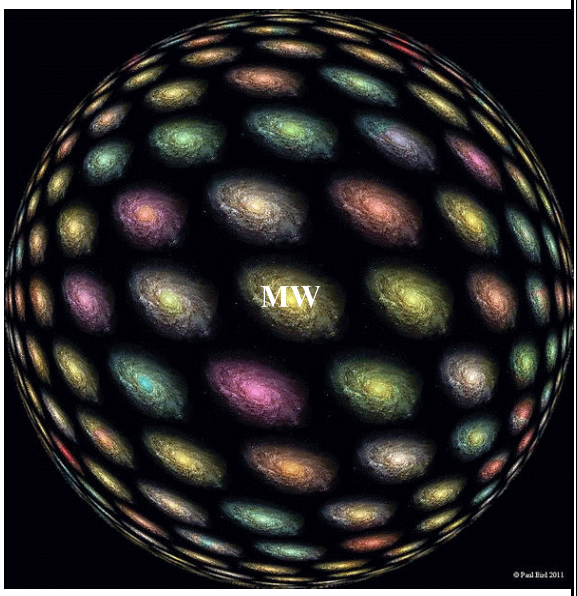
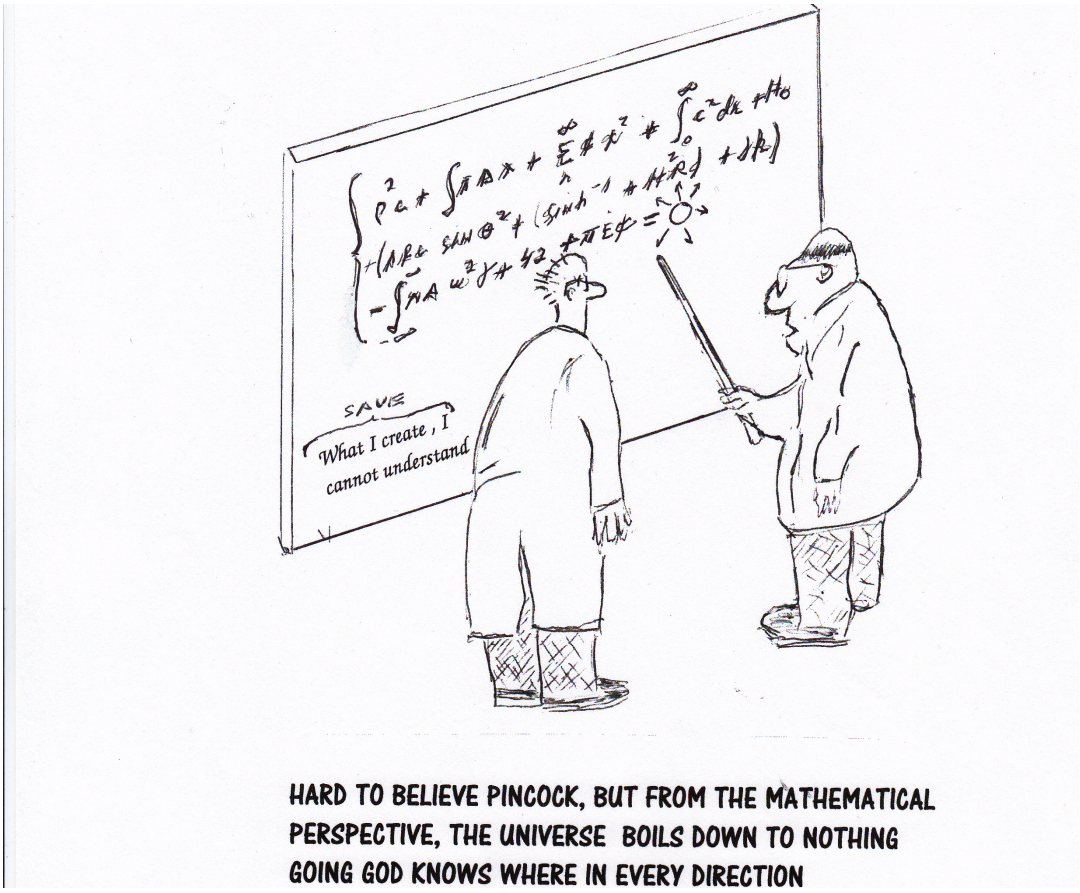


Figure 4B: The perception of our 3-D universe embedded in an expanding four dimensional space. Can the occupants of the 3-D surface distinguish 4-D expansion from temporal change? 3-D curve-landers cannot travel inward toward the interior nor outward to escape just as humans cannot travel backward or forward in time. Measurements made from any location such as the Milky Way, give no clue as to curvature in higher dimensions. All that is known about the expansion of our 3-D space is that it is coupled to the next higher dimension by the constant c.

[27]For a circular area of radius **r** expanding at '**c**' the divergence acceleration of the area per unit of circumference is $\mathbf{2\pi c^2/2\pi r = c^2/r}$, for a sphere of radius **r** expanding at '**c**' the volumetric acceleration per unit of area is $\mathbf{2c^2/r}$ and for a hypersphere of radius **r** expanding at '**c**' the volumetric acceleration per unit area is $\mathbf{3c^2/R}$



HARD TO BELIEVE PINCOCK, BUT FROM THE MATHEMATICAL PERSPECTIVE, THE UNIVERSE BOILS DOWN TO NOTHING GOING GOD KNOWS WHERE IN EVERY DIRECTION

Chapter III

INERTIA

"The readiness with which a body responds to the call of an external force depends on its inertial mass." This law of Inertia, said Einstein, "marks the first great advance in physics; in fact, its real beginning."

The Inertial Field

"Inertia shows us the hand by which matter grips space and space grips matter"
J.D. Ross

In explaining the equivalence of gravitational and inertial mass, Einstein remarked:

"Classical mechanics contains one point which is unsatisfactory in that, in the fundamentals, the same mass constant is met twice over in two different roles, namely as 'inertial mass' in the law of motion, and as 'gravitational mass' in the law of gravitation."

From the insightful recognition that these forms are functionally equivalent, Einstein was able to reduce the mechanics of gravitation to a single equation. Surprisingly, however, he did not derive a physical theory of how inert mass produces gravitational force. Nor does the General Theory of Relativity relate inertial matter to acceleration. In what Einstein described as a "preliminary statement"[1]

"The theory avoids all internal discrepancies which we have charged against the basis of classical mechanics....it allows the treatment of the problem of motion of material points of practically negligible mass in the gravitational field ..it does not take into account the reaction of the "moved" material points on the gravitational field, nor does it consider how the central mass produces this gravitational field."

To complete the specification, Einstein set up a static field equation, the left side of which he referred to as made of "fine marble." It represented the scalar Riemannian manifold which described the geometry of spacetime. The right side he dubbed a "house of straw." It premised matter as the cause. Only after discovering the elegant mathematical beauty of the marble structure did Einstein postulate the relationship between mass and curvature.

In pre-relativistic physics, matter entered classical theory as opposition to changing velocity. Now it takes a new role—an artfully presumed source of static deformation. There is no physical agent to suggests how inert matter influences space and time. This was Einstein's supposal. He was confident about the geometry, but never quite happy with the "house of straw."

In the prescription offered herein, the *principle of equivalence* obviates the need for a new hypothesis conjuring curvature from matter; the present ontogeny unmasks the attraction between masses as inertial counter action. The search for a down-to-earth explicative (pardon the play on words) will lead from creation, to expansion, to reactance, to inertia, to gravity and back to inertia In the end, an old theory is revisited, and a new complexion revealed.

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[1] Albert Einstein, "*Out Of My Later Years*" New York: Bonanza Books, 1989.

Latter-day Cosmology has adopted the **ΛCDM** model (73% Dark Energy **Λ**, 23% **C**old **D**ark **M**atter, and 4% ordinary matter) as the best fit for observational compliance.[2] Underlying the tight constraints upon the ratios is a conviction that the universe is rigidly governed by the General Theory modified by a repulsive force **Λ** that trumps gravity on the global scale. While confidence in the **ΛCDM** model has been bolstered by new experimental techniques, much of the underlying support depends upon yet to be discovered forms of energy and mechanism(s) and a general conviction that density must be critical. Is the universe mostly missing, or is the model fundamentally flawed?

Chapter II left the cosmological constant as the dynamic dominus after pressure and density cancelled. While Einstein's perfectly balanced static universe is incompatible with expansion, it is useful for comparing evolutionary profiles that apprehend from different values of **Λ**. For pictorial purposes, the Einstein universe can be modeled as cylindrical [**Figure 6A**] and expanding space as hyperbolic [**Figure 6B**]. It will be understood that both are depicted as **2-D** structures embedded in three dimensional **x**, **y**, **z** space. Constant time slices taken through a solid cylinder normal to the **Z** axis render as equal area circles ($\mathbf{x^2 + y^2 = r^2}$). In the hyperbolic manifold ($\mathbf{x^2 + y^2 - z^2 = r^2}$), temporal planes (⊥ to the **z** axis) define circles with different areas[3]

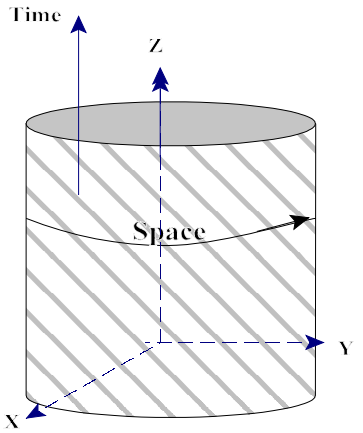

Figure 6A

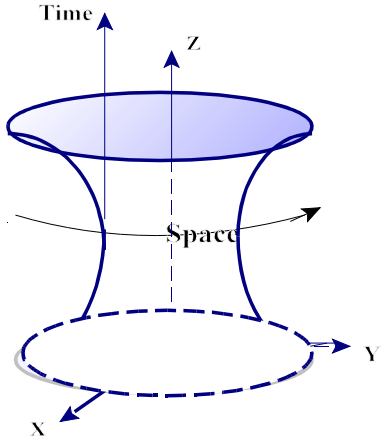

Figure 6B

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[2] The large scale Euclidean geometry of the universe is most clearly evidenced by the temperature topography of the CBR. The amount of luminous matter plus the amount of dark matter required to explain the rotational velocities of spiral nebula is approximated as 27% of the total cosmic mass. To make **Ω** unity as required for flat space, the undetected 73% is postulated to exists as dark energy, alias the cosmological constant **Λ** that drives expansion.

[3]The spatial three dimensional universes, in general, can be imagined as a **3D** volume embedded in flat **4D** space coordinatized by (**x**, **y**, **z**, **w**, and **t**). However, the metric form for specifying spatial geometry in terms of a line element obviates the need for an embedding space. Einstein's static universe as an example, the spatial line element **dl** (the distance between neighboring points in space) can be written as $\mathbf{dl^2 = dx^2 + dy^2 + dz^2 + dw^2 = R^2}$ where **R** is a fixed distance from the origin. By substituting $\mathbf{w^2 = R^2 - r^2}$, the line element becomes $\mathbf{dl^2 = dx^2 + dy^2 + dz^2 + r^2 dr^2/(R^2 - r^2)}$. The metric form specifies the spatial surface in terms of the surface itself.

In both portraitures, a two dimensional section of ambient space at a particular moment is represented by the area of a slice taken perpendicular to the temporal axis. While progressive samples of the Einstein cylinder can only compose as a static closed universe, constant time incisions through the hyperbolic manifold correspond to an initial shrinking phase followed by expanding circular areas as shown in **Figure 7A**. The form first proposed by de sitter was actually mapped on the manifold to comport with Einstein's static universe, but as shown in **Figure 7B**, cuts made at different angles offer a caste of possible geometries which can be closed, flat or open depending upon the obliquity.[4]

Do any of these sections describe physical reality? Can cosmic history be emulated by a single template, and if not, what determines the equation of state and its variations? At some future date it may be proper to ask these as well as the ultimate question of cosmogony–that of how it all started. For lack of sufficient knowledge, we provisionally settle for an extrapolation of the virtual particle parable as a beginning–moderated by the dictates of zero-energy.[5] While observational data does not expressly support the hyperbolic model, neither does it favor a particular theory of creation or past eternal existence. That an infinite **3-D** hyperbolic geometry can be modeled within the auspices of a finite sphere allows hyperbolic space to make its own claim for existence alongside Euclidean space and spherical expansion. But when it comes to apprehending inertia, it is not the shape of space so much as the method of motion, that needs to be addressed.

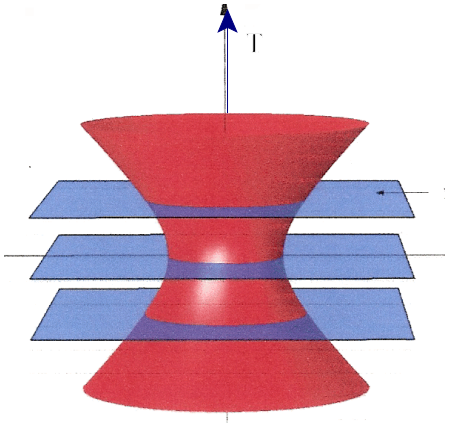

FIGURE 7A

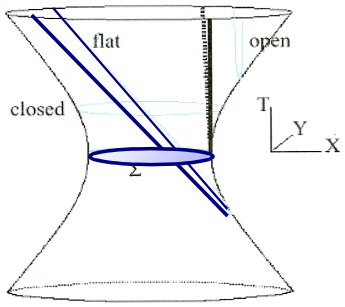

FIGURE 7B

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[4]De Sitter, unlike Einstein, maintained from its inception, that General Relativity required cosmic expansion, an idea later validated by observation and ultimately embraced by Einstein. In their early correspondence, de Sitter proposed a coordinate system mapped on a hyperbolic manifold. In its original form, the spatial sections were static (nothing explicitly dependent upon time) with closed boundaries totally compliant with Einstein's closed universe. But when equally spaced parallel **2-D** planes were sliced through the manifold, the model revealed a time line separation in any spatial plane that increased exponentially with distance. As later conjectured, this property of the hyperbola appeared to fit the mysterious redshifts that had been reported by the American Astronomers, Vesto Slipher and Edwin Hubble.

[5]Science is the art of asking questions at the right time—when they are ready to be answered by careful observation–one step at a time. Nature will not give up its secrets until we have the math and means to ask the questions intelligently.

The credibility of the **ΛCDM** model rests upon the factuality of **Λ**, the yet undetected form of non-luminous energy presumed to provoke exponential expansion. To fit the empirical profile within the interrelated constraints of geometry, density and dynamics, the postulated dark energy (that left over after visible sources and dark matter are subtracted) is wishfully adapted to source cosmological acceleration. Despite numerous theories and experiments designed to reveal it's form and presence, there is yet no direct evidence for a dark energy constituent. Detecting new forms of energy has been a problem for particle hunters, but its absence is benefaction for"an aetherist."

In Chapter II, we suggested an explanation of **1a** supernova based upon the principle of inertial accretion. The symbol **'m'** that appears in the mathematical expression for kinetic energy (**$mv^2/2$**), rest energy (**m_oc^2**), momentum (**mv**), angular momentum (**mvr**), inertial reactance (**ma**), and gravity (**Gm/r^2**), is an acquired characteristic that depends upon the state of the universe–primarily its size. This supposition, as difficult as it is to accept, even for the author, is the only possible synopsis compatible with a zero energy beginning followed by net zero energy balance at all times thereafter. Global net energy is always zero yet the apparition of **$\Omega = 1$** critical density will prevail at all eras. Nothing needs to be fine tuned because negative gravitational energy always balances positive cosmic energy (which must of course include the effective mass of radiation and all other forms of energy).

Traditional beginning scenarios begin with instant mass, or a nearly instant mass generating algorithm. Herein,'*all at once creation,*' is replaced by massless circulatory vacuums spawned during a short period of colossal negative vacuum during the first instant of expansion. More definitively, the legend analogizes the behavior of space to the circulatory behavior of fluids driven by a low pressure atmospheric condition. In the cosmic case, the abrupt transition from temporal interval to space interval seeds angular momentums in form as radiation ultimately becoming the energies from which matter is constructed. As cosmic volume expands, so also does each particles inertial mass in proportion thereto. Increase in the inertial-mass energy of a circulation is matched by a corresponding increase in its negative '**g**' field. For constant expansion velocity '**c**,' the observed diminished intensity of older **1a** events is conveniently explained by the doctrine of gradually acquired energy.

There is popular belief that **1a** data can only be explained as evidence of acceleration. While we will have more to say about this later in this Chapter, it is useful at this point to see if standard interpretation can be fitted to an acceleration which does not depend from dark energy. When positive pressure of inertial matter **$\rho_u c^2/3$** exceeds negative expansion pressure, equation (2.22) reduces to (2.24); the universe shifts gears from (**$q = 0$**) to (**$q = -1$**), to be subsequently ruled by (2.26). Thereafter **H** and **P_s** are invariant. Transition is from a space **S** initially expanding at uniform velocity '**c**' with increasing inertia to accelerating divergence having constant inertia. Conservation of momentum and energy follow from Newton's 2nd law, expressed symbolically as:

$$\mathbf{0 = \int F \bullet dS - E_G = \int \left[m_u \frac{dv}{dt} \right] \bullet dS + \int \left[v \frac{dm_u}{dt} \right] \bullet dS - E_G} \qquad (3A)$$

where **S** is the spatial volume of the Hubble Sphere, **dm_u/dt** is the rate of change cosmic inertia and **E_G** is the negative gravitational energy contained within the volume **S**. A change of either velocity or mass creates force. The integral **$\int m_u(dv/dt) \cdot ds$** will be identified with de Sitter expansion and **$\int c(dm_u/dt) \cdot ds$** Minkowski expansion. During adolescence, expansion velocity is Minkowskian, so **$dv/dt = 0$**. After some seven billion years of uniform growth, the Hubble experienced a mid life crises. The magnitude of negative pressure created by uniform radial dilation diminished (The change in volume per unit of volume [**$(dV/dt)/V = 3c/R$**] for the Hubble sphere). To maintain zero energy, space

must accelerate to balance the steady loss of positive energy matter exiting across the now fixed Hubble horizon. For the emblematic expression (3A) to comport with the zero energy mandate, the operative mode must change. When $\rho_u = 3p_s/c^2$ per (2.22), expansion accelerates per (2.26).

In an exponentially expanding universe, the Hubble term **H** is fixed, and the Hubble radius is constant, so the observable universe coincides with the limit of communicability.[6] Accelerating expansion maintains negative pressure energy in balance with the current energy $\mathbf{M_u}$. During uniform expansion, inertia increases and entropy decreases. During exponential expansion, mass is lost across the Hubble horizon, so entropy increases.

The transition from uniform expansion to accelerating expansion brings both observational and physiological changes. In **q = 0** expansion, the observer sees all luminous objects in the universe. There are neither particle nor event horizons. In an exponentially expanding universe, the Hubble sphere becomes an effective horizon. Any galaxy now beyond the Hubble sphere had in the past a part of its world line inside the Hubble sphere, and was therefore observable at some stage of our history, and while all galaxies, except the gravitationally bound local group, recede and pass over the Hubble boundary, the observer continues to see the lost objects, but with increasing redshift.

If **dS** is allegorized as a line element **ds**, the integral of $\mathbf{c(dm_u/dt)(cdt) = m_uc^2}$ and the integral $\mathbf{(M_u)(dv/dt)ds}$ can be formulated as $\mathbf{M_u(c^2/R)\int ds}$ where **ds** is taken over the distance from zero to **R**, and therefore the two expressions define the same energy. The acceleration phase begins with the inertial mass of the universe maximized at $\mathbf{M_uc^2}$ where it would remain except for the fact that matter is now carried away by the galaxies escaping across the Hubble limit. No dark energy is needed to power the acceleration, the universe remains in balance at net zero before and after transition because each loss of positive energy results in a corresponding loss of its negative energy **g** field. .

General Relativity is silent as to how matter acquires inertia as well as the nature of the spatial structure that must distort to compliment the theory. Herein, force fields are spatial accelerations. Extra space is not created by exponential expansion, there is no space to be disposed of or accounted for. Space has meaning only in the similitude of accelerating motion. Empty space is always empty, but a volume defined by a region of accelerating space is a force field.

When isotropic expansion is thwarted by expansion resisting objects, the result is an increase in negative pressure (called the local **g** field although it extends to **R**). What mimics as an active source is but an inertial reaction acceleration to global isotropic expansion. In the full circle melody played out within these pages, the gravitational *provocateur* is also the inertial *accommodator.*

Since Newton's 2nd law **(d/dt)(mv)** is operative for each dimension, then [$\mathbf{c = \Delta S/\Delta T}$]

$$\mathbf{m_u(dv/dt) = (m_u)c^2/r = -v(dm_u/dt)} \qquad (3.1)$$

where $\mathbf{m_u}$ represents the positive cosmic mass energy at any time (**t**) and lower case **r** is a time

[6]Cosmology, the Science of the Universe, Edward Harrison, Cambridge university press, 2003 at page 453. It can also be argued that the inertial energy gained during uniform expansion is gradually lost across the Hubble horizon when expansion goes exponential. Expelled particles take their negative energy '**g**' field with them, but not immediately. The gravitational field(s) left inside the Hubble sphere weakens as the gravitational sources move further away. The Hubble losses $\mathbf{[\rho_u(4\pi R^2)c]}$ **kgm/sec** or $\mathbf{[12\pi Rc]c^2}$ joules of positive energy per second which must be balanced by an identical expenditure of negative gravitational energy. Since the entire mass of the universe is involved in the acceleration, the energy required to drive the $\mathbf{3c^2/R}$ acceleration engine is $\mathbf{[(3c^2/R)M_u]ds/dt}$, which for **ds/dt = c** per (1.8c). This corresponds to the same rate of energy $\mathbf{(12\pi Rc^2)c}$ lost each second across the Hubble horizon.

dependent variable [$\mathbf{r = f(t)}$]. The time dependent gravitational constant $\mathbf{G(t) = c^2/4\pi r}$ is:

$$\mathbf{m_u G(t) = 4\pi r^2 (kgm/m^2)(c^2/4\pi r) m^2/kgm = - rc^2} \tag{3.2}$$

This takes us back to, Robert Dicke, and in this authors opinion, his well reasoned suspicion that global inertial mass $\mathbf{rc^2}$ always equals gravitational mass $\mathbf{G(m_u)}$. But (3.2) has two interpretations: 1) Expansion increases the inertial property of existing matter by extending the volume of the gravitational field, or 2) it creates new particles. As the reader should expect, the first option is endorsed without hesitation. Acquired inertia is foundational to our theory. No new physics is required and no novel process need be fabricated to justify the creation of new particles.

For a sphere dilating at constant radial rate "**c**," the ratio of volumetric change to volume $\mathbf{\Delta V/V}$ is $\mathbf{3c/r}$. Stress intensity will be greatest when **r** is smallest (as opposed to inflationary scenarios which proceed as geometric doubling). There is no need for an *ad hoc inflationary* beginning or end. Positive matter energy is a seeding consequence of infinitesimally short but intense start-up stress. This accommodates photon creation in the first instant, followed by palliating stress and amalgamation of electrons and positrons therefrom. Further stress reduction follows as the "nuclear synthesis" phase.

To recap, in traditional inflation scenarios, volumetric expansion increases geometrically. In the constant '**c**' dilation model, volumetric growth per unit area diminishes inversely with radius as does the strength of the **G** field per its dependence thereon. [For an electron sized virtual particle beginning, the size of the universe changes from $\mathbf{10^{-15}}$ meters to $\mathbf{3 \times 10^8}$ meters in one second (23 orders) and the volume changes by a factor of $\mathbf{10^{69}}$]. Net cosmic angular momentum is zero as well as net energy even though individual hubs exhibit both angular momentum and positive energy.

Herein, the physics of a beginning are considered only to the extent necessary to provide a plausibility for the present, and our objective of showing how the '*now*' rate of expansion determines gravity and inertia. There are many theories of creation. We adopted the $\mathbf{q = 0}$ universe as a "start-up" condition. It has no singularity; the rapidly expanding false vacuum leads to the creation of positive matter without help. Although the "hand of God" may be at work, it need not furnish any assistance.

For a start-up "kernel' $\mathbf{r_o}$ (the classical electron radius) and energy uncertainty force is:

$$\mathbf{A_n \Delta E = F = (c^2/r_o)(\Delta E)} \tag{3.3}$$

where $\mathbf{\Delta E}$ is the borrowed energy needed to transition a virtual particle to existence.[7] From (3.1):

$$\frac{\mathbf{dm_u}}{\mathbf{m_u}} = -\frac{\mathbf{dv}}{\mathbf{dt}}\left[\frac{\mathbf{1}}{\mathbf{v}}\right]\mathbf{dt} = -\left(\frac{\mathbf{dv}}{\mathbf{v}}\right) \tag{3.4}$$

[7] Quantum fluctuations permit transitory entities called virtual particles to come into existence ex nihilo. To satisfy Heisenberg's Principle, the energy $\mathbf{\Delta E}$ temporarily borrowed from nothing must be paid back within the time increment $\mathbf{\Delta t = h/4\pi(\Delta E)}$. While the existence of a short-lived subatomic particle briefly violates conservation of energy, there is no extended energy debt. The more energy a virtual particle has, the shorter its existence. To balance negative and positive energy the volume must expand at the velocity of light when the energy is repaid Once a **3-D** virtual particle is activated as an expansion mode, a zero energy universe follows.

For $\mathbf{m_u}$ and **v** both greater than zero, then $\mathbf{\ln(m_u) + \ln(v) = 0}$. Global momentum is zero for some velocity **v**, but velocity relative to what? While uniform motion wrt space has no physical significance, there is an intriguing interpretation of (3.4) that follows from the orthogonal coupling between space and time. If (3.4) is a true statement about the universe, then '**v**' refers to something other than motion wrt space. The idea of rest mass energy and relative velocity lead to the notion of matter in motion with respect to '*time.*' At-rest in free space can be mused as ageing at the rate **c**, and the designation of a mass as $\mathbf{m_o}$ brings to mind traveling in time at rate **c**. Time dilation in the context of inertia is causal. While velocity is motion with respect to space, ageing is analogous to motion with respect to time. Motion wrt space increases energy. Motion wrt time increases inertia. Aging rates alter inertia:

$$\mathbf{F = m_o(dv/dt) \neq m_o(dv/d\tau)}$$

where **t** is the rate of passage of time in the rest frame and $\boldsymbol{\tau}$ is the rate of passage of time in a relatively moving frame. From the perspective of the rest frame, mass will exhibit a greater resistance to acceleration if the $\boldsymbol{\tau}$ time runs slower so $\mathbf{dv/d\tau}$ is larger than **dv/dt**. Likewise, an inertial effect follows when mass is subjected to the '**g**' field accelerations of nearby matter. But there is difference. In the first case, motion is relative to a local frame deemed to be at rest. Inertial change due to relative velocity is just that, relative, whereas acceleration involves temporal changes where both observers agree upon which clock runs slow. For relative velocity differences, the observed resistance to further acceleration subsides when relative velocity is reduced. Acceleration is referenced to the temporal frame of the zero energy universe, any increase in inertia by way of local acceleration can be transformed away when referenced to a co-accelerating rest frame. Rest mass inertia, by contrast, is defined by the accumulated '**g**' field which depends from the ongoing action of expansion.

While an unbalanced inertial reactance can be identified with the '**g**' field of nearby matter, it cannot be distinguished from an actual inertial increase in a direction opposite to the '**g**' source nor can it be distinguished from an inertial reduction measured in the direction of the '**g**' source. What then is there that is common between the two inertia(s)?

All accelerating motion can be referenced to a cosmological rest frame of the universe. When a clock is centrifuged, the centripetal acceleration $\mathbf{v^2/r}$ reduces the clock rate by the same factor as that calculated using Special Relativity [(8b-1) infra]. Time dilation in Special Relativity depends upon relative spatial velocity. Time dilation resulting from acceleration changes inertia. The two effects are linked just as space and time are linked. The state of a centrifuged clock with velocity **v** and a clock aboard a spaceship traveling at speed **v** are equivalent because from the earth taken as a rest frame the same amount of energy has been invested.[8] It should come as no surprise to the reader that since both clocks lose the same amount of time with respect to stationary clocks on the earth, they will keep perfect time wrt each other. Time dilation in S.R. does not always correspond to relative motion.

[8]In viscus fluids, stress is allied with "strain rate." Dynamic spatial surfaces, being neither viscous nor substantive, correspond to "strain-rate-of-change." Since $\mathbf{\rho_u = (3/R)kgm/m^2}$, pressure is relative acceleration multiplied by surface density $\boldsymbol{\sigma}$. The counter pressure normal to the surface of a uniform sphere will be $\mathbf{\sigma c^2/R}$. Taking the earth as a two sphere, $\mathbf{\sigma_e = 1.17 \times 10^{10}\ kgm/m^2}$ and **R** is $\mathbf{1.08 \times 10^{26}}$ meters so $\mathbf{c^2/R = 8.33 \times 10^{-10}\ m/sec^2}$, the resulting dynamic pressure at the earth's surface is $\mathbf{9.8\ ntn/m^2}$. Since $\mathbf{9.8\ m/sec^2}$ corresponds to the "**g**" field at the same radius, we see the two factors as one in the same, that is $\mathbf{m/sec^2 = ntn/kgm = ntn/m^2}$ In words, dynamic pressure = acceleration.

In the beginning there was nothing,
And God said: "Let there be Light"
And still there was nothing,
But you could see it.

Theories conjured from the creation and absorption of virtual particles and hypothetical gravitons do not predict the magnitude of the forces they were invented to describe. By contrast, expanding space-time offers internally consistent predictions within the limits of its predications.

Figure 7E illustrates the connectivity between a spatial section and a temporal increment.[9] Aging is presumed to proceed at a constant rate.[10] **S** represents a two dimensional section of a **3D** surface with **T** (time) normal to the point **P** on the **X-Y** coordinate grid. Space growth is indicated by the $\bar{\mathbf{a}}$ and $\bar{\mathbf{e}}$ vectors. **P** is a point on the **S** surface–every other point on **S** will also experience the same growth in the **X** and **Y** spatial dimensions. This illustrates the dynamic modulus in two dimensions of a three dimensional universe. The volume is designated as an **X-Y** surface **S** where the third dimension **Z** is suppressed. **S** thus grows at an accelerating rate. If **S** is a section of the putative Hubble surface, the length of the line drawn from an observer "**O**" to any point on **S** is the Hubble scale. The dynamic acceleration modulus is the acceleration of the volume divided by the spatial area,

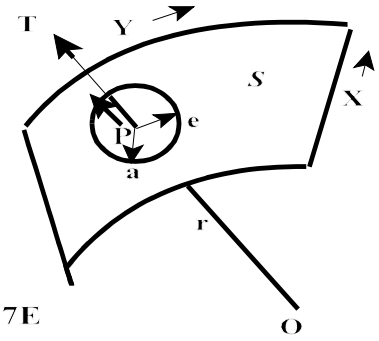

Figure 7E

In both flat and closed geometries, volumetric spatial acceleration will be the result of growth in three spatial dimensions, **X**, **Y** and **Z** (not shown). The a and b vectors illustrate the components of acceleration in the **S** surface.. If **P** represents a positive density locale, temporal distortion also occurs normal to **S** (along the line O-T) in the time domain. This is the time dilation corresponding to slowing of clocks in a G field.

[9]The idea that photons must be massless is predicated on the presumption that inertia increases to infinity as relative velocity approaches "**c**." But this speed limit of Special Relativity is the result of how time intervals are measured in relatively moving frames. Photons are not governed by the rules of ordinary matter because they are transported by the temporal rate **c**. Captured in "time." offers up the notion that photon mass resides as angular momentum temporal transport.

[10]The actualization of Minkowski's relationship is depicted **i**n two dimensional space with "Time" progressing at velocity at velocity ($\sqrt{-1}$)**c** orthogonal to the **X-Y** spatial plane. Temporal change as causal agent of cosmological expansion is illustrated by the **a** and **b** vectors in the **X-Y** plane. Special Relativity demands that the composite Pythagorean interval of space and time distances be equal to the interval **c(Δt)**. A temporal interval **Δt** converts to a space interval **c(Δt)** in each of the three dimensions of space.

Minkowski referred to spacetime as the world. A progression of Events are described as world points joined together as a history line. Interactions between world lines define the geometric relationships that make up the laws physics

<u>Figure 8A: "Inertia-Gravity" Reciprocity:</u> To simulate the global G field, the four corners of the fabric are accelerated upwardly. The inertial reaction of M slows time and stresses the accelerating spatial fabric (observed as the reactionary 'g' field of M). The 'g' field influences the trajectory of nearby objects as well as its own resistance to acceleration. The temporal well created by M's resistance to spatial acceleration is the measure of its inertia as defined by the volume of its 'g' field. Extricating M from its spaciotemporal depression (the 'at rest' state), requires an external force. Temporal rate and spatial acceleration are indicated by side arrows.

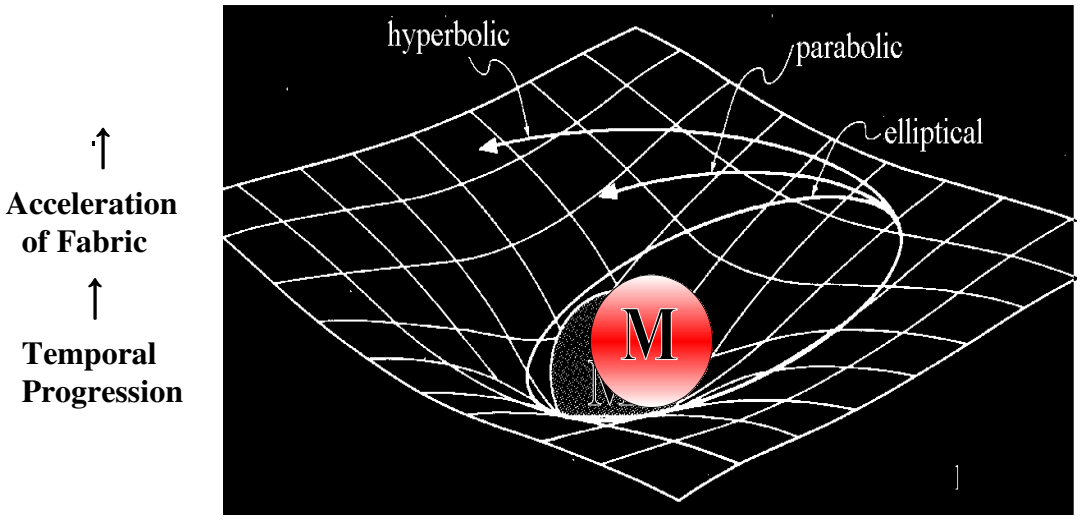

Figure 8B: Gravitational time dilation for a uniform spherical mass M of radius 'r.' At any distance 'd' normal to its surface, the depth of the temporal well is given by the escape velocity √2GM/(d+r). As is the case with in Special Relativity (Appendices 10 and 20), gravitational time dilation can be referenced to a kinetic state of present existence wrt the zero energy universe.

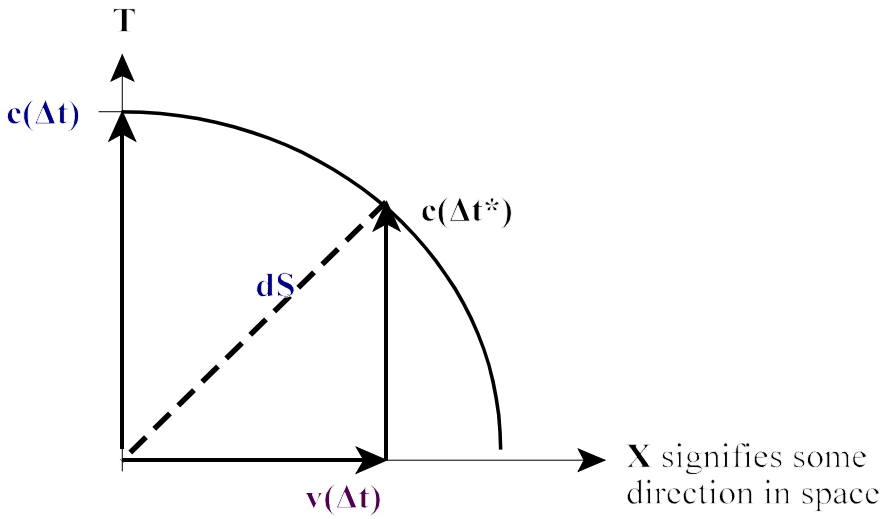

Figure 8B *illustrates how a temporal increment (***Δt****) measured by a non-moving clock in a gravitational field can be transformed to a space-time Pythagorean composite* **dS = *cΔt*** *in the isotropic CBR rest frame of the universe. The spatial increment (**vΔt**) is the distance traveled by space moving toward the gravitational source at the escape velocity **v** relative to the isotropic CBR rest frame and **c(Δt*)** is the distance defined by the temporal increment measured relative to a clock in the CBR rest frame. From the principle of interval invariance (the interval of the space-time composite is equal in all frames) then:*[11]

$$\mathbf{dS = c\Delta t = [(v\Delta t)^2 + (c\Delta t^*)^2]^{1/2}}$$

and therefore $$\mathbf{\Delta t^* = \Delta t\,(1 - v^2/c^2)^{1/2}} \qquad \textit{(8b -1)}$$

Gravitational time dilation for a spherically symmetric mass **M** *of radius* ***r*** *at any distance* ***r*** *or greater takes the same form:*

$$\mathbf{\Delta t^* = \Delta t\,(1 - 2GM/rc^2)^{1/2}} \qquad \textit{(8b -2)}$$

Now **2GM/r** *is the square of the escape velocity* $\mathbf{v_s}$ *at distance* ***r*** *from the mass center so:*

$$\mathbf{\Delta t^* = \Delta t(1 - v_s^2/c^2)^{1/2}} \qquad \textit{(8b-3)}$$

The velocity $\boldsymbol{v_s}$ *is the gravitational equivalent of the kinetic condition of matter falling from infinity. If* ***M*** *were concentrated at the Hubble limit and allowed to collapse upon itself, it would reach a velocity* $\boldsymbol{v_s}$ *at radius* ***r*** *. The convergence from free fall to black hole extinction is prevented by the internal electrical forces that bind atoms together and push them apart .*[12] *From (8b.2) the final state takes form as the* ***g*** *field of a spherical mass* ***M*** *of radius* ***r*** *where the potential of what would otherwise be a kinetic convergence of matter at velocity* ***c*** *is reduced to a gravitational field that corresponds to the escape velocity* $\boldsymbol{v_s}$ *at the surface of* ***M****. The temporal increment* ***Δt**** *of (8b-3) thus fits the kinetics of the Special Theory as well as the gravitational field of the General Theory. In summary, the velocity potential apprehends as the acceleration of space. Just as gravitational and inertial mass are atoned by equivalence, so also are the kinetic and potential fields that derive therefrom.*

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[11] In Special Relativity, any non accelerating frame is called an "inertial frame" and any "inertial frame" is as good as another. The increment **Δt** measured in the frame taken to be at rest is called the proper time and the length **v(Δt)** measured in the same frame is called the proper length. A clock moving at uniform velocity "**v**" relative to a rest frame clock accumulates less time. But two relatively moving clocks cannot each run slower than the other. In actuality, neither clock is running slow, but because a proper distance was laid out in the frame taken to be at rest, less time is accumulated by traversing the distance in the moving frame. Time is dilated in Special Relativity because space and time are unified and the measurement of one involves measurement of the other. Note, it is convention to set up the equation in terms of the temporal and spatial distances measured in the frame of the moving clock. The spatial increment measured in the frame of the moving clock is **vΔt*** so the square of the temporal distance in the rest frame $\mathbf{(c\Delta t)^2}$ is obtained by subtracting $\mathbf{(c\Delta t^*)^2 - (v\Delta t^*)^2}$

[12] The compression of matter to neutrons and then further into black hole non-existence might be imagined as a large shell of neutrons that reach **c** velocity at $\mathbf{r_s}$.

To continue the "inertial inquest," we look once more to Einstein's insight, specifically his principle of "Relative Acceleration." Special Relativity denies the existence of preferred frames; in the featureless void there are no landmarks for anchoring a coordinate reference. Uniform motion with respect to space was posited by Einstein to be undetectable. But what about accelerated motion? Are not the forces felt by objects undergoing velocity change an indication of commutating absolute motion? While working out his theory of General Relativity, Einstein explored the properties the universe must possess to prevent the determination of absolute motion in the case of accelerating reference frames. After discovering the unity of inertial and gravitational mass, he reasoned that these properties could not be locally intrinsic; something global was involved. What followed, was the concept of relative acceleration...the force felt by the crew of an accelerating rocket ship is no different than that experienced by the same crew at rest in a universe undergoing unidirectional acceleration.

Einstein speculated that time and space could be described in terms of curvature, but he needed a way to connect matter. To embrace Mach's idea *post hoc* appeared to require what Einstein called "spooky action at a distance."[13,14] There being no available physics for relating geometry to mass, the want was resolved by turning the problem into a postulate.[15] The equation relating curvature to matter is now regarded as an epic theoretical achievement. Yet Einstein himself considered the connective with skepticism. Tossing all forms of energy into the right side of the equation as the source of spacetime curvature was *ad hoc,* and quickly recognized as needing correction. The subsequent introduction of a Cosmological Constant Λ in 1916 solved one problem while creating another. As then viewed, the new factor left the universe precariously balanced between run-away expansion and collapse. Yet Einstein made no further attempt at resolution, the fate of the universe was left in limbo. In 1916, the significance of Λ could not have been appreciated; expansion was yet to be discovered. **G** had established an empirical place in Einstein's General Theory and it needed a theoretical *ad hoc* balancing factor Λ.

So where does that leave Machian mechanics? The matter field of Mach predicts acceleration as does cosmological expansion. The question is whether matter and/or lumps of matter are necessary, inasmuch as we have already discovered a uniform isotropic global acceleration field that originates without matter.

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[13]In present day cogitates, expansion is perceived as spatial foliation simultaneously affecting all parts of the Hubble universe. Thus, although the transmission speed of gravitational changes is presumed to be finite, reactionary forces will nonetheless be instantaneous if the cosmic acceleration field is a global dynamic function of the universe. Nonetheless, it would be imprudent to dismiss the influence of distant sources, and the collateral implications that out local conditions are the affect of masses at earlier times and other locations. The field do to a distant gravitational source not vary with time even where the **G** source no longer exists. The same is true for accelerations, the center of mass is unchanged between mutually interacting bodies.

[14]General Relativity evolved from 1911 to1917 as an expression of Einstein's theory of gravity. The 1916 equations described a gravitationally unstable universe unless it were either expanding or contracting. To his credit, Einstein inquired of astronomers as to whether there was any evidence of motion that could be interpreted as global expansion. Unfortunately the significance of the red shifts observed by Hubble, Slipher and others, were not then appreciated

[15]The failure of the Michelson-Morley experiments to detect the earth's motion through the ether could be explained if the local speed of light were always measured to have the same value. Einstein's explained the null result by hypothesizing just such a fix

. New Implications Of An Old Idea

The Nineteenth Century physicist, Ernst Mach, proposed that "Newtonian Forces" are the result of other matter rather than the constitutional endowments of empty space. Though the Principle has many interpretations, we will take it to mean that "inertial reactance" is due to the totality of matter in the universe. Einstein was influenced by this idea, and initially attempted to incorporate it as a rudiment of General Relativity. He later changed his perspective (probably because Mach's Theory ostensibly required instantaneous action-at-a-distance).

The schema that distant matter determines local inertia was likely first expressed by Bishop Berkeley in a work published in 1721. Newton's view of absolute space was vigorously attacked by Berkeley, who labeled it a "sideless box" with no physical properties, and by itself was emptiness and therefore nothing. Instead of an absolute space of independent existence, Berkeley invoked a "sky of fixed stars." Mach embellished upon this notion, suggesting that an object's inertia increases only slightly as additional mass is added to the cosmos, and that the measured value is the result of the sum total. Let us examine Mach's and Berkeley's ideas in the light of what we think we know.

Both Mach and Einstein rejected the idea of inertial reactance as an internal property of matter. Neither, however, progressed much beyond conjecture. To admit a cosmological source within the predicate of Mach's principle, we must take the path not taken by Einstein. If local inertia is presumed to be the result of the gravitational influence of other matter, each item of energy will depend upon the totality of the whole with the impetus fully collateralized by the Principle of Equivalence.[16]

In the physics of General Relativity, it is not possible to locate gravitational stress as pressure applied to a particular area or surface, nor is it possible to assign coordinates that quantify the energy density of a spatial void. Newton's second law takes these cabalistic(s) into account wherever found and in whatever form. It is the universal aspect of Newton's law of gravitation and his law of reactance that brings about a new interpretation of expansion.

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[16]There are several popular theories advanced to explain Inertia:

a). Inertia is an intrinsic property of massive bodies unrelated to any other aspect of the universe.

b). Gravity is the source of inertia. The argument turns on the assumption that distant matter acts on local matter with a force inversely proportional to the distance. To honor the principle of equivalence, the proportionality factor must be artificially adjusted. The theory also demands the coupling be instantaneous. John Wheeler, Dennis Sciama and others have sought to explain this in terms of the forward-reverse wave theory originally developed by Dirac, Feynman and Wheeler (a theory originally concocted to resolve the inconsistencies of point-like electrodynamics)

c). Inertia is related to curvature and consequently geometrodynamics. The reasoning is somewhat circular since General Relativity does not explain curvature - it assumes it and provides a hypothetical construct based upon the presence of matter. There is no dynamic that explains the forces felt by test particles when they deviate from the geodesic.

d). The zero point field proposes inertia to be a local interaction with a quantum field. Its advantage is that it avoids the problem of instantaneous coupling, but it also makes no predictions as to the magnitude of the force–ergo ad hoc tuning is needed and a lot of it.

Analysis resumes with the homogeneous universe illustrated in **Figure 3B** redrawn and embellished upon as shown in **Figure 9**. The gravitational force acting upon the non accelerating Hubble centered particle $\mathbf{M_j}$ for any shell of thickness **dr** at radius **r** is zero. $\mathbf{M_j}$ therefore experiences no force and therefore no acceleration. There is, however, an isotropic gravitational attraction between $\mathbf{M_j}$ and the totality of all forms of energy $\mathbf{4\pi r^2(dr)\rho_u}$ that make up the mass of the shell.

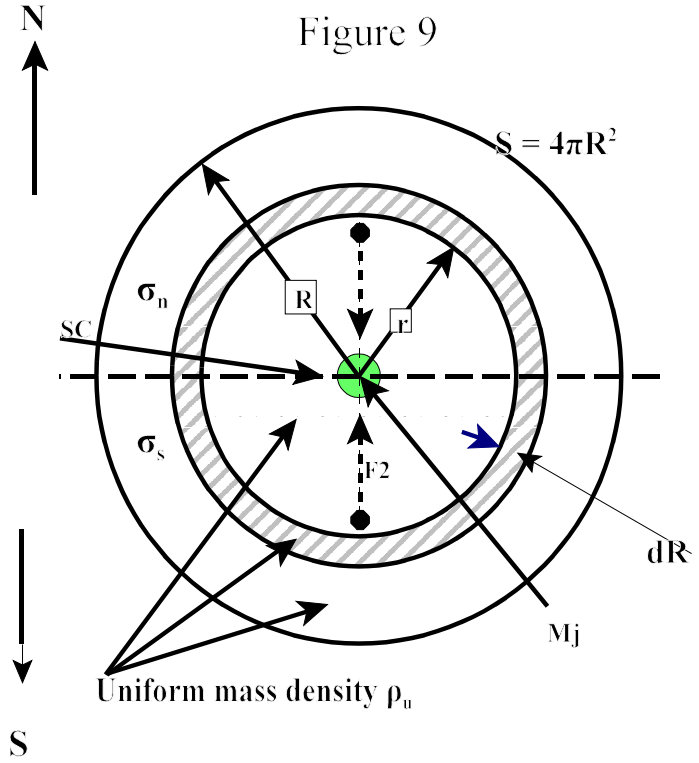

Figure 9 shows a central mass $\mathbf{M_j}$ centered within a spherical shell $\mathbf{S_s}$ of uniform energy density $\mathbf{\rho_u}$. If $\mathbf{M_j}$ is not accelerating, the net gravitational force due to all matter contained within $\mathbf{S_s}$ will be zero irrespective of its location and velocity with respect thereto.

All matter contained within a shell $\mathbf{S_s}$ of thickness **dr** is attracted toward $\mathbf{M_j}$ and each elemental volume of $\mathbf{S_s}$ exerts a **G** force upon $\mathbf{M_j}$. If $\mathbf{M_j}$ is at-rest (or uniformly moving), the net force is zero and therefore the state of $\mathbf{M_j}$ is unaffected. In a homogeneous universe the **G** field between $\mathbf{M_j}$ and $\mathbf{S_s}$ is radially symmetric. The contention to be assayed is whether the inertial reactance of $\mathbf{M_j}$ can be related to this field.[17] If all accelerations are equivalent, then the radial **G** force between $\mathbf{M_j}$ and $\mathbf{S_s}$ due

[17] The premise is based upon the idea that reactive inertia is due to the gravitational field of all matter within the communicable sphere which must be overcome to maintain $\mathbf{M_j}$ in "dynamic" equilibrium during unidirectional acceleration.. It follows from the interpretation of Einstein's principle of relative acceleration wherein a counter force is postulated to emerge if the universe is accelerated with respect to $\mathbf{M_j}$.

to matter in a shell $\mathbf{S_s}$ is:

$$\mathbf{F_{Ss} = M_j M_s(G)/r^2 = G[M_j(\rho_u)(4\pi r^2)dr]/r^2} \tag{3.5}$$

For a uniform density universe, the convergent field intensity added by each shell of thickness '**dr**' is independent of the radial distance'**r**'of the shell from $\mathbf{M_j}$, ergo each spherical shell of thickness **dr** and density $\boldsymbol{\rho_u}$ will contribute equally to the gravitational stress intensity. The central mass $\mathbf{M_j}$ will thus experience the composite **G** field of all shells. If the Hubble scale is **R**, the isotropic inertial force $\mathbf{F_I}$ per unit of central mass is:[18]

$$\mathbf{F}_I = \int_0^{\mathbf{R}} \frac{\mathbf{M}_J(\rho_u)(4\pi)\mathbf{r}^2(\mathbf{G})\mathbf{dr}}{\mathbf{r}^2} \tag{3.6}$$

The field intensity is then:

$$\mathbf{(F_I)/M_j = (4\pi)(\rho_u)(RG)} \tag{3.7}$$

This is the isotropic stress $\boldsymbol{\sigma_G}$ due to all energy within the Hubble volume acting upon unit mass $\mathbf{M_j}$. From (2.3), $\boldsymbol{\rho_u G = 3H^2/4\pi}$, so:

$$\mathbf{(F_I)/M_j = 3H^2R = 3c^2/R} \tag{3.8}$$

Equation (3.8) leads to the same acceleration flux as that derived in (1.6a) for massless accelerating space. Each local inwardly directed **g** field is the result of the cosmological expansion field pulling outwardly upon non expanding particles that make up the mass of the Hubble universe. $\mathbf{M_j}$ like all other particles wherever located, is subjected to the same stress as the mass **M** shown in **Figure 2**, and each counters in kind in proportion to its mass. The gravitational effect of the scattered masses throughout the universe opposes the primary acceleration field of empty space (by analogy, the counter emf induced by rotating motors is in the opposite direction of the primary electric field that brings about the rotation). In this, the local **g** field of each mass operates as an inwardly directed counterpoise in opposition to spatial expansion. But are the two fields equal and therefore totally cancelling? In the electrical analog, back emf is never equal to the primary voltage because friction and other losses must be overcome. But space is a perfect fluid. If the initiating $\boldsymbol{\Lambda R}$ force is $\mathbf{3H^2R}$ per (1.6a), and the gravitational counter force is $\mathbf{(-4\pi G\rho_u R)}$, then the total force $\mathbf{F_T}$ **is**

$$\mathbf{F_T = (-4\pi GR\rho_u)/3 + 3H^2R/3 = 0} \tag{3.9}$$

[18] If we pursue Mach's Principle as the cause of inertia, then building the mass of the universe from successive shells of uniform density leads to a simple cosmological density function. Conveniently. the result is the same if the successive shells are each merged into the first since all shells affect the magnitude of the Hubble center equally. Moreover, it makes no difference whether the shells are merged or layered. In this manifesto, it is the dynamic elasticity of the encompassing Hubble universe that is posited to resists acceleration. Mass can be viewed as one entity internally connected with itself through the universe, and the causal mechanism opposing velocity change is one-in-the same as that which causes gravitational attraction. What is new is the recognition that distant matter yields the same result as the local acceleration field $\mathbf{c^2/R}$ and therefore no time is required to provoke reactions. By this reasoning, gravity and inertia are instantaneous. Mach's theory can be revisited as a pseudo local theory that makes reaction instant–or at least coincident with a local affect, and therefore no longer requiring eons of travel time to make the presence of distant actions felt.

Einstein took aim at a static state, and introduced a cosmological constant Λ to preserve that condition [(See 2.22–2.25) and the discussion thereof]. But because **G** is a consequence of Λ, dynamic equilibrium resulted. The universe is coasting, the expansion rate **c** is constant and therefore ($\mathbf{q = 0}$). The universe is only static from the perspective of momentum and energy which remain constant and equal to zero. Expansion creates gravity and opposes the expansion field to maintain the status quo.

To initiate expansion, the universe required a boost (initially the cosmos was empty, so the de Sitter formalism would be in play as an initial condition of the void). If the gravity field of evolving inertial matter completely checked Λ, net force is zero, and consequently so is acceleration. The only condition that allows both functions to simultaneously exist is the **q = zero** universe. What at first appeared to be a redundant derivation of the global field in terms of Mach's Principle, can now be seen as crucial to the determination of the expansion rate. The driving potential is de Sitter like, but because of the contradiction of inertial matter, force is zero. Things in motion stay in motion unless acted upon by a force. Diminished intensity of older super nova is best explained as higher **G** acting upon less mass. The road from Newton to Einstein to Mach comes full circle back to Newton.

Both cosmic density ρ_u and **G** disappeared from (3.8). What is left after substituting $\mathbf{3H^2/4\pi}$ for $\rho_u\mathbf{G}$ in (3.7) is the precipitate $\mathbf{3c^2/R}$, devoid of mass and gravity, the imperatives of Mach's Principle. Present in the formative, but eliminated in the final expression, 'Mach's perspective' could easily have bene dismissed as an unnecessary interlude. But if there were no gravitational stress due to distributed inertial matter, could a universe evolve into shining stars, planets and people? The answer to this contains the medicament of our existence.

The factor $\mathbf{H^2}$ concatenates inertia, time, gravity and expansion to the coefficient of mass energy **m**.[19] In (3.8) the units are cast in terms of $\mathbf{m/sec^2}$ whereas if pressure and density are considered foremost, inertia is easier to appreciate in units of **ntn/kgm**. The local gravity field of $\mathbf{M_j}$ as the counter action of global acceleration poses no conceptual difficulties. But inertia as a manifest of the local '**g**' field created by inertial reaction, requires a bit of cogitation. The asperity of classical physics, is the **m** factor, met first as the inertial coefficient of reactance **(d/dt)(mv)**, then as the energy transform resolved from temporal progression *a la* $\mathbf{m_oc^2}$ and thirdly as a component of the gravitational equation $\mathbf{Gm/r^2}$. Mass ranks with space and time as a cardinal dimensionality of the universe, but what is it?[20]

To claim mass is energy is to beg the question. Energy is not a substance, it is a condition, a state of existence. It takes many forms, heat, light, potential ....but they all reduce to the kinetics of relative motion. The initial kernels of inertia were contained in the rotational structures formed in the first jiffies of expansion.[21] Angular momentum quantum(s) imbued as newly created rotational energy hubs are resistant to expansion. The rest state of a particle is only a mask, the expansion dynamic is always at work knocking at its structural integrity which manifests as reactance in the form of a counter '**g**' field. This is the continuous action first appreciated by Newton and later by Einstein.

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[19] In the history of classical mechanics since Newton, time rate of change of momentum (**dp/dt**) was regarded as the definition of force by some, whereas the space rate of change of energy (**dE/dx**) was considered the rudiment by others.

[20] For purposes of calculating local inertia per (3.7), the **m** content can be considered to reside in a single shell at any close distance. Likewise, whether a mass $\mathbf{M_j}$ is uniformly distributed over a concentric spherical surface of radius "**r**" to create a surface density $\boldsymbol{\sigma}$ or redacted to a point, the faraway field is the same.

[21] One Jiffy is the time required for light to travel a distance of one fermi, 10^{-23} seconds

Mass finds its place in the broken symmetry of a universe gone ballistic.[22] Whatever the correct ontology, the dimensional units of the universe are three in number, units of space, units of time and units of mass-energy.[23] The idea is illustrated graphically in Appendix II by treating the surface area of the earth as a **2-D** plane in balance with the acceleration flux impacting the Hubble manifold.[24] (This could, of course, be any object; the earth was selected because its size and mass are well known.)

In the space, time, matter trilogy, the mechanical and electromagnetic properties of the vacuum merge. Permittivity (capacitance per unit length symbolized as $\boldsymbol{\varepsilon_o}$) and permeability (inductance per unit length symbolized as $\boldsymbol{\mu_o}$) determine the propagation velocity **c** as $\mathbf{1/[(\mu_o)(\varepsilon_o)]^{1/2}}$ In actuality, the relationship between space and time '**c**' determines $\boldsymbol{\varepsilon_o}$ and $\boldsymbol{\mu_o}$. Unification depends upon the nature of the medium, but its properties are quantified by the space/time ratio '**c**.' Spacetime accommodates mechanical and electrical phenomena within the same forum because they are related by '**c**' squared.

In his noteworthy address at Leiden University on May 5, 1920, Einstein left no doubt about his opinion that space exhibited all the attributes of a propagation medium, save one: "The idea of motion cannot be applied to it." This is a natural and necessary proviso of spacetime unity. In substantive mediums such as air and water, propagation velocities are slow, space and time are orthogonal so the passage of time can be recorded by appropriately placed clocks separated by proper distances measured in a frame taken to be at rest. In unified spacetime, the dimensions by which motion is measured (distance/time) create a problem; the examination of one with respect to the other becomes circuitous. Uniform motion within the ambit of the Special Theory is a mensuration

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[22] In the pre-Hubble era, the null universe is taken as postulation, the initial energy state is uniformly zero. Give it what cause we will, at some point, "length" and "time" are forced to share the universe with a 3rd dimensional player "mass," which takes form in chucks distinguishable from the average energy density of the void. To maintain zero global energy, high density spaces must be balanced by negative potentials (the '**g**' field of the '**m**' chunks). All of which leads us back to the root question, what determines '**m**?'

[23] The historical criticism of Mach's Principle as dependent upon the time required for the influence of distance matter to be locally sensed would seem to be unwarranted. A shell of mass $\mathbf{M_u}$ in contact with $\mathbf{m_j}$ will produce the same force per unit mass as an array of nested shells of density $\mathbf{3/R(kgm/m^2)}$ filling the Hubble sphere.

[24] In resisting isotropic disintegration, particles create a counter reaction to the expansion field. When the mass of $\mathbf{M_j}$ is distributed uniformly over the surface area $\mathbf{4\pi r^2}$ the local surface density $\boldsymbol{\sigma}$ defines the intensity of the **g** field at any radius r greater than the circumscribed volume of the mass. Integration of the **g** field over the area of the surface density $\boldsymbol{\sigma}$ gives the isotropic reactive force $(\mathbf{M_j})\mathbf{g}$. This force is equal and opposite to the cosmological force, specifically the pressure defined by the momentum flux ($\mathbf{c^2/R}$ multiplied by the Hubble surface density $\mathbf{M_u/4\pi R^2}$). From equation (2.7) the Hubble Mass $\mathbf{M_u}$ is $\mathbf{(4\pi R^2)kgm/m^2}$, so the Hubble surface density is conveniently **ne kgm/meter^2**, which looking backward would have to be the case for the units of Newton's transform. Appendix II illustrates the idea for the special case of the earth with the cumulative isotropic **g** field projected normal to the putative Hubble and $\boldsymbol{\sigma}$ surfaces. Specifically, the free space acceleration is multiplied by the ratio of the local surface density to that of the Hubble surface density. For the earth ($\mathbf{M_e}$ **=5.98 x 10^{24} kgm**) and ($\mathbf{r_e}$ **= 6.37 x 10^6 meters**). The surface density $\boldsymbol{\sigma_e}$ is $(\mathbf{M_e/4\pi(r_e)^2}$. Since the Hubble surface density is **one kgm/meter^2** the acceleration pressure at the earths surface is as we previously determined:

$$\boldsymbol{P = Hc(5.98 \times 10^{24}kgm)/4\pi(6.37x\ 10^6meters)^2 \approx 9.8\ ntn/m^2} \qquad (3.9)$$

dilemma. Inertial reactance requires interaction. Einstein concluded, the concept of an ether superfluous to the mensuration processes in Special Relativity. In the General Theory, however, acceleration and related energy issues implicate reactive space.

While the properties of space are ignored in Special Relativity, the electrical characteristics of the vacuum and their dependency upon Λ are inextricable related to isotropic spatial expansion.[25] As later developed, the initial character of matter as angular momentum not only provides the kernel which resists expansion to kick-off the inertial acquisition phase of Hubble expansion, it also provides the environment for the evolution of the electric field. Our version of what Steven Hawking convokes as *model dependent reality* is three dimensional spatial rotation.[26] As an adjunct, the recognition of **3-D** spatial vorticity leads to the proposition that resolves the angular momentum puzzlements identified by Stern and Gerlach during their 1921 experiments.[27] Richard Feynman was so troubled by these perplexities as to call the enigma a contradiction of logic.[28]

In Chapter II, we derived the free space pressure $\mathbf{P_s = -\rho_u c^2/3}$ (equation 2.5) a dynamic modulus $\mathbf{Y_d = 3c^2/R}$ (equation 2.10), cosmic density $\mathbf{\rho_u = (3/R)}$ (equation 2.4) and the Bulk Modulus $\mathbf{\beta_d = c^2/R}$ (equation 2.9), all based upon expansion. For a classical medium, the velocity of propagation $\mathbf{v_p}$ is equal to the square root of the modulus divided by the density. then:

$$\mathbf{v_p = [Y_d/\rho_u]^{1/2} = c} \tag{3.10}$$

From Maxwell's equations,

$$\mathbf{v_p = [1/\varepsilon_o\mu_o]^{1/2} = c} \tag{3.11}$$

[25]Photons and radio waves exhibit paraxial angular momentums. By contrast, electrons and positrons exhibit three dimensional angular momentums.

[26]Model Dependent Reality is a term coined by Stephen Hawking to describe a philosophical approach to scientific inquiry based upon the notion our brains interpret sensory data by constructing a mental model which, if successful, we humans embrace as reality. The theory asserts there is no meaning to the model itself accept its usefulness. Different world pictures that describe the same observations equally can lay equal claim to validity. There is no requirement that the picture be complete or unique–the universe may be describable by overlapping world pictures and in the area of overlap, equally valid models may exist.

[27]To change the direction of one angular moment component, means changing the direction of all other angular momentums intrinsic to the particle. The electric field accords with temporal motion at velocity **c** and the magnetic field, being equal in influence when relative motion is measured at rate **c**, equates to spatial velocity. Photon angular momentum, however, being confined to a single plane of rotation orthogonal to the axial direction of motion, the observed wave can be related to the sinusoidal vestige of interaction between the spatial properties μ_o and ε_o. Since there is no component of angular momentum parallel to the direction of motion, the propagation impedance of free space is resistive. The factors μ_o and ε_o thus interrelate the constant **c** with the characteristics of planes perpendicular to the direction of propagation.

[28]"It is a shocking and peculiar thing...there isn't any descriptive way of making it intelligible that isn't so subtle and advanced in its own form that it is more complicated than the thing you were trying to explain...Understanding these matters comes very slowly, if at all ...the most shocking and disturbing thing about quantum mechanics is that if you take the angular momentum along any particular axis you will find that it is always an integer or half integer of **h**" (Feynman, Lectures On Physics)

Since $\mathbf{Y_d}$ is the inverse of the dynamic compressibility $\mathbf{k_d}$, then the relationship between the mechanical and electrical expressions is:

$$\mathbf{k_d \rho_u = \mu_o \varepsilon_o} \tag{3.12}$$

The Free Space impedance $\mathbf{Z_o}$ is:

$$\mathbf{Z_o = [\mu_o/\varepsilon_o]^{1/2}} \tag{3.13}$$

The ratio of the dynamic Bulk Modulus $\boldsymbol{\beta_d}$ to the vacuum pressure $\mathbf{P_s}$ is:

$$\mathbf{\beta_d/P_s = [c^2/R]/[- \rho_u c^2/3] = 1\ m^2/kgm} \tag{3.14}$$

Having come full circle, we arrive again at "Newton's Transform." Consider then a further twist of his second law in the context of the syllogism previously proposed: Taking '*time*' to be a functional operator:

$$\mathbf{\int F \cdot dS = [(d/dt)(mv)]dS = [m[dv/dt] + v[dm/dt]dS} \tag{3.15}$$

Substitute **ds = c(dt)** to improvise an expression for the "rate of change of energy" in the temporal domain. Specifically:[29]

$$\mathbf{Energy = \int F \cdot dS = \int m(dv)ds/dt + \int (v)(cdt)dm/dt} \tag{3.16}$$

$$\mathbf{= \int mvdv + \int vc(dm)} \tag{3.17}$$

In the first integral **"v"** is the variable and "**m"** is constant. This reduces to the kinetic energy of a mass **m** in motion with respect to the frame of the observer i.e., $\mathbf{mv^2/2}$. In the second integral, mass is the variable of integration and velocity is constant (since uniform velocity is the equivalent of 'at rest'). The velocity which is constant in all frames is **c**, therefore for measurements made in the rest frame of **m**, **v** should be taken as **c** which is already contained in the expression. For temporal progression **t** and **m** at rest (designated as $\mathbf{m_o}$,) the above (3.17) becomes:

$$\mathbf{E_T = mv^2/2 + m_o c^2} \tag{3.18}$$

which is the total energy of a particle of rest mass $\mathbf{m_o}$ traveling at velocity **v**.

The dimensionality between space, time, and reactive force is uniquely determined. Each is embraced within the workings of a single global organic defined by the zero energy mandate from which conservation laws succeed. The actual units chosen are immaterial, whether **c** is expressed as meters per second or furlongs per fortnight, the harmony of the universe is contained in the space/time ratio. The constant '**c**' is a component of other constants, including the properties of space as an electromagnetic medium and the dimension-less ratio alpha.

[29]Except in rocketry and propulsion science, the first integral gets all the attention as **F = ma**
In the cosmological sense, however, the notion of variable mass is an curious notion.

Energy is a condition that has meaning with respect to itself in relation to the universe. it is a state defined at a particular place and time. The ratio '**c**' connects space and time, and $\mathbf{c^2}$ connects mass to energy.

Creation theories reduce to scenarios founded upon the production of a whole lot of something from nothing in a short amount of time. The idea of quick creation is inconsistent self creation. Gradually acquired inertia is a palatable parable that abrogates the patchwork conflations of the standard model. The appeal of graduality doesn't end with the equanimity of its space-time sponsors, nor in the elegant simplicity of its initial implementation. The doctrine of acquired inertia starts with a violent expansion, but it is a self adjusting negative feedback evolution. Inertial hubs (angular momentum spaces) disburse with expansion to assure global homogeneity. In the '*fixed inertia*' fairy tale, the features must turn-on and off with precise timing ...any change in the operation of a functionality would cause newly created inertial compositions to quickly collapse unto themselves. For these early formatives to co-move with space, they must be massless or nearly massless. And this brings us back to Mach's Principle. Mach's principle is synergistic but regulated. The inertia of matter is increased by the gravity of other matter which increases the inertia of the first. The early universe is populated with kernels of rotational space which '*mass-up*' as the volume of their **g** fields grow, but since inertial mass must, by the principle of equivalence, be gravitational mass, the mass of the one is embraced in the mass of the other.

The gravitational constant was developed by considering the mass of the universe uniformly distributed over a surface of radius **R**. This surface density was considered a convenient force producing instrumentality that imitated the cosmological acceleration factor $\mathbf{c^2/R}$. But the correct model of the universe is not a two sphere shell. It is the uniform density 3-sphere (**Figure 9**), with a **G** field defined by integration over the volume as given in (3.6). The reality of three dimensional mechanics demands the size of the Hubble sphere be related to the factors provoking volumetric distribution of matter. The radius $\mathbf{R_3}$ for a homogeneous three sphere was derived from energy considerations namely the difference in energy between a two sphere $\mathbf{U_2 = (1/2)M_u{}^2G/R_2}$ and the energy of a three sphere $\mathbf{U_3 = (3/5)(M_u)^2G/R_3}$. Now if it takes a time $\mathbf{T_2}$ for a two sphere universe to expand to radius $\mathbf{R_2}$ at the velocity of light, and it takes a time $\mathbf{T_3}$ for a three sphere universe to expand to a radius $\mathbf{R_3}$ at the velocity of light. The **G** calculated for the three sphere universe is built into the Machian model (which is based upon a uniform density three sphere). While the mass of individual gravitational entities does not appear significant, the collective reaction of uniformly distributed inertial matter is vital to the regulation of the expansion rate. The changing relationship between mass, gravity, inertia and scale are testament to an underlying harmony we can only dimly perceive. In the words of Edward Whiten:

"The great ideas of physics have geometric foundations."

Like all things sought to be explained at a fundamental level, matter, space, time, and gravity defy individual definition. In a zero energy universe, the collective reactance of all positive matter balances global acceleration to zero. That which has separated out of nothing to take form as positive $\mathbf{mc^2}$ energy is at once the source of negative counter reaction derived from the $\mathbf{m(c^2/R)}$ product. Negative energy potential always equals positive matter energy, both the field and source obtain from the same coefficient "**m**." As previously noted and reproduced here again, Einstein's response when asked to summarize General Relativity in one sentence:

> ***"Time and space and gravitation have no separate existence from matter ...Physical objects are not in space, but these objects are spatially extended."***

Self emergent theories of fields and forces are not new. But they have always been a dangerous proposition that provoked theologians. The preservation of his own life was most likely the motivation for the guarded language and credit artfully bestowed upon the creator in every sentence of this 17th century manuscript:

> **"...the action by which he (GOD) now sustains it is the same with that by which he originally created it; so that even although he had from the beginning given it no other form than chaos, provided only he had established certain laws of nature and had lent it his concurrence to enable it to act as it wont to do, it may be believed, without discredit to the miracle of creation, that in this way alone, things purely material might, in the course of time, have become such as we observe them at present; and their nature is much more easily conceived, when they are beheld coming in this manner gradually into existence, than when they are only considered as produced at once in a finished and perfect state."**
>
> **Rene Descartes (1637)**

A First Course in Creation Theory

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CHAPTER IV

ELECTROMAGNETICS

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"WHIRL IS KING"

ARISTOPHANES, FOURTH CENTURY, BC

THE ELECTROSTATIC FIELD

"Our experience hitherto justifies us in believing that nature is the realization of the simplest conceivable mathematical ideas"

"A theory should be as simple as possible, but not simpler"

Albert Einstein

Many of the worlds great scientific truths are based totally upon mathematical description. The extraordinary results have left the originators obliged to admit of some mysterious and intimate connection between the physical world and its abstract mathematical counterpart. As Einstein queried in his "Sidelights on Relativity (Now available as a free '**e**' book download):"

"Here arises a puzzle that has disturbed scientists of all periods. How is it possible that mathematics, a product of human thought that is independent of experience, fits so excellently the objects of physical reality?"

As far as mechanism is concerned, the history of electromagnetic theory is like that of gravitation and inertia. Faraday had introduced the artifice of a field to explain the interaction between magnetism and electricity, and Maxwell surpassed all previous mathematical machinations in embracing a variety of seemingly diverse phenomena to describe electromagnetic waves.[1] Hertz was quoted to have said:

"Maxwell's theory consists of Maxwell's equations. One cannot escape the feeling that these equations have an existence and an intelligence of their own, that they are wiser than we are, wiser even than their discoverers, that we get more out of them than was originally put into them."

Maxwell set the tone of modern theoretical physics.[2] His equations provided a correct description of electromagnetic waves despite the absence of a physical description of the medium.

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1. Maxwell originally tried to arrive at a physical theory of wave propagation in terms of pressures and tensions in an elastic medium—as did Hertz, Thomson and Poincaré.

2. Even Faraday, the man who was perhaps the most gifted in constructing physical analogies, confessed he could not understand Maxwell's equations, and in a letter in 1857 asked Maxwell if he could "translate them out of their hieroglyphics that we might also work upon them by experiment." Unfortunately, Faraday's request remains unfulfilled to this day.

Spatial Circulation As Causal

To predict electrical action between charged particles in terms of classical principles, the operative impetus must produce repulsive and attractive forces that exceed the gravitational affect of mass-energy by factor of $\mathbf{10^{42}}$. Guided by Einstein's prescription of *"**nature as the realization of the simplest conceivable mathematical ideas**,"* the quest for the electron begins where gravity concluded, namely with the kinetic vitality of empty space the source of inertial reactance. A static void is nothing, and nothing is without influence and incapable of detection. But no such state exists, the volume of any sample of empty space is accelerating, and it is the volumetric divergence thereof that brings about the long range forces of nature.

The simplest electric particles (electrons and protons) have characteristic spin [$\mathbf{h/4\pi}$] which suggests circulation. Spin appears as a quantified property of many subatomic particles, and in the case of electrons and positrons, both the rest mass $\mathbf{m_o}$ and charge **q**, are also quantized. But if charge, spin and mass are mutually related, any theory of "electric force" must take into account entities exhibiting spin without charge and those having charge with non measurable angular momentum(s). It will prove expedient to postpone discussion of the differences**,** and focus instead upon the simplest complex of spin, charge and mass, namely the entity that manifests as an electron. The question is whether 'charge' is a fundamental entity, in and of itself, or alternatively, an unrecognized complection of something already known but masterfully disguised?

The charge **q** of electrons and positrons is defined as $\mathbf{1.6 \times 10^{-19}}$ coulombs. The energy to assemble this charge as a spherical surface of radius $\mathbf{r_o}$ equates to a rest mass $\mathbf{m_o}$ of $\mathbf{9.1 \times 10^{-31}}$ **kgm** where $\mathbf{r_o = 1.41 \times 10^{-15}}$ **meters** (½ the classical radius $\mathbf{r_e = 2.82 \times 10^{-15}}$ **meters**). Electrons, protons, neutrons, neutrinos and a variety of other subatomic entities, exhibit intrinsic angular momentum spin $\mathbf{L_s = h/4\pi = \hbar/2}$ = (**0.53 x10^{-34} joule sec**) along any axis of measurement.[3] This spin (and multiples thereof) is not possible to understand from the perspective of rotating mass since the magnitude of the angular momentum $\mathbf{\hbar/2}$ corresponds to peripheral velocities greater than '**c**' based upon $\mathbf{m_o}$ and $\mathbf{r_o}$. Moreover, the types of particles exhibiting $\mathbf{\hbar/2}$ angular momentum vary widely in characteristics. The inability of "modern physics" to explain quantized angular momentum in terms of rotating matter suggests charge be explored as a form of spatial action rather than mass-in-motion.

Despite its successes, the 'standard model contains many *ad hoc* values not predicted by the theory. To quote Roger Penrose: "...the standard model is clearly not the 'ultimate answer..." Our study of the electron begins with the recognition and acceptance of space as operational. Theory must ultimately lead to an inverse square field, and predict both the magnitude and direction of the force between like and unlike charges. Finally, the model must produce accelerations exceeding $\mathbf{A_n}$ (equation 1.6) by 42 magnitudes. Dirac's ratio $\mathbf{r_o/R \approx 10^{-42}}$ now becomes more than a curosity.[4]

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[3]The actual spin is a three dimensional composite which is always equal to $\sqrt{3}/4\ \hbar$. Along any axis of measurement the spin will be either $\mathbf{+\hbar/2}$ or $\mathbf{-\hbar/2}$, hence the nomenclature 'half-spin particle.'

[4]Carl Sagan: "There is an idea--strange, haunting, evocative-one of the most exquisite conjectures in science or religion..an infinite hierarchy of universes, so an elementary particle, such as an electron, would, if penetrated, reveal itself to be an entire closed universe. Within it, organized into the local equivalent of galaxies and smaller structures, are an immense number of other, much tinier elementary particles, which are themselves universes at the next level, and so on forever–an infinite downward regression, universes within universes, endlessly. And upward as well. Our familiar universe of galaxies and stars, planets, and people, would be a single elementary particle in the next universe up, the first step of another infinite regress.

If massless angular momentum space can be analogized to linear momentum of massless photons, we are immediately led to a model of the electron as rotating space. Specifically, at this stage, it will be presented as vortical in nature, and devoid of mass.[5] Let us extemporize a three dimensional mathematical construct—endow it with peripheral velocity **c** at radius $\mathbf{r_o}$ and temporarily, for the purpose of derivation, insert a concentric inertial factor $\mathbf{m_o}$ (usually labeled $\mathbf{m_e}$ but for reasons to follow, herein labeled $\mathbf{m_o}$) to represent the electron mass as shown in **Figure 10**.

Figure 10 shows a cross section taken through the center of our metaphorical construct illustrating the key aspect of space-mass interaction, namely the influence of rotating space on a concentric spherical mass $\mathbf{m_o}$ diminishes linearly with distance.[6] The mass $\mathbf{m_o}$ will be later identified as the rotational energy contained in the circulatory field.[7] To tie this abstraction to the electric force, it is necessary to again invoke Einstein's principle of "relative acceleration." From the standpoint of reciprocal action-reaction, the electrical force at any point **P** must take into account three planes of rotation and the directional circulation of each. If $\mathbf{m_o}$ is to represent the total inertial energy of the circulatory complex about the point **P**, it must functionally couple therewith. A"massless" rotational space obviates the need for centrifugal internal restraints to prevent destruction.[8] From a theorem due to Stokes:[9]

$$\int_{2\pi r} v \cdot dl = \iint_{S} n \cdot \text{curl } v \; dS$$

$$\mathbf{F_r = m_o c^2 / r_o} \tag{1.4}$$

From whence

$$\mathbf{2\pi r_o c / \pi r_o^2 = 2c / r_o = 10^{-23}\ sec^{-1}} \tag{4.2}$$

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[5]During emission of photons due to orbital transitions of electrons in atoms, the angular momentum of the atom must change, and therefore the photon itself exhibits both angular momentum and linear momentum. The classical analogue is found in the angular momentum $\mathbf{L_s}$ ascribed to circularly polarized electromagnetic waves. For an energy **E**, the angular momentum of a circularly polarized wave is $\mathbf{E/\omega}$ where $\boldsymbol{\omega}$ is the angular frequency $\mathbf{2\pi\nu}$. When combined with the quantum formula $\mathbf{E = h\nu}$ the result is that every photon, irrespective of frequency, has the same angular momentum $\mathbf{h/2\pi}$ but no measurable mass.

[6]The idea of electrons and positrons as three dimensional **c** velocity spatial circulations will be central to our derivation of the electric force. At this juncture the circulation is depicted as vortical to simplify the model, which must account for the diminishing influence of spatial circulation upon the angular momentum reflexed to the central mass $\mathbf{m_o}$ at larger radial distance. This is more fully developed in Chapter V and illustrated in **Figure 14**.

[7] Stokes Theorem declares the line integral of the velocity vector around a closed contour to be equal to the integral of the curl over the surface bounded by the contour. More simply, in the case of circular rotation, the velocity at each small segment of circumferential length **dl** is summed over the total path length $\mathbf{2\pi r}$ and divided by the enclosed area $\boldsymbol{\pi r^2}$. The result is the average value of the curl, or circulation.

[8]This same concept applies on the large scale. Co-rotational space can partially account for the velocity profile of stars within the galactic disc. Less **G** force is required if the relative velocity between the stars and their local space is reduced.

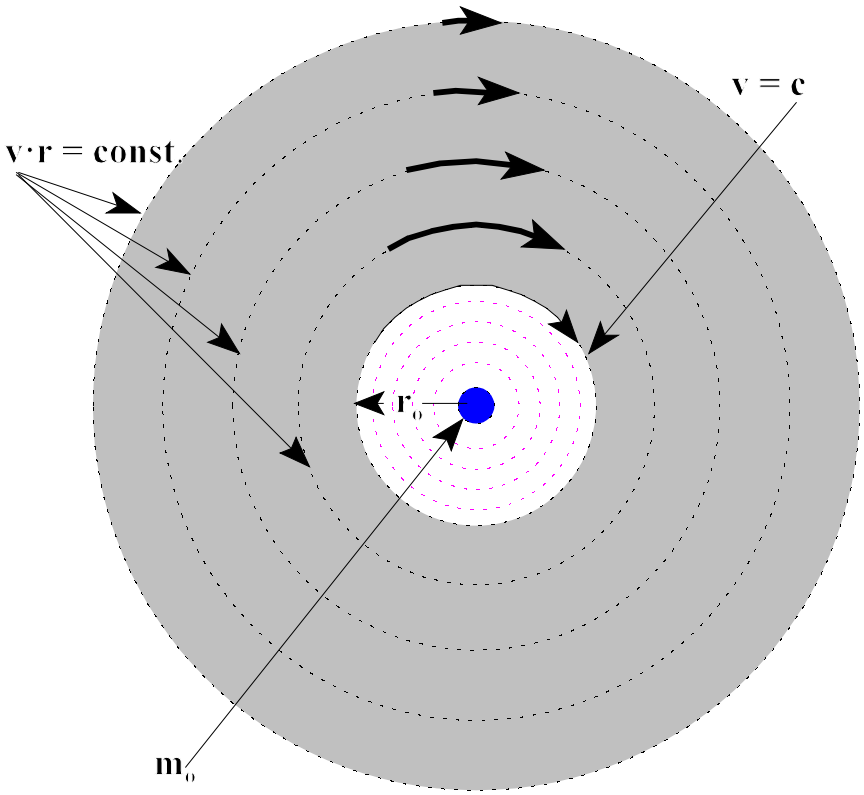

Figure 10. When circulatory flow takes place about a point mass in a perfect fluid a "free" or "mathematical" vortex is created. The velocity distribution in the vortex is given by the relationship v·r = Constant. Since the integral around any closed curve which includes the center equals $2\pi rv$, the circulation 'C' will be $2\pi C$ for all paths which include the center, and zero for all contours which do not include the center. The rotational properties of a free vortex are thus reflexive to its center, a point where the velocity is maximum and the radius is zero. However, the universe does not license unlimited speed—in the case of electrons and positrons, the angular momentum has a limiting value $m_o c r_o$ which defines the coupling of the rest mass m_o to the rotational velocity of space c at the radius r_o. The attractive force between rotational space and the positive energy m_o is therefore $m_o c^2/r_o$. Per equations (4.5) and (4.6) this corresponds to the Coulomb force $k_e q^2/2r_o^2$ at the same distance.

Adverting again to **Figure 10**, the motion field is depicted as a free vortical circulation with velocity increasing toward the center of curvature until it reaches maximum orbit speed **c** at radius $\mathbf{r_o}$.[10] At this stage of our development, we avoid speculation as to the nature of the rotational field within $\mathbf{r_o}$ (In terrestrial vortices such as tornadoes, the circulation within the eye diminishes in proportion to the radius, approaching zero at the rotational center).[11] Here we are only concerned with the circulatory field of space at radii beyond $\mathbf{r_o}$ as the potential source of interaction between charged particles in accordance with an angular momentum defined by ($\mathbf{m_o c r_o}$) field from which the magnetic field derives. From (4-1), the magnitude of the centripetal force constitutes the action defined by the encompassing circulation $\mathbf{2c/r_o}$ wherein the rotational characteristics are centered on $\mathbf{m_o}$ and presumptively coupled thereto. The rotation energy does not involve matter in particle form. Rotational space exhibits angular momentum in a like sense that massless photons transport angular momentum and linear momentum upon impact. Charge morphed as angular momentum space is a dynamic operative frozen in time.

The simple concoction of **Figure 10** begins to look promising. It embraces the correct compliment of acceleration (in accord with our preliminary conclusion that every force can be identified with an acceleration and vice versa). The free vortical velocity-distance relationship is:

$$\mathbf{(v) \times (d) = (c) \times (r_o) = constant} \tag{4.3}$$

For one plane of rotation, the force $\mathbf{F_d}$ acting upon $\mathbf{M_o}$ at distance **d** from the mass center is:[12]

$$\mathbf{F_d} = \mathbf{m_o}\left[\frac{\mathbf{v^2}}{\mathbf{r_o}}\right] = \mathbf{m_o}\left[\frac{\mathbf{c^2}}{\mathbf{r_o}}\right]\left[\frac{\mathbf{r_o}}{\mathbf{d}}\right]^2 = \frac{\mathbf{m_o r_o c^2}}{\mathbf{d^2}} = \frac{\mathbf{r_o}^2}{\mathbf{d^2}}\left[\frac{\mathbf{m_o c^2}}{\mathbf{r_o}}\right] \tag{4.4}$$

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[10]This type of velocity distribution (**v·r = constant**) is known as a free or mathematical vortex. It is closely approximated by tornadoes and other forms of atomospheric disturbance. It also describes the common "drainhole vortex" that develops when a tank is emptied through a bottom orifice.

[11]This mode of circulation (**v = rω**) occurs when a cylinder of radius **r** containing fluid is rotated at an angular velocity **ω** about its central vertical axis. Because of viscosity effects, the fluid eventually rotates as if it were a solidified unit. In atmospheric rotations, the free vortex equation (footnote 1) applies until the velocity reaches some maximum value near the center of curvature. Within this "eye" the velocity tends to be proportional to the radius—decreasing to zero at center of curvature.

[12]Equation (4-4) relates the force along any radial line of action to the product of the central "rest mass" and the vortical field at a point on the putative surface of the particle or beyond. For a distance **d** greater than $\mathbf{r_o}$ the force field falls off in proportion to the ratio of $\mathbf{(r_o/d)^2}$. In Chapter V we develop a rotational model of quantum space based upon reciprocal centrifugal acceleration. In that prototypal, there is not a defined radius $\mathbf{r_o}$ that corresponds to the velocity c; the operative acceleration reduces to $\mathbf{c^2/d}$ at all radii.

A cross sectional slice through **Figure 10** defines a two dimensional vortex coupled to an inertial reactance $\mathbf{m_o}$ all of which is assumed to represent an electron. If the rotational forces correspond to Coulomb's law, our suppositions gain credibility. First the electron as treated as a spherical bubble of electric charge $\mathbf{q_e}$ wherein the self-repulsive force $\mathbf{F_e}$ at the surface $\mathbf{r_o = d}$ is:

$$F_e = \frac{k_e q_e^{\,2}}{2 r_o^{\,2}}$$

$$= \frac{0.5\left(9x10^{9}\ kgm\ m^{2}/coul^{2}\right)\left(1.6x10^{-19}coul\right)^{2}}{r_o^{\,2}} \qquad (4\text{-}5)$$

$$= \frac{11.52\,x\,10^{-29}\,ntn\ m^{2}}{r_o^{\,2}}$$

$\mathbf{F_e}$ is the force in the direction of the outwardly-drawn normal to the surface of the electron bubble.[13] We next "plug- in" the appropriate numerical values for our spatial circulation model of **Figure 10**. From (4-4) the force $\mathbf{F_r}$ is at $\mathbf{r_o = d}$ is::

$$F_r = \frac{m_o r_o c^{2}}{r_o^{\,2}}$$

$$= \frac{\left(9.1x10^{-31}kgm\right)\left(1.4x10^{-15}m\right)\left(3x10^{8}m/sec\right)^{2}}{r_o^{\,2}} \qquad (4\text{-}6)$$

$$= \frac{11.46\ x\ 10^{-29}\,ntn\ m^{2}}{r_o^{\,2}}$$

Comparison of (4-5) and (4-6) shows the mechanical force developed by **c** velocity rotational space corresponds to the self-repulsive force of the electron modeled as a spherical bubble of charge $\mathbf{q_e}$ at distance $\mathbf{r_o = d}$ consistent with the electron radius $\mathbf{r_o}$ defined by the energy of assembly.

[13] The electro-static bubble model of the electron, being self repulsive, is commonly thought to require internal retention forces (sometimes referred to as Poincaré elastic stresses) to prevent "self destruction." As previously iterated, 3-D massless rotating space is not self-conflicting, nor does it require glue.

From the perspective of rotating empty space, the angular momentum attribute imposes a reactive force between two separated electrical particles. To create equal and opposite counter forces, the rotational fields of each circulatory structure must couple to the mass $\mathbf{m_o}$ of the other. The electric field, like gravity is a long range force. Suffice to note, massless linear momentum in the guise of photons is a well established particular of electromagnetic radiation, and while this makes no sense from a classical perspective, it is an accepted fact of quantum theory. As previously underscored, photon momentum in linear motion corresponds to massless rotational momentum in circular motion. But photon angular momentum is always $\mathbf{h/2\pi}$ whereas photon momentum in the direction of travel is frequency dependent. Neutrino(s) exhibits the same angular momentum as the electron, proton and neutron, but no confirmed value of rest mass.[14]

To pursue this intriguing inquiry, it will be expedient to shortcut directly to the ultimate question as to how attractive and repulsive forces between charged particles can be explained in terms of classical mechanics. As with gravity, inertial mass becomes the avenue for equating forces to acceleration. Specifically, in the case of electrons and positrons, it is the´quantum inertia $\mathbf{m_o}$ that becomes the central player. When the implicit acceleration of rotational space is coupled to matter, electrostatic attractions and repulsions emerge from Newton's second law just as gravity followed from global volumetric acceleration. Given the circulatory conjunction between any two fields coupled to a central inertial mass energy $\mathbf{m_oc^2}$ and *voila*, an electric force issues.

Figure 11 shows two identical particle systems $\boldsymbol{\beta_1}$ and $\boldsymbol{\beta_2}$ each comprised of a rest mass $\mathbf{m_o}$ and spatial angular momentum $\mathbf{L_s}$ characterized as a free vortical velocity field governed by equation (4-4) in two dimensional **X-Y** space—it being understood that in the absence of an aligning field, the angular momentum spin axis may assume any and all angles with respect to an arbitrary coordinate system[15] Both particles are assigned clockwise rotations in two dimensional space and separated by a distance **d** many times larger than $\mathbf{r_o}$. The two parallel lines $\mathbf{Y_1}$-$\mathbf{Y_1}$ and $\mathbf{Y_2}$-$\mathbf{Y_2}$ are drawn through the centers of the particles so as to divide the **X-Y** space into three parts. In the absence of influence by the other particle, the vortical field of each system will be spherically symmetrical with respect to the mass $\mathbf{m_o}$. In the presence of the other particle, each field is unbalanced. The spin field of $\boldsymbol{\beta_2}$ is opposite to the spin field of $\boldsymbol{\beta_1}$ between $\mathbf{Y_1}$ and $\mathbf{Y_2}$ and additive in the region above $\mathbf{Y_1}$**.** Similarly, the spin field of $\boldsymbol{\beta_1}$ counteracts the spin field of $\boldsymbol{\beta_2}$ between $\mathbf{Y_1}$ and $\mathbf{Y_2}$ and augments it in the region below $\mathbf{Y_2}$**.** This superposition of spins carries a consequence: When the fields are additive, the centripetal force acting between the central mass $\mathbf{m_o}$ and space will be greater than that due to its own circular field. When the field of the other particle opposes the circulation, the net centripetal force is decreased. As a result, the central mass $\mathbf{m_o}$ of each particle system will be subjected to a greater force in one direction than the other. The net force upon the masses $\mathbf{m_o}$ of $\boldsymbol{\beta_1}$ and $\boldsymbol{\beta_2}$ will be oppositely directed. Like charges repel!

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12. If the neutrino's rest mass is zero, it must travel at a velocity **c**. But different decay reactions require neutrinos to carry away different energies, a subject to be revisited in Chapter V..

13. The superposition of simultaneous spatial vortices that define a spherical surface does not create a problem in a massless medium—there being no traffic congestion in the crossing paths of such a fluid. In actuality, the particles are three dimensional and the rotation about any axis is quantized. For purposes of evaluating the interaction between two particles, however, we consider each as having only a single vortex. In a "*field free*" environment, the precepts of quantum mechanics certify that the spin plane of each vortex will remain undefined until its orientation is determined by the presence of the other particle, in which case the rotations will orient to be repulsive per **Figure 11.**

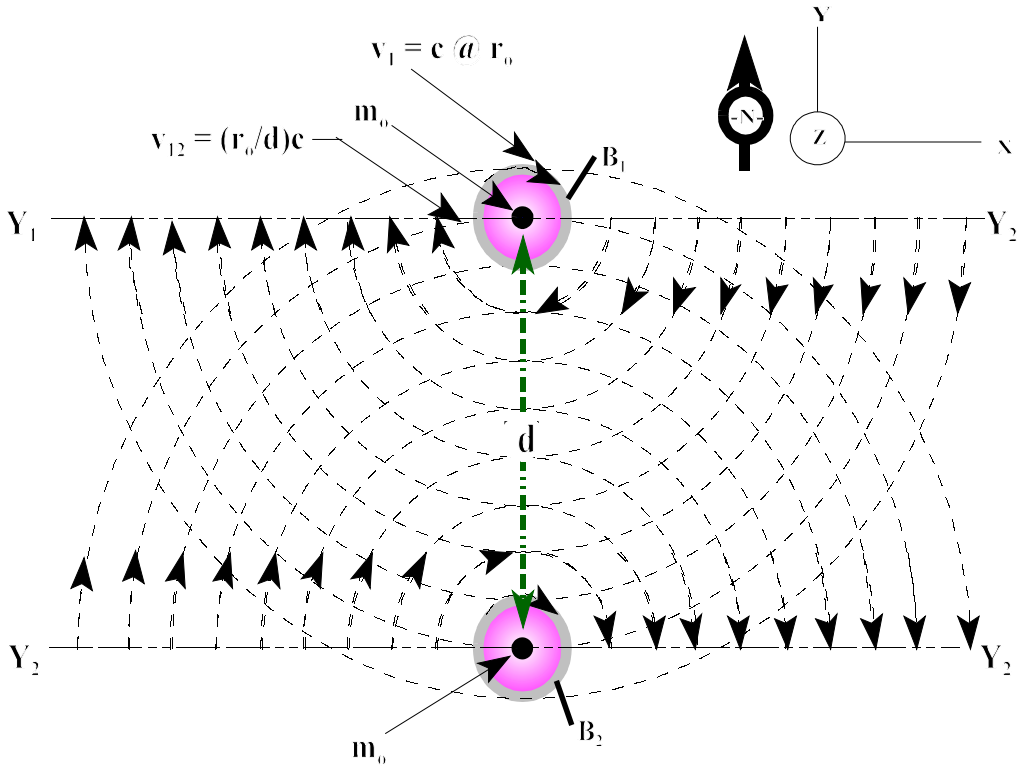

Figure 11. The coupling between vortical fields is shown as being simultaneously both additive and subtractive. The two spatial rotations in the x-y plane each have peripheral spin velocity "c" at radius r_o, and each encompasses an identical symbolic mass m_o. Both circulations are clockwise in the X/Y plane which is divided into three areas by the two parallel east-west lines Y_1-Y_1 and Y_2-Y_2. In the hinter region between these lines the vortical field of each particle counteracts the local angular momentum of the other. In the space north of Y_1-Y_1 the field of β_2 is depicted as augmenting the vortical strength of β_1 and in the area south of Y_2-Y_2 the field of β_1 is depicted as bolstering the strength of β_2.[16] Superposition of the two fields results in an unbalance in the force exerted upon each of the masses m_o. The net force upon β_2 will be southward, and that upon B_1 will be northward. Like charges repel.

[16]The influence of β_2 on β_1 in the area North of y_1-y_1 and β_1 on β_2 in the area south of y_2-y_2 would appear to be limited to the velocity of light **c**. Since the velocity at the radius ro is '**c**' even in the absence of the other particle, the effectiveness of the velocity boosting component of each field may be a nullity. In that case the total force per rotational plane is half that calculated in (4.11). However, there are always two equally effective orthogonal circulations affecting the force acting upon the masses m_o of each system.

The numerical calculations made by inserting the appropriate values into (4-5) and (4-6) insinuate a natural concept of charge as circulatory energy having a representative size and mass commensurate with that of the classical electron. If the affect upon another identical structure is consistent with the repulsive force between two electrons, our model will be have passed a major test. What is left unanswered is the issue of why some spinless particles exhibit charge, and conversely, why some chargeless particles exhibit spin? To address these issues, which we have put-off until now, it will be necessary to tally up the spins, masses and charges exhibited by the constituents of particle decay.[17] The rule for a simple **3-D** rotational complex is:

<u>An electrical charge will be manifest by particles having an odd number of m_o quantum coupled spatial circulations.</u>

In brief, in order for a particle to manifest an electrical field, the induced imbalance of the external spatial circulations must act upon the energy of the vortical complex through the eye of the vortex. The Table shown in Appendix VIII sets forth the characteristics of the auditioning particles and their decay modes—it is from this table we take our tally. Commencing with the electron and positron, each, by definition, satisfy the above dictate (one quantum $\mathbf{m_o}$ coupled circulation). Our prescription also holds for the neutrino and anti-neutrino since neither has a measurable mass energy field to which the spin can couple, these particles should not exhibit electrical properties—which is the case. We next examine the neutron, (of interest since it is a *chargeless* spin particle). During $\boldsymbol{\beta}\mathbf{eta}^-$ decay $(\mathbf{n \Rightarrow p + e + \bar{\nu}})$ one proton, one electron and one antineutrino are recovered as decay products. Even though the standard model rejects the idea of an electron as an internal component within the neutron, we consider it as such for purposes of calculating its contribution to the vortical complex.[1] Within the neutron, electron and proton spins cancel; the only leftover characteristic is the **1/2** spin attributable to the antineutrino which does not interact with matter per se, and so the neutron exhibits zero charge and carries spin **1/2**. Analysis of the proton is similar, and although $\boldsymbol{\beta}\mathbf{eta}^+$ decay of a free proton is not technically permitted because of mass balancing factors, we may nevertheless take note of its decay constituents $(\mathbf{p \Rightarrow n + \bar{e} + \nu})$ and conclude that the protons positive charge and spin are due to the influence of an internal positive particle.

Charged Pions have zero and integral spin momentums.[18] Analyzing these particles is somewhat more involved because the same entities decay in different modes and into different constituents. They are discussed in Chapter V and in Appendix VIII where the above rule is applied and found to be satisfied as to the products of the process. We now return to the all important assertion that classical theory correctly predicts the electrostatic force between charged particles.

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[17]It will be convenient to analyze by the method of reduction and regard the compound particles as though they were composed of decay components that maintain their individual features even though they do not actually exist as entities within the composite structure.

[18]The electric force between particles requires one unit of rest mass $\mathbf{m_o}$**;** it is the only mass which is encompassed by a spatial circulation and is therefore the only active mass which participates in the generation of the electric field. The additional mass of Pions, protons and other particles might appropriately be termed "dead weight"

The Force Between Charges

Current **QED** theory purports to explain electrical phenomena in terms of virtual photons supposedly brought into existence by the intensity of the very fields sought to be explained. The theory itself does not predict the Coulomb force from the known properties of electrons and photons, rather, it owes its endorsement to an extremely accurate prediction of the anomalous *Gyromagnetic* spin ratio.[19] **QED** takes into account the wave nature of the electron, together with the premise that particles only transmit force in increments—the coupling between physical entities being adjusted along the way to correspond to the probability of certain occurrences identified with the strength of the perturbation. The predicted results, however, relate only to a second order effect, and not to a quantitative expression for the force.[20] What we seek here is a physical theory which explains the strength of the electron charge and how it arises.

Figure 12 shows a vortical particle system $\boldsymbol{\beta}_1$ within the influence of a counterclockwise rotational field of like particle $\boldsymbol{\beta}_2$ (not shown). The distance **d** separating the particles is large in comparison with $\mathbf{r}_o$ which permits representation of the $(\mathbf{v}_{12})$ field produced by $\boldsymbol{\beta}_2$ as equally spaced straight lines orthogonal to the line of action drawn between the radial centers of the two particles $\boldsymbol{\beta}_1$ and $\boldsymbol{\beta}_2$. What is desired is an expression for the combined velocity field at all points of superposition on the surface defined by the radius $\mathbf{r}_o$. From this, we will calculate the centripetal force exerted by the effective velocity at all points. The sum of the components of these forces resolved along the line connecting the particle centers is the objective.

For the particle $\boldsymbol{\beta}_1$, the force produced by the superposition of the two velocity fields in the northern (top) hemisphere is given by the square of the sum of the $\boldsymbol{\beta}_1$ field $(\mathbf{v}_1)$ plus the component of the $\boldsymbol{\beta}_2$ field $(\mathbf{v}_{12})$ which is parallel to the $(\mathbf{v}_1)$ field, that is:

$$(\mathbf{M}_o/\mathbf{r})(\mathbf{v}_1 + \mathbf{v}_{12} \sin \theta)^2 \tag{4-7}$$

and in the southern hemisphere, the force is given by the square of the difference between $(\mathbf{v}_1)$ and the $(\mathbf{v}_{12})$ component parallel to $(\mathbf{v}_1)$ i.e.,

$$(\mathbf{M}_o/\mathbf{r})(\mathbf{v}_1 - \mathbf{v}_{12} \sin \theta)^2 \tag{4-8}$$

where θ is the angle measured from the east-west line $\mathbf{Y}_1$-$\mathbf{Y}_2$ which bisects $\boldsymbol{\beta}_1$.

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[19] In **Q**uantum-**E**lectro-**D**ynamical calculations, electrons are described by wavefunctions that exists throughout space. To find the force between two such particles, one must calculate all the probabilities represented by the squared amplitudes of the waves at each point, and then add up the results. Since the wavefunctions overlap at certain places, there will be some locations where the force contributions are infinite. These infinities are disposed by a mathematical contrivance dubbed re-normalization—after which **QED** gives the right values for the anomalous magnetogyric ratio.

[20] **QED** should be applauded for what it is and what it does predict, but it is not a proper theory for explaining the origin of the Coulomb force, which it does not do.

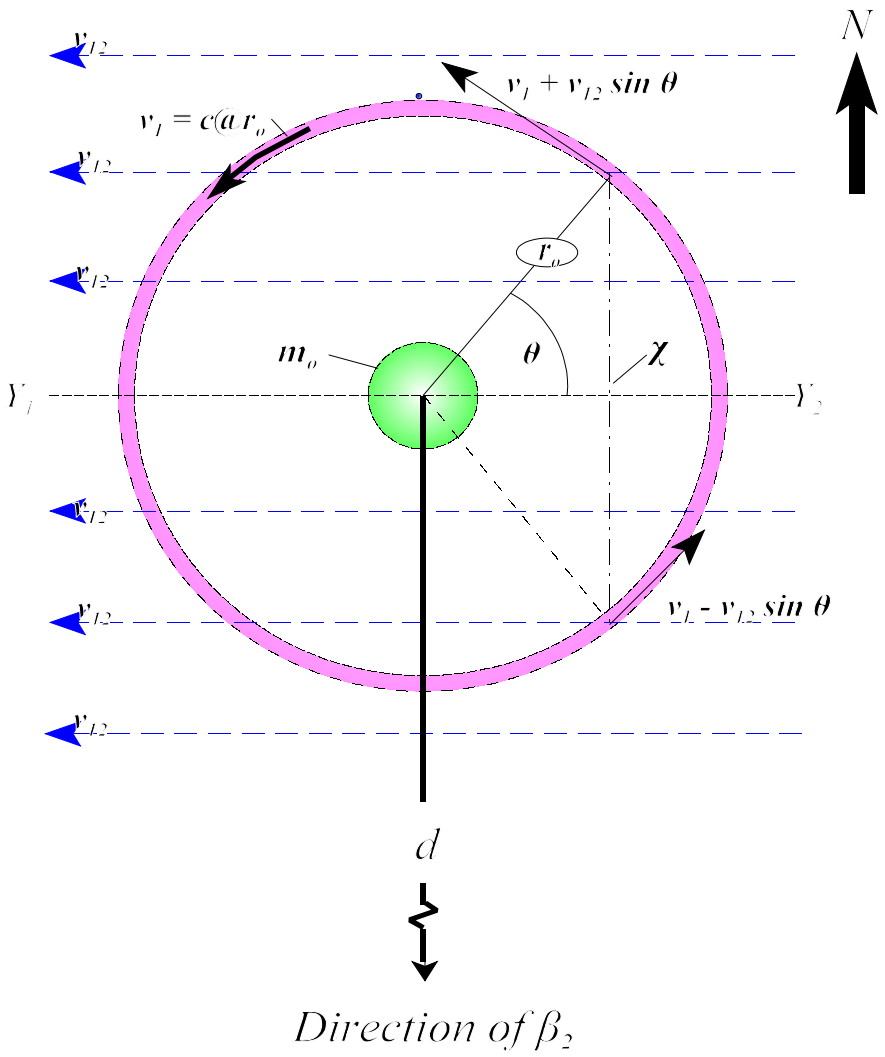

Figure 12. A two dimensional particle system β_1 having counterclockwise rotation is separated from an identical particle β_2 (not shown) by a distance 'd' which is large in comparison with the nominal radius r_o. The local velocity field of β_2 can therefore be approximated as uniformly spaced straight lines v_{12} from east to west. The components of v_{12} that are to be added or subtracted from the velocity v_1 is given by the sin of the angle θ between v_1 and v_{12}. Each point at an angle θ in the northern hemisphere corresponds to a point at an angle -θ in the southern hemisphere. These complimentary locations are conjugate, the velocity v_{12} being additive in the northern hemisphere and subtractive in the southern.[21] Note shown are the interacting spatial circulations in the plane normal to the page which also passes through the centers of β_1 and β_2.

[21] If ($\mathbf{v_{12}}$+ $\mathbf{v_1}$) exceeds "**c**" the analysis must be modified as per pages 62-64 infra.

The net radial force F_r exerted by the superposition of the velocity fields at any two points intersected by the north-south meridian line X is equal to the difference between the squares of the velocities, i.e.,

$$\mathbf{F_r} = \left(\frac{\mathbf{m_o}}{\mathbf{r_o}}\right)\left[\left(\mathbf{v_1} + \mathbf{v_{12}}\sin\theta\right)^2 - \left(\mathbf{v_1} - \mathbf{v_{12}}\sin\theta\right)^2\right]$$

$$= \left(\frac{\mathbf{m_o}}{\mathbf{r_o}}\right)\left(4\mathbf{v_1}\right)\left(\mathbf{v_{12}}\sin\theta\right) \tag{4-9}$$

The component $\mathbf{F_x}$ of the radial force $\mathbf{F_r}$ along the line of action joining the two particles is:

$$\mathbf{F_x} = \left(\frac{\mathbf{m_o}}{\mathbf{r_o}}\right)\left(4\mathbf{v_1}\right)\left(\mathbf{v_{12}}\sin\theta\right)\left(\sin\theta\right) \tag{4-10}$$

The average value $\mathbf{F_A}$ of the north-south component of the unbalancing force as the angle $\boldsymbol{\theta}$ varies from zero to $\boldsymbol{\pi}$ is:

$$\mathbf{F_A} = \frac{4\mathbf{m_o}\mathbf{v_1}\mathbf{v_{12}}}{\pi\,\mathbf{r_o}} \int_0^{\pi} \sin^2\theta \; d\theta$$

$$= \frac{4\mathbf{m_o}\mathbf{v_1}\mathbf{v_{12}}}{\pi\,\mathbf{r_o}} \left[\frac{\theta}{2} - \frac{\sin 2\theta}{4}\right]_0^{\pi} \tag{4-11}$$

$$= \left(2\mathbf{m_o}/\mathbf{r_o}\right)\left(\mathbf{v_1}\mathbf{v_{12}}\right)$$

Comparison of equations (4-4) and (4-11) suggests we have arrived at the correct force for the operative action in both planes. If **c** is the peripheral velocity $\mathbf{v_1}$ at $\mathbf{r_o}$ and $\mathbf{c(r_o/d)^2}$ is the reduced velocity field $\mathbf{v_{12}}$ at distance **d**, then the correct force **F** would be double (4.12).

$$\mathbf{F} = \frac{2\mathbf{m_o}\mathbf{c}^2\mathbf{r_o}}{\mathbf{d}^2} \tag{4-12}$$

Surprisingly, we have arrived at the correct numerical result without considering circulatory interaction in the orthogonal plane. A three dimensional spatial vortex simplifies to the interaction of the two orthogonal planes that pass through the centers of both particles. No component of rotation in a third plane can effect a force since only two planes can pass through both centers. Since (4-12) correctly predicts the Coulomb force as vortical interaction between the two rotational fields, we conclude that superposition of one rotational field upon the other is only effective to reduce the field of the other, i.e., circulatory velocity cannot be augmented to exceed '**c**' for any region of space. With this correction (which is based upon the **c** velocity field of space per Chapter V) we accept (4.12) as correct in that it overstates the force in one plane by 50% but fails to account for interaction in the orthogonal plane which contributes ½ of the composite force.

If either circulation is reversed, the direction of the force will be likewise reversed. Suffice it to say, the force on $\boldsymbol{\beta_2}$ will always be equal and opposite to that of $\boldsymbol{\beta_1}$ since each produces an identical influence upon the field of the other, a commandment of Newton's 3rd law. All electrical charges are defined by the same mass quantum $\mathbf{m_o}$. The ingredients of the proton must therefore include, in some form, an operatively coupled mass $\mathbf{m_o}$, whether this be in the form of three quarks we leave to the musings of the reader and Chapter V. A comparison of the force calculated from equation (4-12) and Coulomb's Law for two particles separated by distance **d** gives:[22]

$$\mathbf{F_e = k_e \frac{q_e^{\,2}}{d^2}} \qquad \underline{\textbf{Coulomb's Law}} \text{ vs } \underline{\text{Spatial Vortex}} \qquad F_A = \frac{2m_o c^2 (r_o)}{d^2}$$

$$\mathbf{= \frac{2.3x10^{-28}\, ntn \cdot m^2}{d^2}} \qquad = \frac{2.3x10^{-28}\, ntn \cdot m^2}{d^2}$$

Originally developed as a theory of classical mechanics, the '*principle-of-least-action*,' will be useful here to explain why identical three spin particles orient as repelling. Minimization of energy during interaction is a systemic stipulation of interacting fields, whether it be moving space or moving mass, and since less energy is required to imbalance the near field rather than reinforce the far field, the spin planes orient so that two of the three will occupy a state of opposition, consequently, the effective velocity field in the hinter region between the particles is diminished. Lower effective velocity decreases the overall energy of the two particle system. The total energy of the field coupled structure is minimized when the in-between velocity field is minimized; this is the state which corresponds to repulsion shown in **Figure 11**. The influence of $\boldsymbol{\beta_2}$ does not actually slow the circulation velocity of $\boldsymbol{\beta_1}$, rather the two fields are superimposed such that the angular momentum is reduced in that part of the field where circulations are opposite in direction. For the positron-electron pair, the force will always be attractive since the directional spins cannot be locked into a near field opposition orientation.

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[22] **For $q_e = 1.6 \times 10^{-19}$ coul, $r_o = 1.4 \times 10^{-15}$ meters, $m_o = 9.1 \times 10^{-31}$ kgm, and $k_e = 9x10^9$ kgm m^2/coul^2**

As developed, the vortical emulation (Figure 10) leads to a specification of electrical charge in terms of first principles, provided spatial acceleration is assigned the task of furnishing reactionary counter force. Modeling the electron mass as a 2-sphere surface having charge $\mathbf{q_e}$ of radius $\mathbf{r_o}$, the electrical electric energy $\mathbf{E_e}$ corresponds to the mechanical work required to assemble the charge $\mathbf{q_e}$ from differential bits:

$$\mathbf{E_e} = \frac{\mathbf{k_e (q_e)^2}}{\mathbf{2r_o}} \tag{4.13}$$

When $\mathbf{E_e}$ is equated to $\mathbf{m_o c^2}$, then:

$$\mathbf{K_e q_e^2 = 2m_o c^2 (r_o)} \tag{4.14}$$

Equation (4-14) is the electro-mechanical transform between the two divisions of classical physics. To shift from one to the other, substitute for ($\mathbf{k_e q_e^2}$) in Coulomb's law, or ($\mathbf{2m_o c^2 r_o}$) in the mechanical formulation.

The question posed at the beginning of this Chapter, that of whether charge is a fundamental entity, has been answered. The propriety of **3-D** spatial circulation, however, is not comprehensible. Motion cannot be assigned to empty space. Spatial flux is a conceptional tool, it can only be related to force as relative acceleration with respect to the reference frame of a zero energy universe. In this sense only, can the spatial motion metaphor lead to mental imagery. Mathematical expression prescribes the force, and model dependent reality follows. It is gratifying that gravitational and electrical forces both reduce to inertial reactions. Space is the massless medium that instantaneously couples all reactionary action to the rest frame of the universe. Any delay in the imposition of inertial reactance to an applied force would violate conservation of momentum and energy.

Charge divergence could have been anticipated at the outset by substituting $\mathbf{2m_o c^2 r_o}$ for $\mathbf{k_e q^2}$. It follows from (4-4). The dependency of the electron charge $\mathbf{q_e}$ upon $\mathbf{m_o}$ and $\mathbf{r_o}$ reveals the electric force for what is.[23] Yet it can be imagined in different ways. Massless circulation driven by a concentrated central mass $\mathbf{m_o}$ projects one picture (space spiraling inwardly toward a black-hole event horizon) whereas charge as circulatory energy $\mathbf{m_o}$ conveys the image of energy in rotational motion. Charge may comprise a positive $\mathbf{m_o c^2}$ core energy that defines the presumably non-expanding central hub balanced by the negative energy of the circulatory field [equations (5.8)-(5.10) infra]. The prospect that the electron itself is a zero energy system is worthy of further deliberation. All this may lead to a new motivation for re-considering John Wheelers scheme of a universe founded upon electrons that take many forms.[24] Although particles having widely different masses exhibit the same charge, electric phenomena can only be reckoned in terms of $\mathbf{m_o}$, $\mathbf{c^2}$ and $\mathbf{r_o}$.

Particle mechanics does not explain mass, indeed, not of electrons, not of protons, not of quarks, nor of any other entity. Classical mechanics defines mass in terms of force and acceleration.

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[23] In arriving at our result, we decreed the distance **d** to be many times larger than $\mathbf{r_o}$. This allowed us to consider the velocity field of $\boldsymbol{\beta}_2$ to be uniformly spaced straight lines in the vicinity of $\boldsymbol{\beta}_1$. In actuality, some correction is required since this field is neither uniform nor straight. The mechanical formulation, like Coulomb's Law, is therefore only an approximation which requires modification when the distance between the particles is reduced.

[24] The radius $\mathbf{r_o}$ derived from $\mathbf{m_o}$, the work-energy required to incrementally build the electron as a two-sphere surface of radius $\mathbf{r_o}$ doing work against the field.

In Chapter III, however, that was qualified by imposing the condition that inertia augments proportionately with the volume of the universe. But what of the electron mass $\mathbf{m_o}$... is it also a variable whose value is orchestrated by the size of the universe? How fortunate we are to have these challenging questions to ponder, and foremost among them, the significance of the minuscule mass $\mathbf{m_o}$ and its role in the grand scheme of things?

The subject of electron size and mass was first resolved by assuming the $\mathbf{m_o}$ energy was entirely electromagnetic in origin. This lead to a relationship between a hypothetical radius $\mathbf{a_1}$ and the electromagnetic mass $\mathbf{m_e = (2/3)(e^2/c^2a_1)}$. Subsequent studies based upon light scattering experiments lead to a slightly different size $\mathbf{a_2 = [(8\pi/3)^{1/2}][(e^2/m_ec^2)]}$. It was ultimately decided to define a classical electron radius as $\mathbf{e^2/mc^2 = 2.8 \times 10^{-15}}$ **meters**. The tack taken here relates $\mathbf{m_o}$ to rotational radius $\mathbf{r_o}$. The concept of the Curl was introduced in (4.2) and for present purposes it can be illustrated as a **2-D** slice taken through the rotational center. The systemic effect of encompassing circulatory space is proportional to the rotational velocity divided by the radial distance.

Our original vortical model of the electron field will be further modified in Chapter V and Appendix I by what we believe to be a more plausible depiction of spatial expansion. The flux encompassing $\mathbf{m_o}$ does not appear to be the result of central attraction as such. Therefore the circulation does not gain velocity as it spirals inwardly as would a natural vortex like that illustrated in **Figure 10**. Rather, the free space velocity is '**c**' at all radii; action is mandated by the circulation factor $\mathbf{2\pi rc}$ rather than the vortical relationship $\mathbf{v = c/r}$. To find the global affect of the circulation we sum the circulation over the scale **R**. The total circulation $\mathbf{C_T}$ equals:

$$\mathbf{C_T = \oint 2\pi c(dr)/\pi r^2 \ = 2c/r} \qquad (4.15)$$

Because the circulatory velocity is '**c**' at all radii, the effective of circulatory action at greater **r** is reduced proportionately. Specifically, the angular rate of change of a circulatory element of space is proportional to **1/r**, so equation (4.4), although derived from the vortical model of the electron, will output the correct force. The space-mass system called 'electron' is spatial circulation rather than rotating mass, and while $\mathbf{m_o}$ is operatively merged with the circulation field, the circulation field is, by the same token, reflexed to the particle hub.

Standard model physics considers the ratio of the **G** force to the **E** force a dimension-less constant. Taking the mass $\mathbf{m_o}$ as the nominal target of the gravity field created by the total cosmic mass and the electric field as that created by $\mathbf{m_o}$ then for any separation distance **d**:

$$\frac{\mathbf{F_G}}{\mathbf{F_e}} = \frac{\frac{\mathbf{M_u m_o G}}{\mathbf{d^2}}}{\frac{\mathbf{m_o c^2 r_o}}{\mathbf{d^2}}} = \frac{\mathbf{(4\pi R^2)m_o(c^2/4\pi R)}}{\mathbf{m_o c^2 r_o}} = \frac{\mathbf{R}}{\mathbf{r_o}} \qquad (4.15$$

The electro-gravitational force ratio $\mathbf{r_o/R}$ has curious implications. If $\mathbf{r_o}$ is constant, then the electric and gravitational forces were equal when **R** equaled $\mathbf{r_o}$,. But if the ratio is invariant, the electric force would increase as **R** increased, and when **R** was equal to the now value of $\mathbf{r_o}$, the then value of $\mathbf{r_o}$ was less by a factor of $\mathbf{10^{42}}$. Reducing $\mathbf{10^{-15}}$ by a factor of $\mathbf{10^{42}}$ corresponds to $\mathbf{10^{-57}}$ meters (the black hole radius of the electron mass $\mathbf{m_o}$). Unless $\mathbf{r_o}$ and $\mathbf{m_o}$ are reciprocally covariant, the value of the electric

force cannot be guaranteed to have a particular value in relation to the gravitational force.

When electric force $\mathbf{F_e}$ is expressed in terms of Coulomb's law, there is nothing to suggest change. But its mechanical pedigree casts doubt upon the credibility of its invariance.

$$\mathbf{F_e = \frac{k_e (q_e)^2}{d^2} = \frac{2m_o c^2 r_o}{d^2}} \qquad (4.16)$$

Whether electrons are microcosms as eloquently described by Carl Sagan in footnote 4 at the beginning of this Chapter, there is an uncanny relationship between mass and scale that is nearly identical to the relationship $\mathbf{4\pi R^2}$ and $\mathbf{M_u}$. The electron mass $\mathbf{m_o}$ is approximated by $\mathbf{(r_o)^2}$. The universe may be but an expanding black hole. Indeed, the present mass $\mathbf{M_u}$ corresponds to a black hole radius $\mathbf{r_s = 2GM_u/c^2}$ or $\mathbf{2R}$. When $\mathbf{r_s}$ equaled $\mathbf{10^{-57}}$ meters, cosmic mass equaled $\mathbf{m_o}$ and the radius of the universe was $\mathbf{r_o}$. And in its present state, **R** defines the now value of cosmic mass $\mathbf{M_u}$ just as the Schwartzchild radius $\mathbf{r_s = 10^{-57}}$ meters perhaps specified $\mathbf{m_o}$. When the scale is shrunk to one meter, the surface density is still one **kgm/mete**r

In Chapter I, the derivation of **G** was based upon an ecumenical distribution of cosmic content over the Hubble surface. Spreading $\mathbf{M_u}$ over $\mathbf{4\pi R^2}$ leads to a surface density of one **kgm** per square meter. As it turns out, there is a maximum amount of information that can be stored in any finite volume, and this is determined by the surface area rather than the volume itself.[25] For a sphere, the amount of information is proportional to the square of the radius rather than the cube.

That electrons have quantized rotations about more than one axis, although predicted before being verified by Stern and Gerlach in 1921,[26] is impossible to comprehend if **h** is due to rotating mass.[27] This has been a disturbing issue for many physicist.

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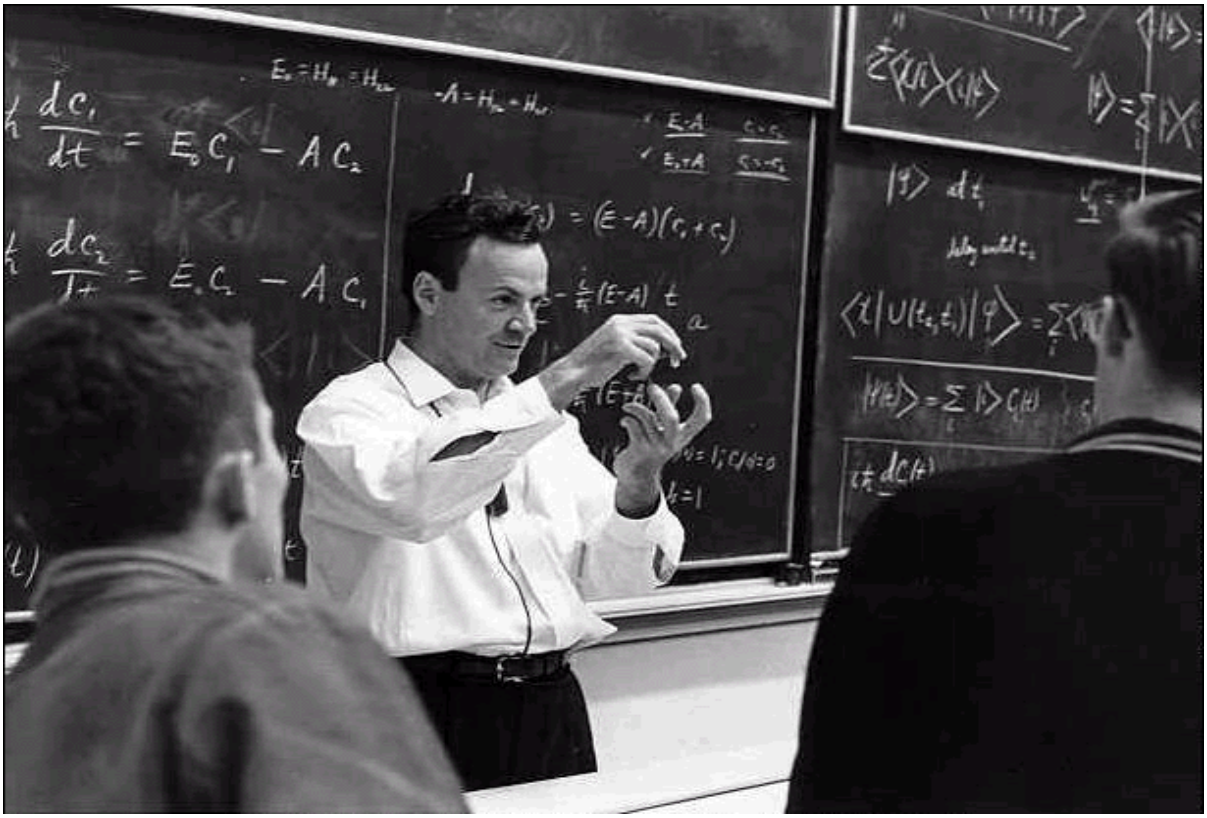
[25]Using the information developed in connection with his study of black holes, the Israelli physicist Jacob Bekenstein showed that the maximum number of information bits for a volume was limited by its surface area.

[26]In 1925, S.A. Goudsmit and G.E. Uhlenbeck proposed the observed characteristics of electrons to be due to a rotational momentum apart from the angular momentum associated with orbital motion about a nucleus. In order to identify it with something physical, it is sometimes envisioned as spatial extension spinning around its own central axis. Since angular momentum of a symmetrical spinning object is independent of the choice of axis for the purpose of momentum calculations, the momentum associated with this spin is at once the particle itself.

[27]

For moving rotational entities, the direction of rotation is defined by helicity. A spinning unit advancing as a right handed screw is said to have positive helicity; a left handed screw negative helicity. The orientation is thus easily defined for photons as they always move at speed **c** with paraxial rotational angular momentum defined by the direction of motion. Positrons and electrons, however, need not be moving, so the spins may be either up or down with respect to each spatial axis; spin orientation between two free electrons is determined by energy minimization. Specifically, there will be a net force which tends to orientate the vortices so that their spins planes are parallel (in two dimensions, one pair both up or both down, and the other pair both left or both right. To understand how this orienting predilection may occur, we revisit **Figure 11** observing that it is easier to weaken the near-field between the particles (the space between $\mathbf{Y_1}$ and $\mathbf{Y_2}$) than it is to augment the far-field (the space above $\mathbf{Y_1}$ or below $\mathbf{Y_2}$). From this perspective, more energy is required to influence the far field, so free electrons will orient two of the three spin planes to counteract whereas an electron and positron can only orientate so that two of the three spin planes reinforce. If the far field is not affected, electrons oppose one another because only near field rotational is weakened. Stated in terms of two anti-parallel spins, all field modification occurs below the line $\mathbf{(Y_1\text{-}Y_1)}$ and therefore like particles,, are urged away from one another. by the intensity of their own velocity field "**c**"in the far hemisphere.

Most notably, Richard Feynman[28]



"I can live with doubt and uncertainty and not knowing. I think it's much more interesting to live not knowing than to have answers that might be wrong"[29]

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[28].....we described how in quantum mechanics the angular momentum of a thing does not have an arbitrary direction, but its component along a given axis can take on only certain equally spaced, discrete values. It is a shocking and peculiar thing....There isn't any descriptive way of making it intelligible that isn't so subtle and advanced in its own form that it is more complicated than the thing you were trying to explain....Understanding these matters comes very slowly, if at all...the most shocking and disturbing thing about quantum mechanics is that if you take the angular momentum along any particular axis you find that it is always an integer or half integer times ħ" **Feynman, Lectures on Physics**

[29]Richard Feynman concluded his exposition of Atmospheric Electricity (Chapter 9, Volume II, Lectures on Physics), with the following antilogy: *"It has apparently been known for a long time that high objects are struck by lightning. There is a quotation of Artabanis, the advisor to Zerxes, giving his master advice on a contemplated attack on the Greeks–during Zerxes campaign to bring the entire known world under control of the Persians. Artabanis said: See how God with his lightning always smites the bigger animals and will not suffer them to wax insolent, while these of a lesser bulk chafe him not. How likewise his bolts fall ever on the highest houses and tallest trees.....so plainly doth he love to bring down everything that exalts itself."*

Feynman then offers the following cautionary advice: "Do you think–now that you know a true account of lightning striking tall trees, you have greater wisdom in advising kings on military matters? Do not exalt yourself, you could only do it less poetically."

What might Feynman advise after reading our account of the electron? It would likely not be poetic!

The Magnetostatic Field

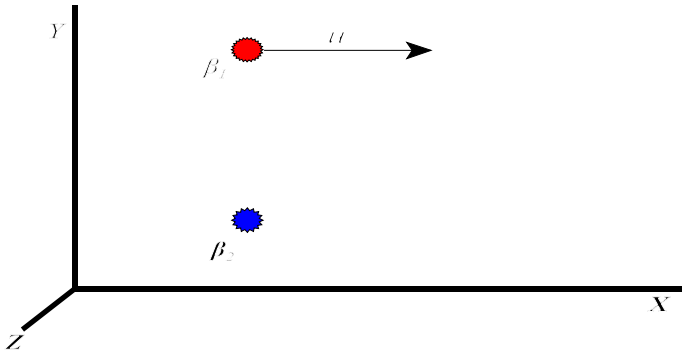

Figure 13. Two charges q represented by the vortical systems β_1 and β_2.

Magnetic force was historically viewed as a separate and distinct wonderment of the electric field. The observational effect as formulated by Ampere's law being the consequence moving charges relative to a fixed field or vice versa. The theory of Special Relativity exposed magnetism for what it really is – an altered manifestation of the of the electric field transformed to a moving coordinate system. As stated by Einstein: " ...the electromotive force acting upon a body in motion in a magnetic field is nothing else but an electric field." We interpret magnetic force as an application of **3-D** vortical theory, wherein relative motion changes orientation angle between interacting circulatory planes.

Referring again to **Figure 12**, we now imagine the vortical system of $\boldsymbol{\beta_1}$ moving at constant relative velocity "**u**" from left to right parallel to the **X** axis of the non-moving XYZ inertial frame of $\boldsymbol{\beta_2}$ as shown in **Figure 13**. With respect to the non-moving vortical field of $\boldsymbol{\beta_2}$ this motion is parallel to the line $\mathbf{Y_1}$-$\mathbf{Y_2}$ of **Figure 12** This results in a decrease in $\mathbf{v_1}$ and enhancement of $\mathbf{v_2}$, and consequently a new force acting between $\boldsymbol{\beta_1}$ and $\boldsymbol{\beta_2}$ due to the relative motion **u**.

To restate the obvious but easily confused geometrics, the force between the two vortical systems lies along their connecting line of action–consistent with Coulomb's Law and in keeping with Faraday's idea of force as a functional coincident of the field. To relate the attributes of charge and mass to space and rotational motion, the circulation must be three dimension. The orthogonal planes of rotation produce the resultant force in terms of the energy difference which is proportion to relative velocity squared. The magnetic force in terms of the classical parameters **u**, **E** and **B**, is then:

$$\mathbf{F = q[E + (u \times B)]} \qquad (4.19)$$

where **q** is the charge, **E** is the electric field, **u** is the relative velocity, and **B** is the magnetic field.

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The parenthetical (**u x B**) signifies the cross vector product. The Lorentz force is an empirical statement; it relates the measured values of **E**, **B** and **u** to their orientations, the direction of the electric force is parallel to the **E** field and the magnetic force is perpendicular to the direction of motion. There is no component of magnetic field parallel to **u**, but there is a perpendicular field in the **Y** direction:

$$\mathbf{B_\perp = (u_x \times E_Y)/c^2} \qquad (4.20)$$

:

$$\mathbf{B_Y = -\, u_x/c^2[E_y]} \qquad (4.21)$$

Substitution of (4.21) into (4.19) relates the force in the moving frame of $\boldsymbol{\beta_1}$ to the electric field in the frame of $\boldsymbol{\beta_2}$.

$$\mathbf{F_Y = q[E_Y + (u \times B_Y)]}$$

$$\mathbf{= q[E_Y - (u^2/c^2)E_Y]} \qquad (4.22)$$

In the moving coordinate system of $\boldsymbol{\beta_1}$, the electric field transforms as $\mathbf{1/(1\text{-}u^2/c^2)^{½}}$ so (4.22) needs to be corrected. Specifically,

$$\mathbf{F_Y = q[E_Y][1\text{-}(u/c)^2][[1\text{-}(u/c)^2]^{-1/2}}$$

Accordingly

$$\mathbf{F_Y = qE_Y[1\text{-}(u^2/c^2)]^{½}} \qquad (4.23)$$

Since **u** is always less than **c**, the net force upon the $\boldsymbol{\beta_1}$ - $\boldsymbol{\beta_2}$ vortical system is repulsive, approaching zero as the relative velocity **u** approaches **c**. The magnetic attraction between two moving particles is a second order effect in terms of the velocity ratio $\mathbf{(u/c)^2}$ that only equals the electrostatic force when the relative velocity **u** equals **c** . In terms of the velocity parameter **'c'** that specifies the electrostatic force (4.12), the magnetic force per coulomb is:

$$\mathbf{F/q = E_Y[u_x^2/c^2] = 2c^2r_om_o(u_x^2/c^2)/d^2}$$

$$= \mathbf{(2r_om_ou_x^2)/d^2} \qquad (4.24)$$

This is the electric force (4.12) with **c** replaced by **u**. The description of both the electric and magnetic force in terms of vorticity concludes this Chapter.

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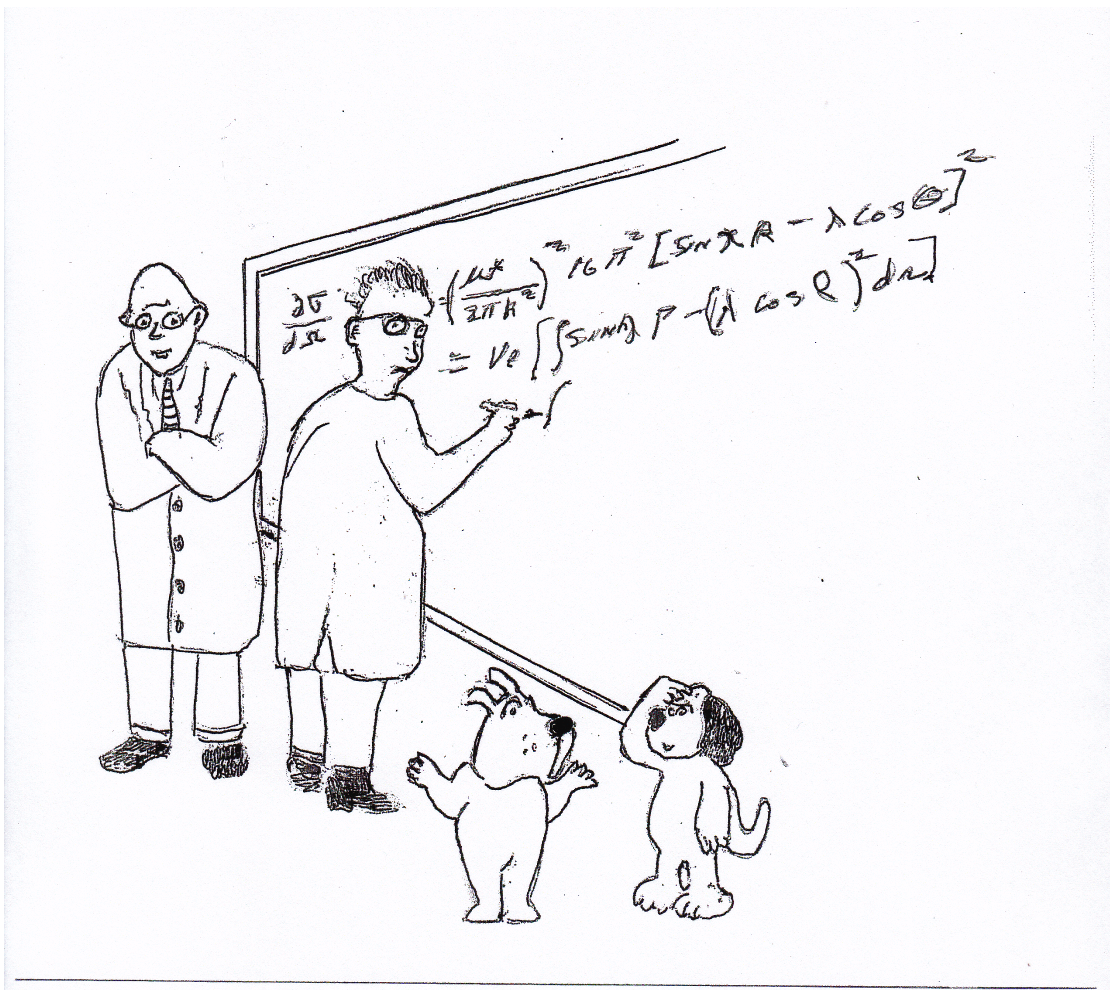

So why should we feel confounded. Humans invented Quantum Mechanics and they have never been able to understand it.

CHAPTER V

A PRESCRIPTION FOR SPACE

If we are not content with the dull accumulation of experimental facts, if we make any deductions or generalizations, if we seek for any theory to guide us, some degree of speculation cannot be avoided.

Arthur Eddington

Much Ado About Nothing

Dynamic spacetime is a puzzling phantasm, with neither shape nor substance; it cannot characterize in the same sense as matter. To explicate upon the void, its particle anthesis is studied with the hope of finding enlightenment in the discovery of something substantive. But the deeper the probe, the more nebulous the form. Particles differ from space by resisting expansion. From the perspective of uniformly expanding space, particles are obstructionists.

Underlying current research is the belief that understanding will come through reductionism–breaking subatomic entities against one another in the hope of finding natures ultimate secrets. Standard theory regards electrons as mathematical points with neither volume nor area. Connection to the familiar classical world is lost, perplexity follows and infinities arise when dimensionality is abandoned.[1] The approach taken here is to explore space in the immediate vicinity of the simplest particles in the hope it will lead to a better understanding of what's inside. Physical properties are defined by interaction of fields. To pervert an already overused wit of wisdom, to discover what is in the box, we must think outside the box. In this Chapter, it is the mass-void interface that will prove revealing.

Chapter IV exposed the electric field as a circulatory spatial dynamic. Using classical principles, the electron charge $\mathbf{q_e}$ was related to its size $\mathbf{r_o}$ and mass $\mathbf{m_o}$. The electric phenomena, however, is not restricted to these dimensions, nor is it confined to half spin particles. What then can be said as to the significance thereof in deriving the force based thereon. To answer this question, it will be useful to examine space as a plenum of individual quantum(s).[2]

Proceeding by way of an imaginary experiment (what Einstein referred to as Gedanken) we begin with a spherical container in empty space far removed from fields of influence. The container is closed and sealed, yet when examined, it is found to be oozing space. Because the size of our imagined spatial quantum(s) is much smaller than the spacing between atoms, porosity is unaffected by the density or thickness of the material. The rate of spatial production divided by the surface area defines the expansion modulus $\mathbf{3c^2/R}$ per (2.25).

Perhaps early philosophers would call it quintessence, expansion seemingly powers the universe for free. Multiplication of the modulus $\mathbf{3c^2/R}$ by the Hubble density $\boldsymbol{\rho_u = (3/R)\ kgm/m^2}$ converts acceleration to <u>*spatial pressure/unit length*</u>, i.e.,

$$\mathbf{P_L = (3c^2/R)(3/R)kgm/m^2 = 9H^2(kgm/m^2) = 3\Lambda(kgm/m^2)}$$

$$\mathbf{= 4.67 \times 10^{-35}\ (ntn/m^2)/m} \qquad (5.1a)$$

[1]When Richard Feynman was interviewed as to how he modified the theory in such a way that led to his Noble Prize, he responded: "By sweeping the infinities under the rug."

[2]As between accelerating space and accelerating matter, the distinction depends upon the viewpoint. Accelerating space manifests as gravity, accelerating mass displays as inertial reaction.

In (5.1a), the expression for the expansion modulus of free space takes the same form as its electrical parameters (ε_o capacitance per meter, μ_o inductance per meter). The ratio $\sqrt{(\mu_o/\varepsilon_o)}$ defines the impedance of the void. As more fully developed and related herein, local pressure depends upon energy density. Spatial stress and spatial acceleration are other words for expressing the pressure due to expansion. The expansion modulus is an inveterate characteristic of the void, independent of the sample size. Forces acting between separated objects are the behest of changing momentum–all action at a distance is connected via local spatial acceleration to the rest frame of the universe.

Consider next a modification of the Gedanken; the spherical container shrunk to the size of an electron. When the volume $\mathbf{(4/3)\pi(r_o)^3}$ is multiplied by the free space density $\mathbf{\rho_u = 10^{-26}\ kgm}$, the mass-energy $\mathbf{m_n}$ is:

$$\mathbf{m_n = \rho_u(V) \approx 10^{-69}\ kgm} \tag{5.1b}$$

The mass of a quantum sample of free space of size $\mathbf{r_o}$ will prove to be of significance in what follows. The properties of the electron are conjunctive with an eye area $\mathbf{4\pi(r_o)^2}$. When the electron angular momentum $\mathbf{h/4\pi}$ is expressed in terms of spatial rotation relative to the eye, the mass $\mathbf{m_o}$ can be viewed as uniformly spread over the surface of the eye. As is the case with vorticity, the manifest of any circulation encompassing the eye is reflexed to the eye. There are thus two angular momentums in play, 1) the electric field angular momentum $\mathbf{m_o c r_o}$ extracted from (4.12) and the **3-D** intrinsic angular momentum quantum $\mathbf{h/4\pi}$ and multiples thereof associated with a wide range of subatomic entities,

$$\mathbf{h/4\pi = 6.63 \times 10^{-34}/12.56 = \underline{5.3 \times 10^{-35}}\ \underline{kgm\,(m^2/sec)}} \tag{5.1c}$$

The two momentums are related! As developed infra, the local angular momentum associated with the properties of the eye $\mathbf{m_o c r_o}$ is a conventional circulation of mass-energy whereas the half spin angular momentum $\mathbf{h/4\pi}$ of (5.1c) is a **3-D** spatial circulation. As later developed, the ratio of the two angular momentums has special significance in quantum physics.

Expansion now re-enters the picture as the source of orthonormal stress between the non-expanding eye and its circulatory spatial envelop. A free space '**c**' velocity circulatory flux will increase in radius at velocity '**c**' so a circulation tied to the non expand-ability of the eye will map as an Archimedean Spiral $\mathbf{\Delta r = c\Delta t}$ for each $\mathbf{2\pi}$ increase in angular position. As previously emphasized, there is no physical circulation to detect, spatial motion is a figment of mathematical modeling.

The angular momentum of a rotating mass increases proportionately with radius. But as developed *infra,* moment of momentum for a *fixed mass-rotational-space-complex* increases inversely with radius. [In what follows, the virtual velocity field of circulatory space will be taken as **c** at all radii so the circulation at any radius **r** is $\mathbf{2c/r}$ (per 4.2). The angular influence of spatial circulation upon a non expanding

mass energy $\mathbf{m_o}$ thus diminishes with radius, so the effective electric field formulates as a free vortex per the discourse accompanying **Figure 14**]. As between the electric field and angular momentum, the latter is primary. The electric force, like gravity, is a consequence of inertial reaction. Gravity depends from expansion, **q** depends upon expansion. Local **g** fields result from conservation of zero energy during expansion, local **q** fields are the implicate of conservation of angular momentum during expansion. Gravity is to inertial mass as electric charge is to angular momentum. Gravity is the compliment of spatial acceleration divergence and charge is the compliment of expanding spatial circulation. Both are coextensive with the universe, and both are tied to stress created by mass subjected to orthonormal acceleration stress.[3] While these influences are virtual in the sense space is not material, they are measurable manifestations of the global field acting upon non-expanding matter.[4] In denouement, all forces communicating between objects separated by empty space are extrapolations of the in-between space, in form as the fields created by the inertial reaction of local matter.

Complex particles (those evidencing internal structure) come in multiplies of $\mathbf{h/4\pi}$ fielded by circulatory space. Except for neutrons and protons, subatomic particles generally decay into electrons, positrons, neutrinos or radiation. For an angular momentum field $\mathbf{h/4\pi}$ expanded to the Hubble limit, then $\mathbf{r = R}$ and the effective mass $\mathbf{m_x}$ is found to be approx equal to that calculated from (5.1b), a preview of mass variability during expansion and contraction:

$$\mathbf{h/4\pi \approx m_x cR} \qquad (5.2)$$

$$\mathbf{m_x \approx (5.3 \times 10^{-35}) / (3 \times 10^{8})(1.3 \times 10^{26}) \approx 10^{-69} kgm}$$

---

[3] Accepting positive energy as having come-to-pass in the manner proposed in Appendix XIV (or some similar sequence of events that resulted in a hot dense state birthed by stress creating expansion of empty space), then what is initially nothing transforms, first into oppositely polarized angular momentum companions that separate into gamma ray photons acquiring individual positive energies each balanced by the distending volume of the gravitational-inertial field that conserves net zero energy. From these two dimensional rotations, electrons and positrons form and as the first **3-D** angular momentum particles, and the attendant functional effect of increasing resistance to acceleration (inertia). Conformal Expansion (which specified herein as radial divergence orthogonal to the rotational field) is confined to the incorporeal circulation field of space in a manner that conserves angular momentum).

[4] If circulatory flow takes place in a perfect fluid, a free or mathematical vortex is created. The velocity **v** is constant along the vortical streamline so the integral of **ds** is merely the length of the closed curve at radius **r** which leads to the velocity distribution $\mathbf{v \cdot r = C}$ (where **C** is a **c**onstant) as developed in Chapter IV. The circulation calculated along any closed contour which includes the center is $\mathbf{\Gamma = 2\pi C}$, and conversely, the circulation calculated along any closed path that excludes the center is zero. The rotational properties of a vortex are therefore concentrated at its center, which mathematically reduces to a single point where the velocity reaches infinity. But the real universe does not permit infinite velocity or zero dimensions, the vortical field reaches velocity **c** at radius $\mathbf{r_o}$

What manner of matter is represented by (5.1b) and (5.2)? If quantified with a spatial angular momentum unit **h/4π**, is it classifiable as a particle, e.g. a non kinetic neutrino? Having density commensurate with empty space, it fulfils the description of the quantum(s) earlier proposed as an angular momentum plenum. Overlapping circulations then exist as passive quantum(s) which gain recognition only when accelerated to near **c** velocity as participants of some subatomic transition or decay. Forces arise as spatial fields when empty volumes of angular momentums are collectively energized as a local spatial acceleration field? This basal depiction of space does fill the simplicity requirement, but is it too simple?

While neutrinos can be taken as space-density angular momentums when not in motion, they will exhibit significant mass when traveling at relativistic velocities. Like photons, they exhibit no electric field because they have no measurable energy relative to free space. Ergo, they interact only weakly with gravitational and electric fields even though they acquire significant energy during subatomic transformations Since the angular momentum facade **h/4π** is spatial, non-kinetic neutrinos look to be consistent with the requirements of space as an angular momentum plenum. In summary, the neutrino density is equal to space (in essence neutrino's are a unit of angular momentum space, and as such they cannot be distinguished therefrom except when ejected at high velocity). During the first instant of expansion the circulatory volumes were seeded with infinitesimal stress energies which acquired mass during subsequent eons of expansion. In the second instant of expansion the circulations took form as neutrinos with densities equal to empty space (See **Figure 15**).

A space composed of angular momentums provokes new issues and new possibilities. The idea of expanded spatial angular momentum quantum(s) each having an effective mass $\mathbf{m_x}$ and **h/4π** angular momentum satisfies the long sought after countenance of space as both granular and continuum. The feeling among theorists is that space must be quantified at some level. This has spawned elaborate mathematical theories of strings and loops, but little in the way of predictive power. When faith based theories are institutionalized as fact, scientific progress is retarded.[5]

While uncertainty kinships between coordinate and conjugate momentum operators frequently appear in quantum theory, the Heisenberg relationship:

$$[\textbf{angular mom uncertainty } (\Delta \mathbf{L})] \times [\textbf{angular uncertainty } (\Delta \boldsymbol{\theta})] \geq \mathbf{h} \quad (5.2a)$$

has trifoliate significance for both space and particles. As with wave-functions, angular momentums are holistic in nature and cannot be identified by location.[6] In dealing with angular momentum as rotating mass, the orientation angle **θ** repeats every **2π** radians. When moment of momentum is the result of a **3-D** spatial operative, the angular uncertainty **Δθ** is spread over **4π** rather than **2π**.

It has been shown that mean angular momentum **h/4π** is quantified for any

[5]Faith defined by Humorist, Mart Twain: "Believing in something you know just ain't so"

[6]Two orthogonal components of angular momentum cannot be simultaneously known or measured. The most that can be known about an angular momentum vector is its magnitude and one of its three vector components, quantified in units of **h/4π**.

minimum-uncertainty state obtained from any uncertainty relation involving the angular momentum operator and a conjugate coordinate. Just as **2-D** photon spin is characterized in multiples of "**h/2π**" so also are **3-D** particles imbued with three angular momentum options. Circulations portrayed as spatially distended could conceivably collapse instantaneously when two particles combine.[7] If transformations take place instantaneously, the associated forces will snuff or create instantaneously. Speculations on space need not be limited or impeded by the dimensionality of the circulation. The spatial extent of an angular quantum may be indefinitely large, encompassing the circulatory centers of many others.[8] Conversely, an angular momentum quantum moving with high velocity has been likened to a 'neutrino' (a rest mass $\mathbf{10^{-69}}$ kgm defined by an angular momentum **h/4π**).[9] The enigma of spatial energy and the mystery of neutrino mass appear to stem from a single symptomatic.

Position uncertainty within the cosmic volume corresponds to energy uncertainty within the age of the cosmos, $\mathbf{(\Delta E)(\Delta t) > h/4\pi}$, and therefore if $\mathbf{\Delta t = \tau_o}$

$$\mathbf{(\Delta E) > [(h/(\tau_o)] > (hH)} \qquad (5.3)$$

The energy **ΔE** corresponds to $\mathbf{\Delta t = \tau_o}$ where $\mathbf{\tau_o}$ is the Hubble period $\mathbf{T_o}$. This conforms to the mass-energy defined by the wavelength **2πR** and (5.2). If $\mathbf{m_x}$ is a transform for energy defined by a **4π** angular momentum directional uncertainty, then the minuscule energy $\mathbf{10^{-69}}$ **kgm** is a matter of interest (so to speak).

Angular momentum is independent of the location about which the angular momentum is computed (Appendix 17). Every point is a Hubble center and consequently could be used as a coordinate origin for a Hubble volume. A general statement about angular momentum in the frame of an otherwise empty expanding cosmos follows from a slice taken through any Hubble sphere. If **L** denotes the momentum of momentum, then for conservation during expansion:

$$\mathbf{dL/dt =[(m)v(dr/dt) + (m)r(dv/dt) + vr(dm/dt)] = 0}$$

Therefore: $\mathbf{(m)v(dr/dt) = - r[m(dv/dt + v(dm/dt)]}$

Hence $\mathbf{mv^2/r = - [d/dt(mv)] = (F)}$

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[7] Minimum-uncertainty angular wave packets and quantized mean values Kostelecky and Tudose, Physics Dept, Indiana, Phys Rev 1996

[8] In this supposal, overlapping spatial circulations manifest collectively as a dynamic whole In lieu of the structural rigor to be expected from a space composed of independent constituents precisely fitted together to completely occupy a volume, the rotations effuse unto neighboring circulations to collectively create a transcendent energy density.

[9] In order to conserve both angular momentum and mass energy, the decay of complex particles constructed from the amalgamation of multiple circulatory structures would results in the ejection of a spatial angular momentum unit **h/2** at near "**c**" velocity. As observed by the 4th Century BC philosopher, Aristophanes: "Whirl is king"

For the universe, $\mathbf{v = c}$, $\mathbf{r = R}$, and $\mathbf{m = M_u}$. Newton's transform follows as:

$$\mathbf{M_u\,[\,c^2/R] = F} \tag{5.4}$$

The primacy of momentum is an essence of the universe.[10] In the scheme of things, the **mv** product expresses a property of nature more elemental than *'mass'* or *'velocity'* alone.[11] To build a medium from spatial angular momentums, the spacing between rotational centers would be on the order of $\mathbf{2r_o}$ [12]

The quantum mechanical expression for the energy $\mathbf{E_n}$ of a particle in a box of length $\mathbf{L_d}$ is:

$$\mathbf{E_n = n^2\,h^2/8mL_d^2} \tag{5.5}$$

where **"m"** is the particle mass and the subscript **"n"** signifies the possible values for the energy which depend upon the quantum number for a fixed mass **m**. For $\mathbf{n = 1}$ and $\mathbf{L_d}$ taken as $\boldsymbol{\pi}\mathbf{R}$, then, perhaps not surprisingly, the number $\mathbf{m_x}$ recurs :

$$\mathbf{(E)(m) = \hbar^2(2\pi)^2/8(\pi R)^2} \tag{5.6}$$

Since $\mathbf{E = mc^2}$,

$$\mathbf{m \approx [\hbar^2/2R^2c^2]^{1/2} \approx \hbar H/(2)^{1/2}c^2 \approx 10^{-69}\ kgm} \tag{5.7}$$

It has been three centuries since D'Alembert proclaimed perfect fluids produced no pressure drag when moving at constant velocity. At the time, this was a puzzling and disturbing incongruity—but now understood as a conservation property of an in-viscid fluid in frictionless motion. In the void, the equations governing the motion of inertial matter apply. The "perfect fluid" of free space creates no net force to be measured unless velocity is changing.

The reader will recognize a dose of tautology. Beginning with expansion as the global agent, we configured particle angular momentum and hinted the electric field consequential—thus sanctifying the discrete based upon collaboration with the whole. While the angular momentum link to the electric field was not suggested in Chapter IV, the next few pages will re-introduce the charge quantum $\mathbf{q_e}$ in the light of angular momentum conservation during expansion. Specifically, we will make the claim that electric fields are the countenance of expanded angular momentums.

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[10] During development of the Special Theory, Einstein was confronted with having to choose between conservation of momentum or mass He correctly intuited that momentum is preserved

[11] A remarkable property of a symmetrical rotation is that angular momentum along the spin axis is independent of the choice of the location used for computation (See Appendix XIV- F).

[12] For $\mathbf{M_u = 10^{53}\ kgm}$ [per (2.7)] and interstitial spacing $\mathbf{10^{42}/m^3}$, then $\boldsymbol{\rho_u \approx 0.6 \times 10^{-26}\ kgm/m^3}$. Separation between centers corresponds to $\mathbf{[(1)/(10^{42})(4\pi/3]^{1/3} \approx 6 \times 10^{-15}}$ (6 fermi). The number of elements on the surface of a Hubble sphere is about $\mathbf{(2\pi)(\,10^{26})/(3 \times 10^{-15}) \approx 10^{42}}$. If space is quantified in terms of the number of elements that can fit within an otherwise empty universe, each element would be required to antes-up a mass $\mathbf{m_x = 10^{-69}\ kgm}$, our cosmic quota would be met.

During expansion, angular momentum is conserved, being now manifest as the electric field energy contained in the volume. When acting upon masses devoid of measurable angular momentum, expanding space takes form as accelerating volume/per unit mass. When the energy of rotational space undergoing expansion is referenced to the non-expanding eye, the energy of the particle must be balanced to zero in the rest frame of the universe.[13] The energy of the electric charge is the integral over the energy density:

$$\frac{\varepsilon_o}{2}\int_V \mathbf{E}\cdot\mathbf{E}(\mathbf{dV}) = \int_{r=0}^{R}\frac{\mathbf{q}^2}{32\pi^2\varepsilon_o\mathbf{r}^4} = -\frac{\mathbf{q}^2}{8\pi\varepsilon_o}\frac{\mathbf{1}}{\mathbf{r}} \qquad (5.8)$$

Using the relationships developed in Chapter IV substituting $\mathbf{4\pi\varepsilon_o = 1/k_e}$ then:

$$\mathbf{Energy = 2m_oc^2(r_o)/2r}\big|^{r=R} - \mathbf{2m_oc^2(r_o)/2r}\big|_{r=0} \qquad (5.9)$$

which straightaway revives the problem of particles as points. Clearly, there is no difficulty with the limit **R**, but for **r** = zero, the field energy per (5.9) is infinite. The problem evaporates, however, if the lower limit $\mathbf{r = r_o}$ in which case (5.9) reduces to

$$\mathbf{Energy = m_oc^2} \qquad (5.10)$$

consistent with the relationships derived in Chapter IV based upon $\mathbf{r_o}$.

In the 'inertia-gravity' confluence, negative **G** field energy balanced positive inertial energy. In the case of the electron, the negative field energy equals inertial mass $\mathbf{m_o}$. The vortical electric field and the angular momentum field are jointly coupled through the eye.[14] Both fields are quantified circulations as per (5.11) infra.

Conservation of angular momentum during expansion requires the *velocity-mass* product decrease as the radius of rotation increases (5.2). Thus, for a constant spatial rotational velocity '**c**,' at all radii, mass will not be conserved. This leads to the factitious value $\mathbf{m_x = 10^{-69}\ kgm}$ at the Hubble limit **R**. Contrariwise, if mass-energy is fixed, rotational velocity will decrease with distance, the result formulates as a free vortex. The field of a quantum of charge **q** derived in Chapter IV was based upon a vortical emulative, but in actuality, it is the diminishing affect of a constant **c** circulatory flux at increasing radial distance that replicates the electric field.

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[13]Equal and opposite circulations are presumed to arise during the initial instant of expansion when stress intensity was maximum. There is never a net energy due to the consequent **G** field and there is never a net global angular momentum since the number of positrons locked up in protons will be always equal to the number of electrons .

[14]Unlike angular momentum, the electric field is symmetrically well defined with respect to the location of the electron. But there is no real rest core energy since there are no inert chunks of matter to be found at the subatomic level, only complexity of motion. Perhaps a better nomenclature should be to eye of the vortical field.

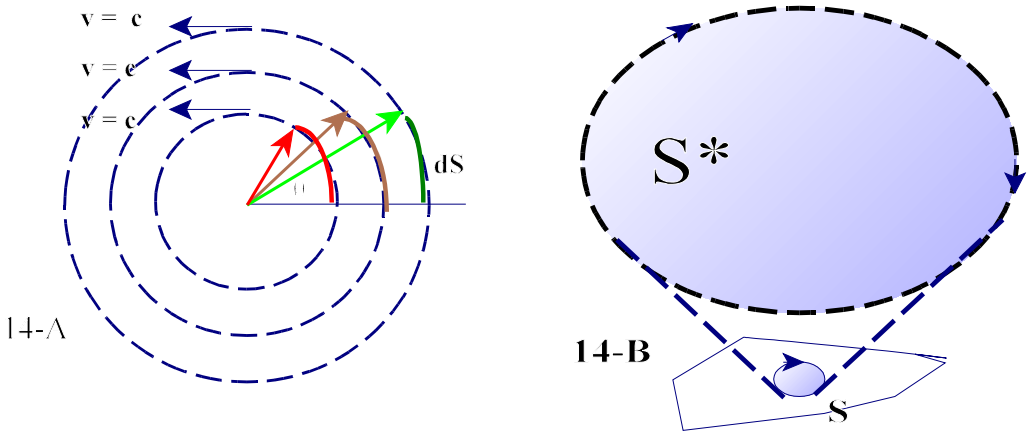
Mechanical physics acquires a new faculty when applied to rotating space, specifically, when the angular momentum field is reflexed to the circulatory center, the role of mass and space is reversed, the particle loses its prominence as a local place in space. Angular momentum will be conserved if: 1) the effective rotational velocity is constant and the effective inertial factor diminishes inversely with radius, or 2) the energy content per unit of distance along the flow contour is constant and the effective velocity at all radii diminishes inversely with radius. For the electro-angular-momentum complex, only the latter formalism is in play. The circulation field is a facet of expanded space and its scale **R** is the universe. The influence of rotational space upon angular position **θ** is by Minkowski's transform $\mathbf{c(dt) = r(d\theta)}$ and therefore the angular rate $\boldsymbol{\omega = d\theta/dt = c/r}$. The contribution of spatial rotation to angular momentum is not $\mathbf{m\omega r^2}$ as would be the case if the mass were in motion about a center of rotation, rather it diminishes as $\mathbf{cr_o/r}$ reminiscent of a free vortex velocity function per (4.4). Thus, while there is a constant velocity **c** associated with circulatory spatial flow at all radii, the contribution at radius **r** is distributed over the spatial length $\mathbf{2\pi r}$, and since this length increases with radius, the effect of circulation at a particular radius will be inversely dependent upon the radius.[15]

The challenge reduces to showing that the **3-D** circulatory spatial field derived in Chapter IV has the same moment of momentum as the spatial angular momentum field $\mathbf{h/4\pi}$ per (5.1c). The electric field extends from $\mathbf{r_o}$ to **R**. The circulation in a plane passing through the eye at radius **r** is $\mathbf{cr_o/r}$. Just as there are two orthogonal planes of spatial rotation contributing to the electric force, there are only two orthogonal rotational planes that can intersect both the center of rotation and an arbitrary point in space. They correspond to the complex conjugate solutions of the wavefunction representing the two circulations. The spatial angular momentum is therefore the square root of the sum of the squares of two orthogonal circulations multiplied by the central mass $\mathbf{m_o}$, and therefore the total moment of momentum $\mathbf{LC_T}$ of the two intersecting orthogonal circulation fields at any radius **r** is:

$$\begin{aligned}
&\mathbf{LC_T = \sqrt{2}(m_o)\int_{r_o}^{R}\frac{cr_o}{r}(dr) = \sqrt{(2)}cr_o(lnR - lnr_o)(m_o)}\\
&\mathbf{\approx \sqrt{2}(cr_o)(ln10^{26} - ln10^{-15})(m_o)}\\
&\mathbf{\approx (1.414)(3x10^{8})(1.4x10^{-15})(60-[-35])(9.1x10^{-31})}\\
&\mathbf{\approx 5.1x10^{-35}\,meters^2 kgm\cdot sec^{-1} \approx \frac{h}{4\pi}}
\end{aligned} \tag{5.11}$$

[15]A feature of disk galaxies is that star velocities are constant wrt the galactic center. If the mass distribution of these systems were similar to the visible elements, the orbital velocities should decline with distance as is the case where most mass is concentrated at the rotational center. This discrepancy is usually explained by hypothesizing the galaxy permeated with a large amount of dark matter even to the extent of its halo. However, the phenomena may also be analyzed as symptomatic of space-matter circulation. The rotational disc then takes form as the flow circulations **2v/r** wherein the individual stars will behave as they should in order to conserve systemic angular momentum.

In Summary, the electric field and the angular momentum **h/4π** field are manifestations of **3-D** spatial circulation, the quantum charge **q** being a concatenation of angular momentum. Two effects are at large, and whilst intertwined by a common expansion mechanism, the angular momentum **h/4π** will be denominated "primary" in that it remains constant during expansion. At any point in space, the total angular momentum of an electron resolved along one directional axis will be **h/4π**. The electric force between two electrons is caused by the repulsion of their interacting spatial angular momentum circulations.



<u>FIGURE 14A</u>: <u>Uniform Spatial Circulation Reflexes as Virtual Vorticity.</u> For a circulatory system of matter provoked by a low pressure center, the rotational flow is described by a free vortex wherein the tangential velocity at any radius r is proportional to 1/r. For an angular momentum system built upon circulatory space, the velocity flux is constant at all radii, so the contribution at any radius is also 1/r. In the figure, each dotted circle represents a spatial velocity c. The circulation at all radii sweep out the same distance dS = c/r per unit of time dt [ds is red for a small radius, green for a greater radius and brown for the largest radius]. The angular velocity 'ω' = dθ/dt = ds/r(dt) = c/r.

<u>Figure 14B: The action of expansion upon angular momentum.</u> In Aristotelian physics, the points of space retain their identity from one moment to the next. In Galilean space there is no meaning attached to a location from one moment to the next. Each instant of time creates a new space, what was previously an angular momentum h/4π in S is now an angular momentum in h/4π embracing a much larger space S* As the universe ages, the angular momentum is spread over progressively greater area. Since expansion rate is constant, the thickness of each shell is (3 x 10^8 meters for each second of cosmic age). Conservation of angular momentum requires that the circulation velocity c also be invariant.

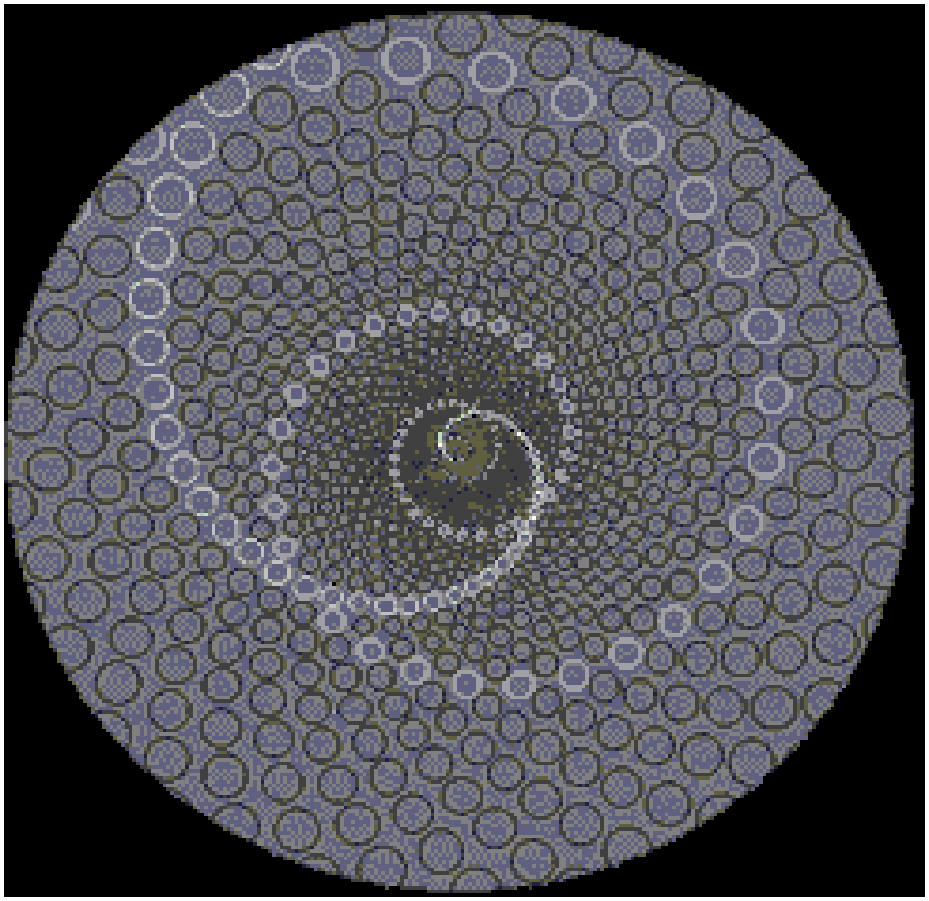
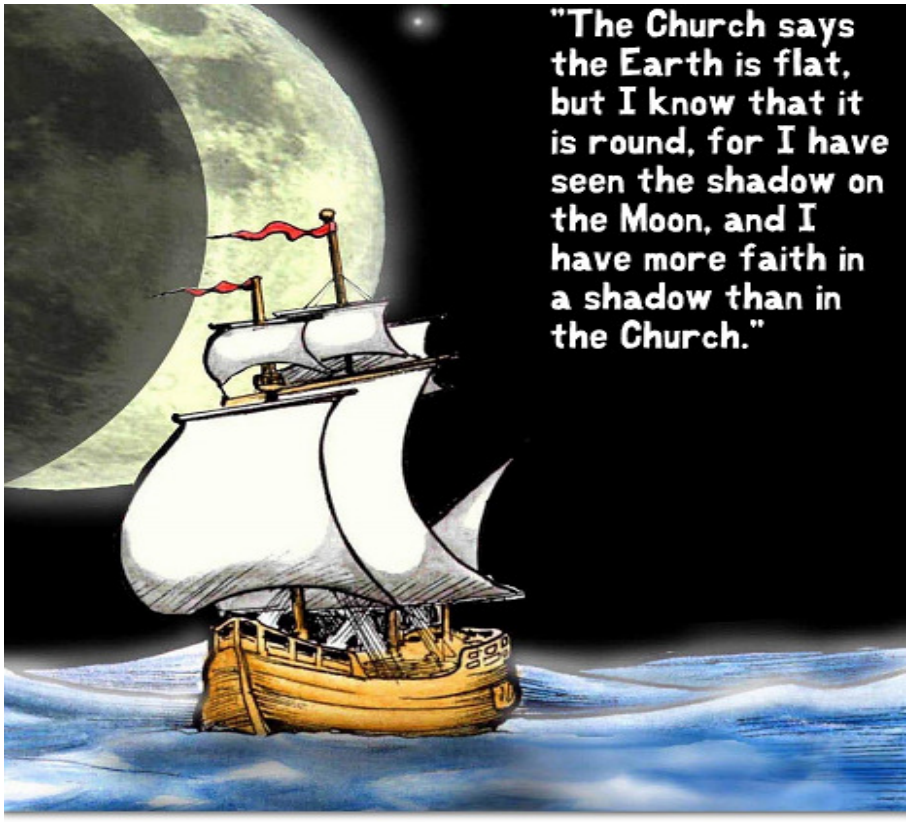


Figure 15. Adaptation of an artistic rendering to illustrate the early universe. The rapidly dilating Hubble volume hybrids a variety of circulatory entities. Motion and expansion of two oppositely rotating angular momentum vortices (e.g., a positron and electron to be) are highlighted in gray. Each follows a different space-time path depicted as oppositely spiraling logarithmic functions similar to many growth patterns found in nature. The non highlighted circles represent expanding angular momentum spatial quantum(s) h/4π.



Attributed to Ferdinand Magellan, Portuguese Navigator, 1480-1521

From Ocean Waves to particle Waves[16]

The "probability" interpretation of Schroedinger's equation proffered by Max Born is, by learned authority, correct, yet, at the time, it was strongly opposed by Schroedinger himself.[17] The impetus for its development was de Broglie's earlier representation of matter waves ($\lambda = h/mv$); Schroedinger reasoned that the amplitude ψ of these waves could be determined by a differential wave equation with physical significance, but he was unable to specify what was waving. If force fields are accelerating space, angular momentum in motion should create wavelike disturbance.

[16]The Ancient Greeks also regarded the shadow as evidence of the earth's shape. Aristarchus had measured the angle between the earth and Sun when the moon was half phase. From this he determined the Sun to be much larger than the earth (likely what led him to the heliocentric theory). By observing the moon carefully during a lunar eclipse, it was determined that the earths conical shadow at the distance of the moon was about 2(½) times the moons diameter, from which the distance to the moon was calculated to be approximately 240,000 miles. Whether the heretical comment was the utterance of Magellan is not certain. We would like to think the legend is true.

[17]Edwin Schrodinger was by no means a young man when he set off with an attractive young mistress to the seclusion of a mountain retreat for the stated purpose of finding an equation to explain De Broglie's wave. Able to utilize both mind and body successfully during his two week ordeal, the affair led to a Nobel Prize for Schrodinger and his recognition as a man with more than one talent.

ALPHA

The dimension-less parameter $\boldsymbol{\alpha}$ is a shorthand label for the Sommerfield "fine structure constant." Dimension-less constants are ratios of factors also believed to be constants:

$$\boldsymbol{\alpha = k_e q^2/\hbar c = [k_e q^2/c]/\hbar} \tag{5.12}$$

Alpha comes into play when waves interact with particles. The ratio (5.12) corresponds to the velocity of an electron in the first *Bohr orbit* relative to the velocity of light **c**.[18] Its numerical value ($\approx 1/137$) has always been a mystery.[19] From (4-15),

$$\boldsymbol{\alpha = [k_e q^2/c]/\hbar = [2m_o c^2 r_o/c]/\hbar} \tag{5.13}$$

Since $\mathbf{m_o c r_o}$ is the angular momentum $\mathbf{L_o}$ of the electron eye, then from (4.17), alpha reduces to:

$$\boldsymbol{\alpha = L_o/(\hbar/2) = m_o c r_o/(\hbar/2)} \tag{5.14}$$

Equation (5.14) reveals $\boldsymbol{\alpha}$ as the ratio of two angular momentums. The numerator is the pseudo moment of momentum related to the energy of the electric field reflexed to the circulatory center [to which we attribute a finite fixed size embodied as the eye having surface density $\mathbf{m_o/4\pi(r_o)^2}$]. The denominator is the intrinsic **3-D** global angular momentum spatial field $\mathbf{h/4\pi}$ associated with half spin particles.[20] The coupling factor *alpha* is the origin of the one with respect to the dependency of the other. The pseudo angular momentum $\mathbf{L_o = m_o c r_o}$ is the maximum angular momentum possible for an energy content $\mathbf{m_o}$ distributed over a surface of radius $\mathbf{r_o}$ having relative angular velocity '$\mathbf{c/r_o}$.' $\mathbf{L_o}$ can be thought of as a virtual reactionary counter spin; the eye mass itself cannot rotate at velocity '**c**' just as a photon cannot be considered real mass moving at the speed of light '**c**.'

Electrons and positrons are circulatory fields having spatial size and finite eye radii taken herein to be synonymous with an effective rotational distance $\mathbf{r_o}$. In the brief study of the *Strong Force* which follows, the proposition of pseudo reactionary angular momentums will be revisited in connection with the local interaction between the heavy particles involved in binding nucleons together.

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[18]The constant $\boldsymbol{\alpha}$ plays a crucial role in **QED** theory in that it relates the electrostatic quantities $\mathbf{k_e}$ and **q** to the value of **h** and **c**.

[19]See Appendix XIV for a derivation of the Bohr model. The small value of alpha justifies the perturbative expansion of the Dyson's equation—the ratio of the spatial angular momentums to local angular momentum slightly alters the gyromagnetic ratio.

[20]In order to explain the magnet moment of the electron, the spin field devised by Goudsmit and Uhlenbeck (footnote 25 of Chapter IV) was modeled as a rotating cloud of energy. The ratio of the magnetic moment $\boldsymbol{\mu_s}$ to the angular momentum $\mathbf{L_s}$ is approx **2(e/m)** where **e** is electron charge and **m** electron mass. The true value **2(1.001159615)(e/m)** is accurately predicted by perturbation theory, now more conveniently symbolized and calculated from Feynman diagrams.

Strong Force/Weak force

In 1933, Hideki Yukawa hypothesized the nuclear binding potential could be related in form to the Coulombic force if multiplied by an inverse exponential time delay function conflated to reflect a mass factor approx 200($\mathbf{m_o}$):

> "It seems natural to modify the theory of Heisenberg and Fermi in the following way. The transition of a heavy particle from neutron state is not always accompanied by the emission of light particles. The transition is sometimes taken up by another heavy particle."

The $\boldsymbol{\mu}$ meson (207$\mathbf{m_o}$) now called muon, was initially thought to be Yukawa's particle, but as later shown, it did not fit the *standard theory* of forces that evolved around the idea of spin one virtual particles traveling between nucleons. Somewhat heavier mesons called pions were subsequently discovered and adapted to the standard theory, leading to a Nobel prize for Yukawa.[21] While not a part of the *standard model,* muons will play a key role in circulatory coupling theory.[22]

Gravitational and electrical forces have measurable coefficients **G** and **q**, so new theories of gravity and charge are easily falsified if they do not produce the correct force. The strong and weak interactions, by contrast, depend from complex geometric(s) involving rotational and positional uncertainties. Our excursion into the subatomic world will be limited to an extension of circulatory created acceleration forces. This reinvigoration of the laws of classical physics on a Lilliputian scale will lead to consistency and simplicity in the sense first recognized by William of Occam. Still, the interaction of micro components within the confines of nucleons cannot be celebrated without some postulation.[23] Something new is required.

This is where the muon debuts. For a self repulsive field, larger mass comports with smaller size. If muons are analogized as contracted electrons having no internal structure, then the entire energy could be contained within a radius on the order of $\mathbf{r_\mu = r_o/207.}$ At distance $\mathbf{d > r_o}$, muons and electrons exert the same force:[24]

$$\mathbf{F = [2(m_\mu)(r_\mu)c^2\ ]/d^2 = [2m_o r_o c^2]\ /d^2} \qquad (5.15)$$

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[21]The recognition of the muon as a fundamental particle with no role in the standard model has been disconcerting for theorists, prompting Nobel laureate I.I. Rabi, to quip: Who ordered that!

[22]Without a physical theory of how particles effectuate binding, there is no hope of finding an analytical expression for the magnitude of the force based upon fundamental principles. How and why pions somehow lasso neutrons and protons together is never explained

[23] Binding forces increases with distance until a nucleon breaks free. From a classical perspective the breaking of a nuclear bond is not possible unless the bound particle has a higher KE than the binding potential. It is explained by a wave mechanical phenomena known as tunneling first proposed by G. Gamow and R Gerney in 1928.

[24]When the orbital electron of a hydrogen atom is replaced with a muon, the muonic atom is much smaller because the ground state wavefunction is much more localized due to the larger mass.

In theory supported by experimental findings, the muon radius is indeed less than an electron, but as developed herein, factors other than mass come into play in determining its operative range as a binding element.[24] So while the minimum muon radius $\mathbf{r_\mu = r_o c/m_u}$ the effective radius $\mathbf{r_e}$ as an instrumentality of the strong force will likely depend upon angular momentum, but which angular momentum?[25] To achieve strong binding forces from circulatory coupling interaction, flow energy must be compacted into confined spaces. This can take form either as density endowed rotational space or the rotational momentum of the particle itself.

In developing the coupling constant '*alpha*," two angular momentums came into play (local angular momentum $\mathbf{m_o c r_o}$) and the global circulation $\mathbf{h/4\pi}$ associated with electric fields. The eye angular momentum of the electron is limited by its size, and mass. But in the case of the muon, the limiting alpha factor can be unity, that is because of its larger mass, the effective local angular momentum of the eye can be as high as $\mathbf{h/4\pi}$. The compacted rotational flux could conceivable have the same circulatory energy as the electric field $\mathbf{m_o c^2}$ summed over the Hubble sphere. This, at first glance, would appear to sustain a preliminary account of the strength of the nuclear binding force based upon its limited range. But the situation is not so clear.

To explain the experiments, rotational entities are postulated to experience the angular momentum of other rotations if they are enclosed within the effective rotational radius of the other. If the muon is taken to be a fundamental particle (i.e, a shell having no internal structure), its $\mathbf{h/4\pi}$ angular momentum is accommodated by an effective radial rotational length $\mathbf{r_e}$:

$$\mathbf{r_e = (5.3 \times 10^{-35})/(207)m_o[c] = 0.93\ fermi}. \qquad (5.16)$$

The assumption of a local counter angular momentum based upon the mass factor $\mathbf{m_\mu = 207 m_o}$ leads to a momentum transference rate in the range of the estimated strength of the strong force. For present purposes it is only necessary to consider the muonic coupling mechanism as short range, the effective momentum of momentum for purposes of binding adjacent particles being confined to an area defined by the muon's positional configuration within a pion as more fully developed herein below. The rate of change of momentum will be effectuated by the operative density of the muon rather than the standard story based upon ejection and absorption of virtual particles. The density of the muonic interface determines the force.[26]

Pions by contrast are compound structures which come in two varieties as shown in **Figures 16A** and **16B**. Those with charge normally decompose as muons of the same polarity plus a neutrino, neutral pions usually create two gamma rays.

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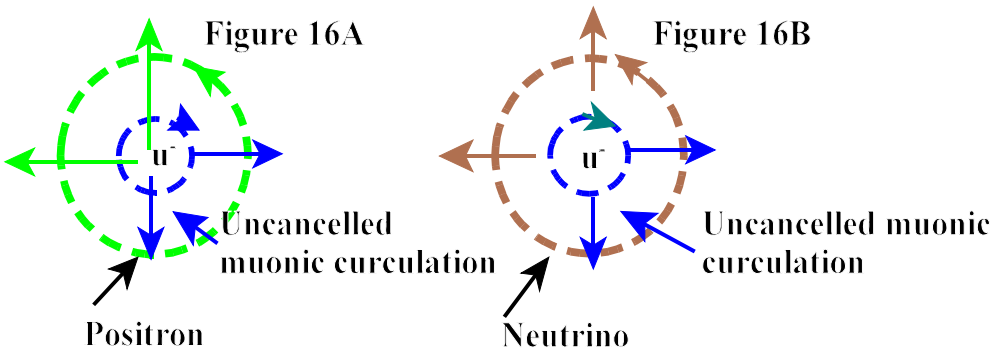
[25]Much effort has been directed to endorsing certain actions, processes and particles, not because they are proven by the experiments, but because they are not excluded by the results.

[26]High density spatial environments mean high pressure and pressure augers compression. If pressure transfigures electrons to muons then stress emancipated muons unlax as electrons. For constant circulatory flux '**c**' angular momentum will be conserved if mass-energy sheds during expansion and accretes during contraction.



The neutral pion π^o can be constructed from a $\mu+$ coupled to an electron shell as shown in **Figure 16A** or a μ^- nested within a positron. The muon-electron decay products are positrons, electrons and radiation; the muonic component would appear to be transformed to leptons and radiation as part of the decay process which takes place during an average time of $\mathbf{1.8\ x10^{-16}\ sec}$. Both the electron and its muon companion μ^- have ponderable mass, ergo for concentric spatial circulation fields at distances greater than $\mathbf{r_o}$, the angular momentum fields are equal *a la* (5.15) and canceling. But that is not the case when the μ^- is hosted by an anticlockwise spatial angular momentum (what we will henceforth regard as a quasi-static neutrino (**QSN**) as shown in **Figure 16B**).[27] Equal and opposite neutrino angular momentum $\mathbf{h/4\pi}$ cancels the angular momentum adjunct of the neutrino, so net local angular momentum is zero, but the electric field of circulatory space derives solely from the mass $\mathbf{m_u}$, no part being contributed by the nearly massless neutrino. To restate, the mathematical rotational field of space beyond the neutrino radius $\mathbf{r_n}$ is unaffected, but the local angular momentum is net zero. Since the massless neutrino cannot exhibit electrical properties, the electric field belongs to the muon.

Thus while the local net moment of momentum is zero, the rotational spatial field between $\mathbf{r_n}$ and $\mathbf{r_\mu}$ is not canceled. Both charged and neutral pions have spatial circulation fields between the muon radius $\mathbf{r_\mu}$ and the electron radius $\mathbf{r_o}$ (the neutrino size is deduced from the fact that its angular momentum $\mathbf{h/4\pi}$ must cancel the muon field $\mathbf{h/4\pi}$ at all distances greater than $\mathbf{r_o}$ to comport with spin zero pion angular momentum. The circulatory forces in the hinter land between the muon and its companion element (a neutrino for charged pions, an electron or positron for neutral pions) varies with the circulatory interaction. The greater the number of flux lines enclosed by the circulatory field of the one within the other, the greater the force.[28]

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[27]The **QSN** is an embellishment of the spatial unit previously introduced as a **3-D** quantum angular momentum $\mathbf{h/4\pi}$ in attempting to give meaning to a quantum theory of space. Adaptation as a counter rotating shroud in concert with a muon, net angular momentum is zero (like two equal flywheels on the same shaft rotating in opposite directions).

[28]The nuances of directly interacting subatomic particles is treated in the standard theory as quarks prophesied to exist in triplets assigned *ad hoc* masses and fractional spins. Particles are regarded as *point-like* to facilitate mathematical representation. As observed by Paul Dirac, the object is not so much to get a model that conforms with current physical ideas, but rather to find a scheme of equations which can be used to calculate all the results obtained from experiments.

Admittedly, a physical model built upon dimensions deduced from scattering experiments, measured masses, and the remnants of bombardment is guaranteed to be woefully incomplete at best, and most likely totally wrong. Nonetheless, trial and error can be used starting with the construction of kaons from pions, and nucleons from kaons, to see what might be modified to make things fit. If the structures shown in **Figures 16A** and **16B** can be paired with similar sub-assemblies, then a step has been taken in the direction of explaining nuclear forces as an extension of classical mechanics. Along the way, a glimmer of light will be shed upon the peculiarities of nuclear magnetic moments[29] All this demands a new spin be put upon small circulations (so to speak).

In the usual treatment of subatomic angular momentums, the addition rules are defined by Clebsch-Gordon coefficients for spin pairs where either can have up or down spin. This follows from the traditional view of angular momentum as rotating mass, the permitted states thus spanning a **4-D** space (↑↓), (↓↓), (↑↑), (↓↑). Richard Feynman's lament regarding the difficulty of comprehending isotropic quantum angular momentum thus infects the two particle system as well. But as was the case with single particles, relief comes in the form of Einstein's Principle of Relative Acceleration, cultivated herein as circulatory space. In the case of quantum fields, it is the intrinsic acceleration of the rotating spatial field rather than rotating mass that manifests as angular momentum; the enigma of isotropic spin is abrogated when the roles played by space and matter are reversed.

To sustain the interpretation of $\mathbf{h/4\pi}$ as an electric field, charged pions present a problem if they are instituted as we propose, the purveyors of the strong force. The constellation of subassemblies within nucleons must self-arrange to exploit the dimensional disparity between muons and leptons. In our models of neutral and charged pions (**Figures 16A and B**), muon spins are countered by lepton spins, but because lepton radii are larger than muon radii, the spatial rotational field there between is un-canceled. This is the domain of the circulatory field that brings about the binding force to which we now assign a provisional factor $\mathbf{\psi = m_u c^2/[r_e]}$ where $\mathbf{r_e}$ is the effective radius of the muonic component of a pion. Neutrino angular momentum counters muon angular momentum in all three dimensions at all distances greater than $\mathbf{r_o}$. This leaves the intensity of an un-canceled circulatory shell to be approximated in our drawing by a single circulatory radius $\mathbf{r_u < r_e < r_o}$. The constellation of two **3-D** antiparallel rotations having different radial limits reduces to a circulatory shell having two sharply defined limits at $\mathbf{r_o}$ and $\mathbf{r_\mu}$. In this range, the strong force increases with distance to a maximum value, and then abruptly cuts off at about 2 fermi. Experimentally, the binding energy of protons is approximately **150 MeV** (approximately equal to the rest mass energy of a pion).

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[29]The neutron carries no electric charge, yet it exhibits a magnetic moment of ($\mathbf{-1.91\beta_I}$) where $\mathbf{\beta_I}$ is the nuclear magneton obtained by dividing the product $\mathbf{e\hbar}$ by the proton mass. Also puzzling is the negative sign, which shows the neutron's magnetic moment to be opposite to the direction of its angular momentum. After transition to a proton, the angular momentum is ($\mathbf{+2.8\beta_I}$).

Accordingly, the field equation for the strong force will have the form:

$$E_S = [\rho_s c^2/r_\mu r_o][\Delta s] = \psi[\Delta s] \qquad (5.17)$$

where **Δs** is the offset distance from concentricity illustrated in **Figure 17** and ρ_S is the density of the space that constitutes the mass of the particle.

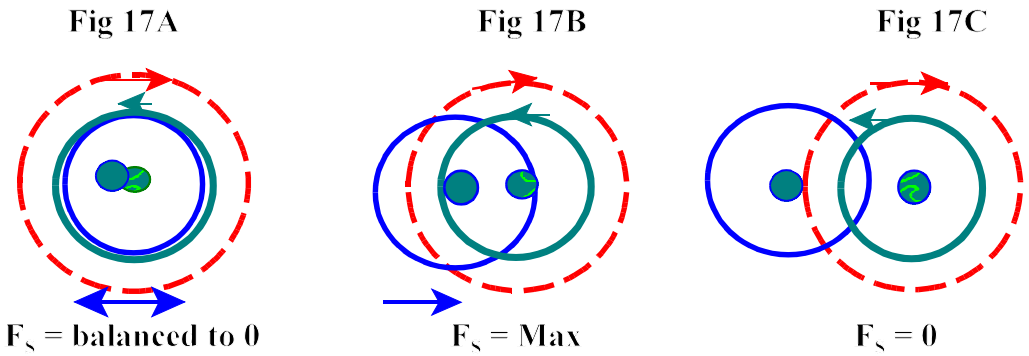
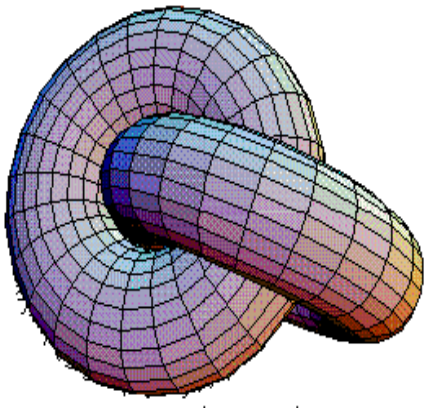


Figure 17 (A, B, and C) depict a pion comprised of a central muon (Green counterclockwise swirl) nested within an outer clockwise circulatory shell (red) [representing a neutrino for the neutral pion concoction (Figure 16A) and an electron for the charged pion (Figure 16B)]. The red particle has no interior structure or field, so the force acting upon the rotational field of the unspecified third particle (blue) is due to the muon (the green circulation ring representing the effective circulatory radius of the muon r_e). The interaction between the muon and the blue circulatory field is the binding force. When the rotational centers of the blue and green circulations are nearly concentric (Fig 17A) the net binding force tends to zero. Increasing the distance between the blue and green rotational centers increases the re-centering force (Fig 17B). If the blue circulatory center escapes the effective circulatory radius of the muon (Fig 17C) the binding force F_s drops to zero (for the neutral pion) or reverses to the electric repulsive force if the blue and green particles have the same charge.

Long range force fields are the manifest of dynamic expansion. Short range binding forces are confined to small areas and consequently the coupling flux must be highly concentrated. The retentive force that holds nucleons together and indeed, the elements that make up nucleons, are testament to the high density circulatory interaction sustained by the angular momentum flux. Free space pions as imagined in **Figures 16A** and **16B**, would bear little resemblance to the same depictions when locked in a binding mode like that shown in **Figure 18**. ------->



That a circulatory flux can produce localized forces via transfer of angular momentum is no less credible than the standard theory imaged as showers of virtual pions continuously transferring momentum between point particles. Quantum theories of force are grounded upon all or nothing momentum impact exchange, consequently a different particle is called into existence to explain each force. Virtual particles are never seen, there is no accounting for their numbers, annihilation is without regard for conservation. Real particles, by contrast, are endowed with measurable properties. Charge, baryon number (protons + neutrons) and angular momentum is conserved no matter how many new particles are created in a process. When the mass **m** of a particle is sufficiently large, the alpha factor is unity and the counter rotational velocity **c** corresponds to an angular momentum flux $\mathbf{mcr = h/4\pi}$. For the muon, $\mathbf{m_m = (207m_o)}$. This corresponds to a rotational radius $\mathbf{r_e = 0.93\ fermi}$ per (5.16). The maximum force is therefore in the range of:

$$\mathbf{F_e = m_m c^2/r_e} \tag{5.18}$$

approximately 320 times the electrical force.

The fabrication of nuclei from a combination of spins could begin with a tally of the minimum mass needed to build a neutron.[30] The total mass is almost always different than the sum of the parts.[31] Creation of extra nucleons during high energy proton bombardment suggests pions, and their decay products, are prone to re-configure formatively as nucleons. On the global scale, dark matter is hypothesized to make up what is missing from the universe. For nucleons and other subatomic composites, missing matter is added as gluons.[32] The problem is that of composing neutrons and protons from the composites produced by kinetic bombardment. Protons smashed against other protons create pieces of protons along with additional protons. While this seems to complicate an already complex affair, it may be a clue as to a how nucleons are structured (Appendix XXI).

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[30]Curiously, within the limits of experimental findings, the mass needed to compose a neutron ($\mathbf{1838.63m_o}$) can be assembled from kaon debris within an accuracy of 0.01% if no energy is budgeted for binding. Here is the recipe: Take one **μ+** ($\mathbf{206.78m_o}$), one neutral pion ($\mathbf{264.3m_o}$), two **π minus,** three **π plus (5)(273.3)$\mathbf{m_o}$** and one electron $\mathbf{m_o}$. Mix together to get a total of $\mathbf{1838.58m_o}$,.

[31]Adding up the quark masses that go to the make-up a proton or neutron is a useless exercise if one wishes to learn something about the matter content in relation to the binding energy. For example the three light quarks (**uud**) that are theorized to constitute the proton total about 1% of the proton mass. According to **QCD** theory, a baryon consists of a sea of quarks and the gluons that bind them together. Physicists generally classify the compositional components of baryons using *parton distribution functions*, or **PDF's**. While theories built upon unverifiable foundations can be made to work with enough tinkering, the experiments only admit certain outcomes as not inconsistent.

[32]As with "Higgs Bosons." it not possible to visualize how the short lived massive products of extreme kinetic collisions can communicate the correct mass to new particles. In impact experiments, for example, hydrogen nuclei struck by protons having kinetic energies greater than (**6GeV**) create proton-antiproton pairs [two new particles complete with mass plus the original impacting protons are observed. Proton-proton scattering at lower energies (**E > 290 MeV**) creates additional neutrons and pions by ($p + p \rightarrow p + p + \pi^o$) and ($p + p \rightarrow p + n + \pi^+$)].

Spatial Dynamics and the Elsewhere

There are complementary aspects to reality. In the prosaic and congenial view, forces and masses are associated with particles having size, shape, location, duration and destructibility. Fields and waves, are the stuff of mediums. The two perspectives merge toward something that is neither particle nor wave—the subjects collect into drops or dissolve into fog as focus is sharpened upon one or the other. This is the realm of virtual vorticity.

How is it, asks Einstein,"that mathematics, a product of human thought that is independent of experience, fits so excellently, the objects of physical reality?" For a theory to be complete, there should be only one choice for the constants that define it–the values we observe. To unlock natures secrets is to find the cause of her constants. Space, time and uncertainty are always with us, so let them be admitted into evidence as the likely instruments of expression.

The creation and existence of particles is of no significance without organizational structure. By whatever theory one chooses to model the neutron, it is the orchestral wonder that enables composition. A universe filled with non-clumping particles is as meaningless and uninteresting as an empty universe. For many, the existence of a miraculous binding organ is evidence of natures objective. The ideas behind mathematical relationships would seem to stand on their own, there need be no beginning and no universe for representation. But change, organization and configuration would seem to require management and continuity. Still, a genesis for the present phase is not necessarily inconsistent with eternal pre-existence. Immanuel Kant, in his critique of pure reason (1781) argued that the world could have a beginning and yet be eternal. Kant called the Philosophy "Transcendental Idealism." It has reappeared in different forms in recent years {The Instanton model of Hawking and Hartle (1983) premised upon an absolute beginning, and the transition from an earlier state proposed by Linde and others (1984) to name but a few}. To avoid the *intelligent design syndrom*, the constants must be shown to be unique in the sense that in a zero energy universe, things could not be otherwise.

In these pages we have shown the relationship between space and time is encoded in the coefficients of the *Force Constants* as $\mathbf{c^2}$, and that charge, angular momentum, nuclear bonding, and gravity, reduce to physics of divergent space. To find the reason for the rules of matter, we have looked to the void. Electron mass ($\mathbf{10^{-30}\,kgm}$) contracted to black-hole size, corresponds to a radius $\mathbf{10^{-57}}$meter. If $\mathbf{r_s}$ is expanded by $\mathbf{10^{42}}$, the result comports with the electron radius ($\mathbf{r_o = 10^{-15}\ meters}$). Expansion of $\mathbf{r_o}$ by $\mathbf{10^{42}}$ coincides with the scale $\mathbf{R = 10^{26}}$ meters. Reduction of the scale factor **R** by $\mathbf{10^{42}}$ accords with the classical electron radius ($\mathbf{10^{-15}}$), and a decrease by $\mathbf{10^{42}}$ in the nuclear density ($\mathbf{10^{16}\,kgm/m^3}$) reduces to cosmic density ($\mathbf{10^{-26}\ kgm/m}$). Space is the common commutator, that which relates action to the rest frame of the universe. The universe must obey the law of zero energy because the law of zero energy is the universe. How could it be otherwise?

All this leads back to the beginning—back to Arthur Eddington. Eddington's effort to relate the masses of the electron and proton through numerology was considered by his colleagues as misguided obsession. Unconventional theories and circuitous arguments based upon Einstein's cosmological constant eventually earned him the unenviable reputation of "physicist gone mystic." But in the decades since passed, much has been learned about the universe. In the light of these new discoveries, Eddington's discernment(s) now appear more insight than dementia:

"***..in these astronomical discoveries in the remoteness of space we have picked up the key to the mysteries of the proton and electron..***"

The thrust of modern scientific thinking has been reductionism—dividing the enigma into smaller parts for separate analysis. But some mysteries, like jig-saw puzzles, can only be solved by putting pieces together. These problems are holistic, not synthesize-able by dissection. The failure of quantum theory to explain classical theory, or be explained in terms of classical theory, is a paramount example of the limited applicability of reductionism. Yet it is not surprising. Such methods "teach away" from universal connectedness. What is wanting, is an interpretation of subatomic entities as parts of the whole. As the classical forces have been shown to be the derivatives of expansion, so also does the origin and existence of particles depend thereon. It is the cosmos that "wags its subatomic tail" and it is the tail that wags the classical world. To understand the infinitesimal, it is necessary to study the heavens; to understand the heavens, it is necessary to look inside the atom.

Human visibility, however, is limited on the large scale by the Hubble scale, and on the small scale by uncertainty. That which lies beyond the CBR curtain is censured. Exploration within the atom is confined to the calculation of likelihoods. Between these limits lies the hope of finding answers. But the noble endeavor for enlightenment will likely lead to a disheartening observation:

"The more we comprehend the universe the more pointless it seems"

Stephen Weinberg

Reflections

In this undertaking, classical methods are stretched to explain how forces arise. After three centuries we returned to Newton's *Law of Inertia* to explain his *Law of Gravity,* and from that inquest, *Mach's Principle* re-emerged, consistent with global acceleration and effective for its understanding. Electric charge was identified as mechanical in origin; an isotropic rotational field within a massless fluid medium that leads to Coulomb's Law. These findings were consistent with Dirac's **LNH**, and they opened the door to other connections. In particular, circulatory space as the electrical counterpoint of quantum angular momentum was explored and the moment of momentum pressed into service to elucidate nuclear binding as the compliment of the electric field. Alas, with the weak force rationalized as statistical inertial imbalance, all but gravity is whirl. In the end, even gravity, because of its form [velocity squared divided by distance ($\mathbf{c^2/R}$)($\mathbf{1/4\pi}$)], becomes somewhat suspect. Is spatial circulation on the cosmological scale subjecting local masses to rotational centrifugal action. If so, we are left with only one action to explain natures forces.

In the context of *time* and *space*, the *here-and-now* can be anywhere between antithetical infinities. The "beginning-of-time" and the "end-of-space" are words without meaning. *Alpha* and *Omega* dissolve into dimensions without limit. The idea of an infinite and eternal universe is intensely captivating. Yet there is bewitching intrigue in the concept of an illimitable past with the countenance of a genesis. What manner of cosmic jester would perpetrate a universe with neither a reason for a beginning nor an objective for an end?

In these pages, the idea of space has been promoted from nothing to something. Yet the stuff of which it is made remains the ultimate mystery. Only the consequences of acceleration can be measured. The recipe for the contents of the universe will always be a subject of intellectual discourse. It is likely the pursuit of the Holy Grail will lead to more pleasure than finding it. The author recommends a panel of friends gathered before a fireside on a cold winter's night, moderated by the glow of mild intoxication. It is where this book started, and where it now ends.

Throughout scientific history, force and matter were the underlying concepts in all endeavors to understand nature. Much effort has been directed to reducing the apparent complexity of the physical world to these fundamental perceptions. This idea was expressed even in the work of the Atomist, Democritus, 23 centuries past:

"By convention, sweet is sweet, hot is hot, color is color.....
But in reality, only the atoms and the void are real."

Incredible as it seems, we have found the universe to be even less substantive:

It only the void that is real!

Epilogue

"Whether we will philosophize, or whether we won't, we all must philosophize." Aristotle

Gravity and inertia derive as the products of acceleration; electrons expose as spatial circulations. Out of these mathematical methods a model of the universe emerged, and with it profound implications about *beginnings* and *endings* that discredit the anthropic doctrine founded upon God created *constants. Only* one dynamic functionality is required to bring spacetime to the fore, and matter into being. And here ends our quest, for physical theories cannot reach beyond material boundaries nor can they shed light upon "*our*" uncertain place in an uncertain universe.

The extension of classical theory to non-material fields suggests new relations between old structures, but the identity of the things themselves remains tenuous. Our good fortune is that the benefactions of many are available to study the implications. Future revelations will recast what is offered here—ultimately confirmations or falsifications will emerge. What is certain, is that no theory will ever be complete. John Wheeler once delivered a lovely but chilling paradox: "*At the heart of everything is a question, not an answer. When we peer down into the deepest recesses of matter, or at the farthest edge of the universe, we see, finally, our own puzzled faces looking back at us.*"

"I cannot help feeling that the darkness in which the final secret of the universe lies hid is part of the Great Design. This world of ours has been constructed like a superbly written novel: we pursue the tale with avidity, hoping to discover the plot. The elusiveness of the chase heightens our ardor, until the search becomes part of our religion. For the secret of secrets recedes as we run. The ultimate reason for man's existence is the only fruit in the garden of life which he can never hope to pluck."

Sir Arthur Keith

Pisa, Galileo's birthplace, and according to the apocryphal legend, weights were dropped to verify the uniformity of gravitational acceleration. The 2002 photo of the author dispels a widely held belief the tower is leaning. In questions of science, being "off-plumb" depends upon the perspective.

APPENDICES

REFERENCES

Appendix A-I (Derivation of G)

The rate of change of a spherical volume of radius **R** expanding at radial rate **c** is:

$$\frac{\partial V}{\partial t} = 4\pi R^2\left(\frac{\partial R}{\partial t}\right) = 4\pi R^2\left(\dot{R}\right) = 4\pi R^2 c$$

For a changing radial rate, the volumetric acceleration is obtained from:

$$\frac{\partial^2 V}{\partial t^2} = 8\pi R\left(\frac{\partial R}{\partial t}\right)^2 + \left(4\pi R^2\right)\left(\frac{\partial^2 R}{\partial t^2}\right)$$

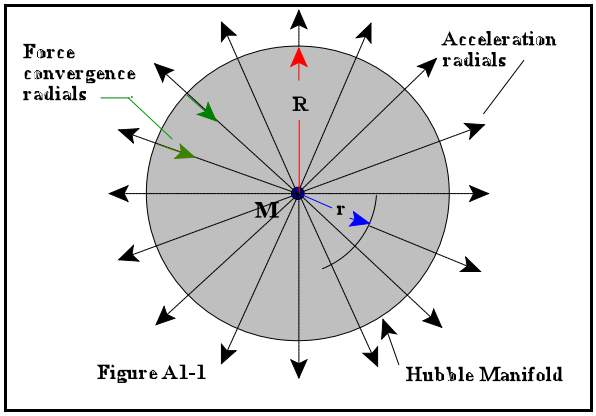
where the second term may be positive, negative or zero. The rate of volumetric acceleration divided by the area $\mathbf{4\pi R^2}$ enclosing the volume is the divergence modulus of expanding space. This factor is a holistic property of the universe which decreases as the radius grows. An imaginary gaussian surround coincident with the Hubble surface at any instant takes the measure of recessional flow; the volumetric change is transformed to the integral of the spatial flux taken over the surface $\mathbf{4\pi R^2}$. To relate accelerating space to the gravitational reactionary field of a point mass **M** immersed therein, **M** is expressed as an inertial surface density $\boldsymbol{\sigma} = [\mathbf{M}/4\pi\mathbf{r}^2][\mathbf{meters}^2/\mathbf{kgm}]$. Newton's second law then applies straightaway. From (1.6b) and the discussion pertaining thereto, the reactionary field for a **q = -1** expansion dynamic along any radial spoke is $\mathbf{c^2/R}$, and therefore:

$$\mathbf{E_M = (c^2/R)[M/4\pi r^2][meters^2/kgm]} \qquad \text{(A1.1)}$$

Our objective will be to find the reactionary field of **M** in the usual form which incorporates the gravitational parameter **G**:

$$\mathbf{E_g = G[M/r^2] = Force\ per\ kgm} \qquad \text{(A1.2)}$$

Figure A1-1 depicts acceleration flux exiting the Hubble manifold (black arrows) and reactionary field (green arrows). The blue arrow denotes the radius **r** of the sphere where the reactionary field of the mass **M** has a surface force **σ**



The formalization of **G** is then what is left after extracting the factors **M** and $\mathbf{r^2}$ from (A1.1) to a bracketed multiplier. The inertial matter field (A1.1) in terms of a bracketed multiplier as shown in (A1.2) is therefore:

$$\mathbf{E_M = \{c^2\ meters^2/4\pi R\ kgm\}\ [M/r^2]} \qquad \text{(A1.3)}$$

where the inertial reactionary field at any distance **r** is determined by inserting the values for **r** and **M**. If the terms within the first bracket are equivalent to **G**, then:

$$\mathbf{G = \{c^2\ meters^2/4\pi R\ kgm\}} \qquad \text{(A1.4)}$$

For the three sphere **q = (-1)** universe, $\mathbf{R = (1.29 \times 10^{26}\ meters)(5/6)}$, so the directional reactionary force of a mass **M** expressed in **kgm** at any distance **r** is:

$$\mathbf{E_g = [G][M/r^2] = [6.7 \times 10^{-11}\ meters^3/(sec^2)(kgm)][M/r^2]} \qquad \text{(A1.5)}$$

The above (A1.5) outputs the reactance of **M** in **ntn per kgm**. No tag along units are required since dimensional congruity is encoded into **G** *vis a viz* the introduction of a reactive surface density **σ**.

The Hubble sphere contains all forms of energy receding at less than the velocity of light, therefore the putative surface of the Hubble sphere at distance $\mathbf{R = L_H = c/H}$ recedes at velocity $\mathbf{U_H}$ equal to $\mathbf{d(L_H)/dt}$, that is

$$\mathbf{U_H = c\ (1+q)}$$

Energy Flux (isotropic Hubble Flow) at distance $\mathbf{L_H}$ recedes at the velocity of light **c**. In decelerating universes **q** is positive so the Hubble sphere grows faster than the recessional velocity,

$$\mathbf{U_H - c = cq}$$

For accelerating universes (**q < 0**) the spatial recessional velocity will eventually overtake the rate "**c**" at which the communicable distance (Hubble scale) increases. This occurs at a radius $\mathbf{L_H}$ where the Hubble velocity $\mathbf{U_H}$ equals the recessional flow "**c**." For de Sitter space, **q = -1** so $\mathbf{U_H}$ is zero thereafter.

Appendix A-2

Earth's Gravity vs The Universe

The acceleration field subsist as the totality of exiting energy summed over the Hubble manifold. In a Mercator projection of the cosmological field and the earths gravitational field, each is represented as a flat surface of area $\mathbf{S_R}$ and $\mathbf{S_e}$ respectively, as shown in **Figure 3A**. If the total cosmic mass-energy $\mathbf{M_u}$ is deemed concentrated as a surface density $\boldsymbol{\sigma_u}$ in $\mathbf{S_R}$ and the earths mass $\mathbf{M_e}$ is likewise concentrated as a surface density $\boldsymbol{\sigma_e}$ in $\mathbf{S_e}$ then for the universe the surface density is $\mathbf{M_u/4\pi(R)^2}$ and for the earth of radius **r** the surface density will be $\mathbf{M_e/4\pi r^2}$. Profiling space as an accelerating massless continuum and relating the negative pressure at the earths surface $\mathbf{A_n M_e/4\pi r^2}$ to the negative manifold pressure $\mathbf{M_u(A_n)/4\pi R^2}$, then for $\mathbf{A_n = Hc}$ and cosmic mass density $\mathbf{M_u/4\pi R^2 = 1}$, the ratio of the earths pressure to the cosmological pressure is:

$$\frac{g}{A_n} = \frac{\sigma_e}{\sigma_u} = \frac{\dfrac{m_e}{4\pi r_e^{\,2}}}{\dfrac{M_u}{4\pi R^2}}$$

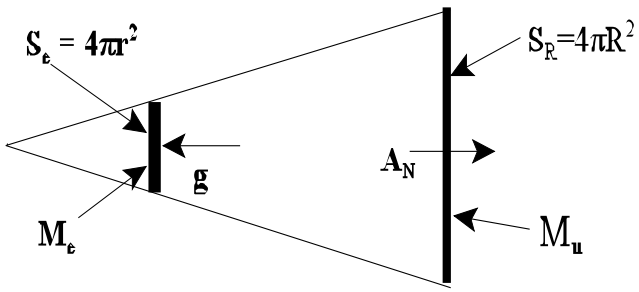


Figure A2-1

Taking $\mathbf{M_e}$ as **5.98 x 10^{24} kgm** and **r** as **6.37x10^6** meters, then

$$P = Hc(5.98 \times 10^{24}\text{kgm})/4\pi(6.37 \times 10^{6}\text{meters})^2 \approx 9.8\ \text{ntn/m}^2$$

Appendix A-3

The implications of the General Theory are bound up in the alteration of space and time; it ties the metrical properties of the container to the density of its contents in contrast to the pre-relativistic schematic of *a priori* definable geometry. In Einstein's world, gravity is described by tensor equations relating the four dimensional distances (three space and one time) to neighboring space. While curvature in 4 dimensions cannot be visualized, the time independent Swartzschild solution for a uniform spherical mass **M** does have a physical analog which appears as a defect in the measured area **A** of a concentric spherical surface encompassing **M**. Specifically the actual radius $\mathbf{r_m}$ of this surface will exceed the radius calculated from Euclidean geometry by an amount proportional to **M**. The excess radius **δr** for a static space is:

$$\delta r = r_m - (A/4\pi)^{1/2} = MG/3c^2$$

Distortion of accelerating space based upon the dynamic bulk modulus β_d follows from the constructs of Chapter II. If half the Hubble mass M_u were concentrated at its center and the other half imagined as a contiguous series of nested shells each having thickness **dr** and uniform density ρ_u, then the volumetric strain **ΔV/V** produced by the **G** force is:

$$\int_o^m \frac{GM_e}{r^2}(dm) = \int_A \beta_d \frac{dV}{V}(ds)$$

Since $\beta_d = (\rho_u)c^2$ and $dV/V = 3dr/r$ and $dm = \rho(4\pi r^2)dr$, substitution and integration gives:

$$GM_u\rho_u(4\pi R) = 3c^2\rho_u[dR/R]4\pi R^2$$

The change in the radius is therefore:

$$dR = M_u G/3c^2$$

which is the same as the static solution based upon General Relativity. Since the two formalisms produce the same curvature, either can be used to predict the path of a moving mass in the gravitational field of another mass.

Appendix A-4

Friedmann Equations from Newtonian Physics

In the decade that followed publication of General Relativity, only de Sitter and Friedmann had been able to extract an evolving dynamic. A simple analogy relating expansion to gravitation would not be discovered until 1934 by Edward Mill

In its simplest form, the development starts with a uniform density sphere of fixed radius "**a**" where the escape speed (the velocity needed for a particle to reach infinity with zero kinetic energy) is $\mathbf{v_e = 2GM/a.}$ The strength of the **G** field outside the sphere depends upon **M** and the distance "**r"** from its center, but not the radius "**a.**" If **M** itself is considered as expanding so the surface particles have radial velocities, the expansion profile will follow the same trajectory as a particle launched normal to the surface. If the expansion velocity at the surface is less than the escape velocity, the sphere will slow and eventually begin to contract. If the launch velocity equals or exceeds $\mathbf{v_e}$, expansion is eternal. The total energy is the sum of the kinetic and potential energy. If the sphere represents the universe, then at time $\mathbf{t_o}$ the radius of the sphere will be "$\mathbf{a_o}$" and the cosmic scale factor will be $\mathbf{R_o}$,. Therefore $\mathbf{a/a_o = (R/R_o)}$ so the cosmic radial velocity is $\mathbf{(a_o)[(dR/dt)/R_o]}$, then:

$$\dot{R}^2 = \frac{8\pi G \rho R^2}{3} + C\left[\frac{R}{a}\right]^2$$

For a uniform density sphere, the second term is constant; it corresponds to the analogized orbits of ejected surface particles which can be elliptical, parabolic or hyperbolic as shown in **Figure 8a** of Chapter III. As applied to a universe where gravity is not an expansion dependent force, it predicts the ultimate cosmological fate (collapse or eternal expansion). For convenience, **R** can be scaled by a normalizing factor $\mathbf{R_o}$ so that **CR/a** is represented by a single constant **(-k)** which takes the value **[+1]** for elliptical paths, **[0]** for parabolic orbits and **[-1]** for hyperbolic trajectories (eternal expansion of negatively curved space). In the Newtonian analogy **k** identifies the flight of an ejected surface particle whereas in General Relativity, **k** is the curvature constant, expressed in terms of the distance scale as $\mathbf{K = k/R^2}$. The Hubble term $\mathbf{H = (dR/dt)/R}$ and $\mathbf{q = - d^2R/RH^2}$ Substitution in the above gives:

$$\mathbf{K = H^2(2q-1)}$$

$$\mathbf{4\pi G\rho = 3qH^2}$$

Appendix A-5

Inertial Reaction As Causal

The mechanical syllogism of negative pressure is isotropic momentum flow. Inertial mass immersed in an isotropic acceleration field takes form as spatial stress in the guise of gravity

In **Figure A5-1**, tension springs **ABCD** and **WXYZ** simulate negative dynamic pressure created by the inertial opposition to spatial expansion in the proximity of condensed matter. To make things simple, $\mathbf{M_1}$ and $\mathbf{M_2}$ are assumed to be uniform spherical masses initially isolated and at rest in a static universe; there is no acceleration flux, and therefore spring tension is zero. Newtonian theory asserts that $\mathbf{M_1}$ and $\mathbf{M_2}$ will be attracted to one another along the line of action joining their centers. In Einstein's construct, masses $\mathbf{M_1}$ and $\mathbf{M_2}$ distort static space and time so that each is affected indirectly by the proximity of the other. But there is yet another etude based upon motion:

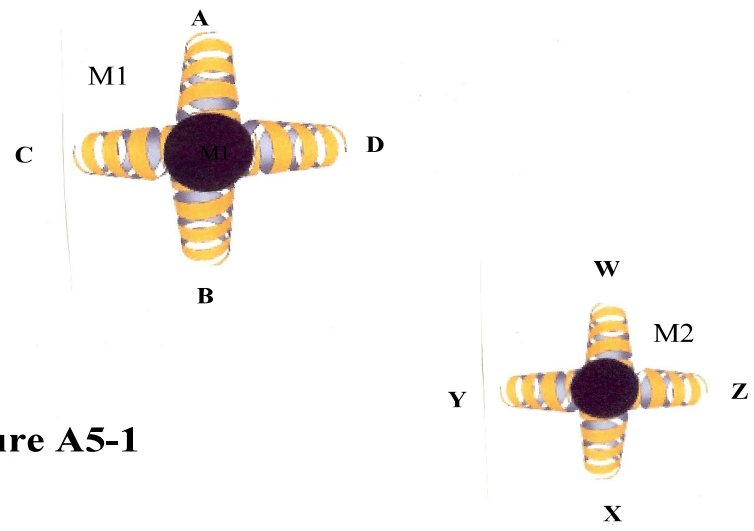


Figure A5-1

Starting with the premise that the velocity-distance law would cause two spatial locations to separate with cosmic age, then the same should be true for two massless objects. With no inertial resistance, $\mathbf{M_1}$ and $\mathbf{M_2}$ would be effortlessly wafted apart by the dilating space. This would also be true for comoving masses in a uniform velocity field. But the Hubble flow is not uniform, velocity depends upon the proximity of other matter. Because expansion involves comoving masses rather than motion of masses with respect to space, the distance between $\mathbf{M_1}$ and $\mathbf{M_2}$ would increase as the cosmos ages save for the retarding force of gravity opposing the Hubble flow.

The velocity distance law per se does not require the nebula to accelerate - rather it specifies that the distance between non-gravitationally bound objects grow in proportion to the separate distance. In the **q = -1** universe, non-gravitationally bound objects move apart with greater speed. Counter reaction is proportional to the acceleration as depicted by springs **A-D** and **W-Z.** Inertial matter cannot be effortlessly accelerated with respect to the cosmological rest frame.

While the isotropic divergent acceleration field $\mathbf{c^2/R}$ acts upon individual masses $\mathbf{M_1}$ and $\mathbf{M_2}$ to dismantle them, the internal forces prevail to preserve structural integrity. $\mathbf{M_1}$ and $\mathbf{M_2}$ remain in tack to provoke local distortions of the cosmological source field (manifest as their local **g** fields), the counter reaction of each depending upon their inertial content. The gravitational field of matter in the form of condensed energy is catalyzed by the isotropic acceleration field; the convergent reactionary field [**g**] being proportional to the local mass upon which it depends. Were it not for the internal forces holding masses together, they would dissociate leaving only the ghost of a local **g** field.

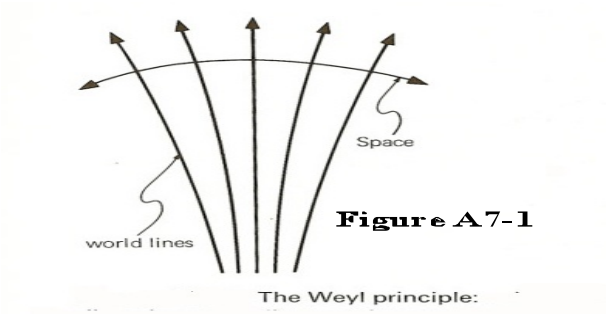
Restated, the local inertia of clumped matter distorts the global acceleration field **G** creating local **g** fields that appear to emanate therefrom. For nearby objects such as $\mathbf{M_1}$ and $\mathbf{M_2}$ their local reactionary accelerations exceed the free space isotropic acceleration **G**. Each will be attracted to the other with a force that depends upon the product of their masses divided by the square of the distance between their inertial centers. The isotropic global field is depicted by the eight tension springs (**A**,**B**,**C** and **D**) and (**W**,**X**,**Y** and **Z**). The gravitational attraction corresponds to an increase in the tension of (**B, D, Y** and **W**). When $\mathbf{M_2}$ is accelerated by the gravitational action of $\mathbf{M_1}$ each experiences the same force along the line of action connected their inertial centers. Each mass acting under the gravitational field of the other, experiences the same acceleration force and each responds to the in-between field by accelerating toward the other at rate inversely proportional to its own mass. If $\mathbf{A_1}$ is the acceleration of $\mathbf{M_1}$ and $\mathbf{A_2}$ is the acceleration of $\mathbf{M_2}$, then $\mathbf{M_2A_2 - M_1A_1 = zero}$. Internal forces are always in balance as required for conservation of energy and momentum.[1]

[1]Widely separated massive entities are effortless carried apart by comoving space, whereas these same structures internally resist isotropic disintegration when acted upon by the same field. $\mathbf{M_1}$ and $\mathbf{M_2}$ derive individual gravitational fields by resisting cosmological divergence, but where the relative Hubble recessional velocity exceeds the escape velocity of one from the other, they grow apart.

Appendix A-6

THE SCALE OF EXPANSION

The first graphical representation of expansion was introduced by Herman Weyl in 1923, years before it became a fact. Galaxies were pictured stationary in uniform space orthogonal to their diverging world lines as shown in Figure A7-1.



Since the Weyl hypothesis, many ideas have been advanced to explain the cause and nature of expansion, but none addressed its significance in subatomic mechanics. In what follows, much will be tendered to reinforce the proposition that expansion is the root cause of all forces acting at a distance. Specifically, a variant of circulatory space will be chronicled as the *strong force* that binds protons and neutrons together to form atomic nuclei. To this end, it is necessary to examine the limited range of the strong force and to adopt an estimated size and composition for neutral and positive nucleons to see how they might together bring about a truncated field theory.

Beginning in the early 1970s much experimental effort was devoted to testing the mathematical models of the neutron and proton put forth by Feynman, Gell-mann and others. As the theory known as the *eightfold way* developed, its contributors begin to question whether the mathematical continuities introduced to complete the model could be real physical operatives. Scattering experiments indicated that both the proton and neutron were composed of smaller interior entities that absorbed kinetic energy when bombarded by high speed electrons. The interior particles were given different names by the theorists (Feynman called them *partons*, Zweig named them *aces* and Gelman opted for *quarks*, which is the name that stuck). Whether the quark model is correct is not at issue here–what is of interest is whether a spatial circulatory model can explain the strong force and if so, can it be made consistent with the scattering experiments and other predictions of the *standard model* that have been verified.

Here we treat protons and electrons as quasi-classical structures having an identifiable mass and an effective size. As with the electron, it is the immediate space that gets our focus, the distance where the particle quits and vortical space takes over. Size is an imprecise when calculated from the behavior of rebounding electrons. To reach some conclusions in Appendix XV, we take the proton and neutron radii $\mathbf{r_p}$ to be approximately **0.75 fermi** (about 1/2 the electron eye) based upon a limited consensual average:[Christensen, *The structure of the Atom*, 1990, (**0.5 fermi**); Millikan, *Protons, Photons, Neutrons and Cosmic Rays*, 1990 (**1 fermi**); Brown, *The Physical Science Encyclopedia*, 1980 (**0.5 fermi**); *World Book Encyclopedia*, 1998 (**1 fermi**)].

Appendix A-7

Null Universe The kinetic energy **dE** of a shell of mass density **ρ,** area **A** and thickness **dr** is:

$$\mathbf{dE = (A\,dr)(\rho)(v^2/2)}$$

and since **v=Hr**, and $\mathbf{A = 4\pi r^2}$ the total kinetic energy **E** is:

$$= \frac{\rho}{2}\int_0^R 4\pi r^2 H^2 r^2 (dr)$$

$$= \frac{\rho H^2}{2}\left[\frac{4\pi R^5}{5}\right]$$

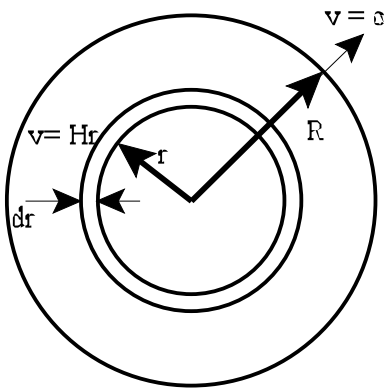


Figure 7a

If the Universe is assembled by building it from thin spherical layers of thickness **dr** as shown in **Fig 7b**, the differential work at each stage is:

$$\mathbf{dU = Gm_r(dM)/r}$$

since $\mathbf{M_r = \rho(4/3)(\pi r^3)}$ then $\mathbf{dM = \rho(4\pi r^2)dr}$; the work in bringing-up the universe is:

$$\mathbf{U} = \mathbf{G}\int_r^R \frac{16}{3}\pi^2(\rho_u)^2 r^4 (dr)$$

$$= \frac{3G(M_u)^2}{5R}$$

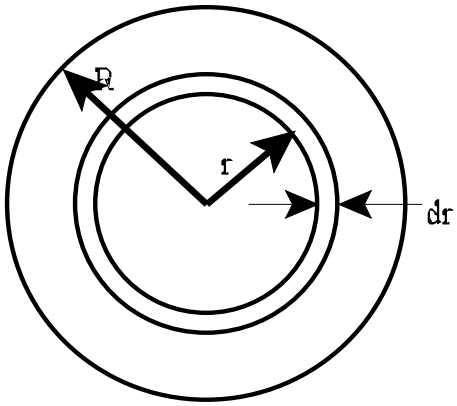


Figure 7b

In a "null" universe, positive **energy** in kinetic form balances negative potential.

$$\frac{\rho_u 4\pi H^2 R^5}{10} = \frac{3(\rho_u V)^2 G}{5R} \qquad \therefore \qquad \rho_u = \frac{3H^2}{8\pi G}$$

This comports with the **q = ½** universe which kinetically decelerates to zero at eternity. The dilating matter field creates negative potential in the form of tension to maintain the balance **E - U = zero**. If instead of considering only KE ($\mathbf{½\ mv^2}$), the total positive energy is taken as $\mathbf{mc^2}$ then the density $\mathbf{\rho_u}$ will be $\mathbf{3H^2/4\pi G}$. This value corresponds to the **q = -1** de Sitter universe driven by **Λ** wherein negative pressure $\mathbf{c^2(\rho_u/3)}$ exactly cancels density in Einstein's gravity equation (2.22).

Appendix A-8

Spin-Charge Characteristics for Eleven Sub-atomic Particles

Particle	Symbol	Charge	Spin	Central Mass
Electron	e	– 1	½	Yes
Positron	$\bar{e}$	+1	½	Yes
Neutron	n	0	½	Yes
Proton	p	+1	½	Yes
Neutrino	ν	0	½	No
Antineutrino	$\bar{\nu}$	0	½	No
photon	γ	0	1	No
+ pion	π+	+1	0	Yes
- pion	π-	– 1	0	Yes
0 pion	π^o	0	0	Yes
Graviton	---	0	2	No ?

Charged pi mesons are produced in collisions between high energy nucleons. Lifetime is approx $\mathbf{10^{-8}}$ seconds, and like other particles thought to be responsible for forces, they have integral spin momentums. Pions foster rather complex genealogies in that they exhibit different modes of decay; the $\boldsymbol{\pi^+}$ and $\boldsymbol{\pi^-}$ pions always decay into a neutrino or antineutrino and another particle with a complementary "half-spin" plus mass—thus accounting for the charge and integral spin of the composite original (half spins cancel or add, but if a ponderable mass is exhibited, there will be a net charge). The $\boldsymbol{\pi^o}$ pion normally decays into a pair of photons (consistent with its zero charge), but it can also decay into an electron-positron pair and a photon—which produce the same totality of integral spins. The graviton is part of quantum theory, but undiscovered, and unproven—theoretical spin is **2**; moves at light velocity and per the Standard Theory has zero rest mass.

The tabulations are exemplary of the transformations applicable to a few well known subatomic transitions. Of the particles considered, in some fashion or another, complex particles appear to conserve the constituents of structures involved in the decay process, whether created thereby or internally pre-existing—collectively they satisfy the rule governing the dependence of charge upon a precise quantity of un-canceled mass encompassing spin.

Appendix A-IX

Critical Distance for Gravitational Binding

For a mass **m'** in the gravitational field of a point sized central mass **M**, the escape velocity $\mathbf{v_e}$ is determined by the gravitational potential **m'MG/r** At distance **r** from the mass center **M** the acquired kinetic energy for free-fall from infinity **is ½** $\mathbf{m'v^2}$ ... therefore:

$$\mathbf{v_e = (2GM/r)^{1/2}}$$

In the absence of a gravitational field, space growth is isotropic per the velocity distance law **v = Hr**. The corresponding Hubble divergence that corresponds to the escape velocity $\mathbf{v_e}$, is:

$$\mathbf{r_c = (2GM/H^2)^{1/3}}$$

This Schema can be visualized as comoving space, divergent for expansion, convergent for gravity.[1] The idea has found support in what is commonly referred to as the inflow theory of gravity, which postulates that space is somehow absorbed by matter. While the idea is frequently used metaphorically to illustrate the action of black holes, there appears to be no verifiable evidence that matter in general, compresses or absorbs space. A similar scenario based upon quantum space merger is introduced in Chapter V.

[1]To complete the picture, however, convergent flow is reasoned by its supporters to be somehow attracted toward matter where it is mysteriously absorbed. No mechanism is proposed by the proponents of the theory to explain the absorption process nor is there a bonafide force that can account for the attraction. The theory also leaves unanswered the nature of the spatial source needed to fulfill the generation of new space. Nonetheless, the theory is not without its followers. It offers as a cornerstone the fact that both divergent and convergent spatial flow can be described by the same mechanism, namely the attraction of masses and the recessional velocity of the nebula are classical examples of momentum flow.

Appendix A-X

Notation, Numbers, Symbols, Conventions and Math Methods

1) Throughout this treatise, bold type is used to distinguish, equations, numbers, symbols and characters from the text (whether or not they have special significance). For example, the radius of the Hubble sphere **R** has a special meaning but the ratio **a/b** in paragraph 2) below simply sets it apart as not being regular word. This practice should not be confused with the common custom of identify vectors in bold.

2) A rational number is the ratio of two integers **a/b** where **b** cannot be zero because the quotient is undefined.

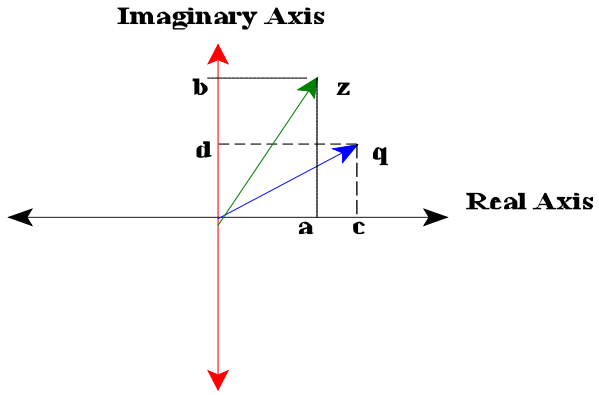
3) Exponent notation is commonly used to represent large numbers. The number **N** raised to the **3rd** power is written $\mathbf{N}^{3}$ meaning **N x N x N**. Thus $\mathbf{5^3 = 5 \times 5 \times 5 = 125}$. One million is $\mathbf{10^6}$ which means multiply **10 x 10 x 10 x 10 x 10 x 10 = 1,000,000**. To multiply two numbers together the powers are added and the coefficients are multiplied. Thus **500 x 30000** looks like $\mathbf{(5 \times 10^2)(3 \times 10^4) = 15 \times 10^6 = 15}$ million. A negative exponent means reciprocal. $\mathbf{(N)^{-4} = 1/N^4}$ **so** $\mathbf{3^{-1} = 1/3}$. To raise a number represented in exponential form to a power, the exponent is multiplied by the power. For example, if the Hubble sphere has radius $\mathbf{R = 10^{26}}$ meters, then the volume of the Hubble universe is $\mathbf{(4\pi/3)R^3 = (4\pi/3)(10^{26})^3 = (4\pi/3)(10)^{78}}$ **meters**^{3}**, or** $\mathbf{(4\pi/3)(10)^{78}}$ **m**^{3}

4) Calculus was invented by Isaac Newton to explain planetary motion. Newton's convention for denoting temporal change was a dot over the variable. For example a dot placed over x would denote velocity along the **X** axis, two dots over x would denote acceleration in the x direction. An alternative convention is **d/dt[F]** which means apply the differential operator to some function F to see how the function is behaving at a particular time. Again, using the same example, the operator (**d/dt**) operating on **x** translates to **dx/dt** which can be read as the ratio of the instantaneous change in distance along the x axis divided by the instantaneous change in time i.e., the velocity at a moment in time. The differential operator notation has greater generality since there are many occasions where it is desired to find how a function behaves with respect to changes in some variable other than time such as distance (**dx/dy**), mass **(dx/dm**) etc. For example to find the slope of a parabola $\mathbf{y = x^2}$ apply the differential operator to the equation to get $\mathbf{dy/dx = 2x}$. The opposite of differentiation is integration - it sums up what ever is described by the function between the limits of integration. For example to find the volume **V** of a sphere of radius **R** composed of layered shells each with thickness **dr** and area $\mathbf{4\pi r^2}$ the integration is taken from **r = 0** to **r = R**

$$\mathbf{V = \int 4\pi r^2 dr = (4/3)\pi R^3}$$

5) Any plane orthogonal to all 3 spatial dimensions is designated by the imaginary number $\mathbf{i} = \sqrt{-1}$ (in electrical engineering, it is called the **j** plane, in cosmology it corresponds to the time domain **t**).

The simple gimmick of creating a number which cannot exist withing the realm of ordinary numbers (because the square of a positive number and the square of a negative number are both positive) turns out to be the gateway to a rich and surprising mathematical world. It extends the system of real numbers into a mathematical realm rich in amazing revelations.



Any arbitrary number **z** can be represented in the complex plane by a real component **a** and an imaginary component **ib**, that is **z = a + ib**. To add two complex numbers **q = c + id** and **z = a + ib**:

$$\mathbf{(c+a) + i(d + b)} \qquad \text{(A10.1)}$$

To multiply two complex numbers **q** and **z**:

$$\mathbf{ac + i(cb + ad) + i^2db = (ac - db) + i(cb + ad)} \qquad \text{(A10.2)}$$

In both addition (and subtraction) and multiplication (and division), the result comprises a real part and an imaginary part. All the rules of algebra work with complex numbers. Complex numbers, however, were historically viewed with suspicion–probably because they did not represent tangible quantities. But when '**i**' is interpreted as *time* they provide a glimpse of the universe on the deepest level, an exposition not possible with ordinary numbers. When represented in polar form and combined with the mathematical methods of logarithms, the precipitates are preternatural.

A physical connotation follows from a few observations. The addition of two complex numbers (A10.1) simply involves a translation at an angle $\boldsymbol{\theta}$ **tan^{-1} (c/d)** which is read {***θ is the angle whose tangent is c/d***).[2] This corresponds to the way vectors are added using the parallelogram rule. When a complex plane is transformed unto itself by addition, all points in the plane shift the same distance parallel to the slope defined by the angle $\boldsymbol{\theta}$. Shapes and sizes are preserved without rotation.

[2]Tan^{-1} is called the arctan of an angle . The (-1) does not mean reciprocal, it defines the angle in terms of its tangent (or slope) as the ratio of the rise "**c**" divided by the length of the horizontal distance "**d**"

When the complex map is transformed by multiplication, some curious results occur. Multiplication of the complex plane (all points mapped thereon) by "i' creates a 90° counterclockwise rotation. Multiplication by $\mathbf{i}^2$ rotates all points 180 degrees, $\mathbf{i}^3$ effects a 270 degrees rotation and $\mathbf{i}^4$ constitutes a complete $\mathbf{2\pi}$ rotation bringing all points back to their original orientation. This exposes a graphical interpretation of the mysterious number $\mathbf{i} = \sqrt{-1}$ as a $\boldsymbol{\pi/2}$ rotational operator. Multiplication by **i** effects a right angle geometrical transformation. Multiplication of **z** by a complex number **q** adds an additional element in that (not only is some rotation involved due to the **i** component), there is also a scaling multiplier that depends upon the magnitude of the real part of the complex multiplier. Coordinates in the complex plane thus transform as an expanding and/or contracting rotation. For example, taking the values for **z** as (**a = 1, b = 0**), and for **q** as (**c = 1, d = 1**) the point at unit distance one displaces to **1 + i**. Using this for the new location, the next value **0 + 2i** follows and taking this as the coordinates of a **2nd** point gives the **3rd** product **2 + 2i** and so on.

Figure 10B. Illustrating Multiplication of z = a +ib By q = c + id of the point For z = 1 + 0, q = 1 + i

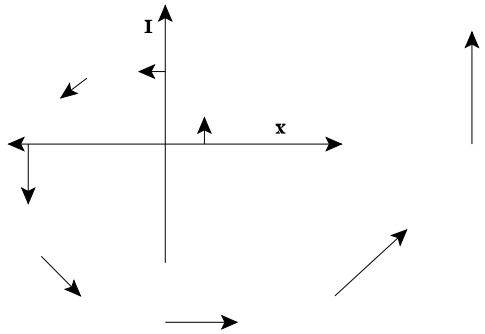
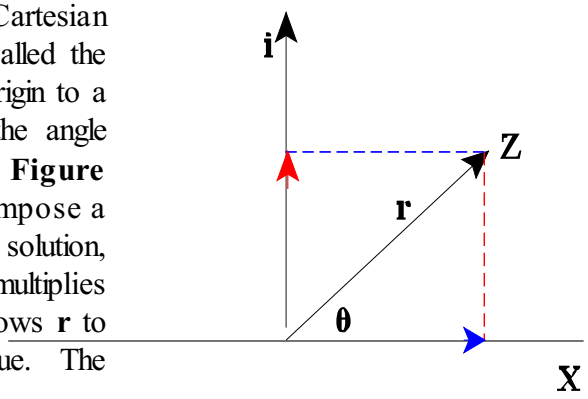


Figure 10C: If the polar form is used to represent a point in the complex **z** plane instead of Cartesian coordinates, then the positive real number **r** (called the "*modulus*") represents the distance from the origin to a point in **z** and **θ** (called the "*argument*") is the angle between **r** and the spatial **X** axis as shown in **Figure 10C**. In some applications it is convenient to impose a limit on **θ** that corresponds to an unambiguous solution, in other exercises it is handy to allow integer multiplies **2π** to be added to the argument since this allows **r** to wind around the origin without changing its value. The trigonometric relationships are:



$$\mathbf{x = r \cos \theta}$$

$$\mathbf{i = r \sin \theta} \qquad \text{(A10.3)}$$

There are unexpected benefits to manipulating complex numbers as logarithms:

A logarithm is the reverse of exponentiation. Raising a number to a power converts addition into multiplication as in the example $\mathbf{(5 \times 10^2)(3 \times 10^4) = 15 \times 10^{(2+4)} = 15 \times 10^6}$. In order for the formalism of logarithms to work in the general case of complex numbers exponents such as **z** and **q**, [the defining relationship $\mathbf{(b^{(z+q)} = b^z \times b^q)}$] demands that when complex $\mathbf{z = 0}$, then $\mathbf{b^0}$ must be **1** and $\mathbf{b^1}$ must = **b**. By the same reasoning, if **z** is **-1**, then $\mathbf{b^{-1}}$ must mean divide by **b** which exemplifies as $\mathbf{b^{-1} \times b^q = b^{q-1}}$ so $\mathbf{b^{-1}}$ operates to reduce the number of multiplications of **b** x **b** specified by **q** by subtracting **1** which is the same as dividing by **b**. And since dividing by **b** is equivalent to multiplying by **1/b** then $\mathbf{b^{-1}}$ must equal **1/b**. Hence the notation $\mathbf{b^{-2}}$ divides twice by **b** and $\mathbf{b^{-n}}$ means $\mathbf{1/b^n}$. When **z** is a fraction such as ½ then $\mathbf{(b^{1/2})^2 = b}$ and therefore $\mathbf{b^{1/2}}$ represents the spare root of **b**, and by like reasoning $\mathbf{b^{1/n}}$ is the nth root of **b** which is unique and well defined so long as **b** is a positive real number.

When **b** is negative, there is no real solution for $\mathbf{b^{1/2}}$ since $\sqrt{\mathbf{-b}}$ is managed only by the introduction of **i**. Enter now the world of mathematical wonderment. Complex number multipliers accommodate the introduction of "**i**" without further postulation. The hitch will be to find some base **b** that satisfies the defining functionality $\mathbf{b^{(z+q)} = b^z \times b^q}$ for complex **z** and **q**. Specifically, taking the logarithm of both sides of $\mathbf{b^{(z+q)} = b^z \times b^q}$ there is a unique base **b** such that

$$\mathbf{Log_b\,(z \times q) = Log_b(z) + Log_b(q)} \qquad (A10.4)$$

will be preserved when **z** and **q** are complex. The magic number is called the base of natural logarithms, symbolized as **e**. It is an irrational number defined by the convergence of an infinite number of additive factorial terms:

$$\mathbf{e = 1 + 1/(1!) + 1/(2!) + 1/(3!) + 1/(4!) + 1/(5!) + \quad = 2.718281828.....}$$

where the exclamation point denotes the factorial **1! = 1x1, 2! = 1x2, 3! = 1x2x3** etc.

Hereinafter the subscript **b** is dropped and the natural logarithm as labed **ln**. As observed, there is a multi-valued aspect to $\mathbf{b^z}$ when **z** is complex. Polar coordinates and natural logarithms address this peculiarity as complex planes. Referring to **Figure 10C**, the point **z** in Cartesian coordinates is $\mathbf{z = x + iy}$. To find this point in polar form as the modulus rotated through and angle **θ**, relate **x** to a distance **r** such that $\mathbf{e^x = r}$ and therefor **ln r = x**. Since **iy** defines a distance **y** in the **i** plane in Cartesian format, polar form requires **y** to be the distance laid out along the arc subscribed by an angle **θ** which corresponds to the point **z**. Since **i** measurements and spatial distances are orthogonal in both Cartesian and Polar coordinates, the **i** plane in two dimensional polar representation is a circle. Accordingly,

$$\mathbf{z = ln\ r + i\theta} \qquad (A10.5)$$

The polar form thus conveniently separates the real and imaginary part of **z**. Obviously, the addition of 2π to the angle θ is another solution that defines from the same point. The many solutions to (A10.5) leads to interesting mathematical consequences. For example the polar form of the function $w = e^z$ reduces to:

$$w = e^z = e^{(\ln r + i\theta)} = e^{\ln r} e^{i\theta} = re^{i\theta} \qquad \text{(A10.6)}$$

From (A10.6) the rule for multiplying complex numbers is: "*Add the arguments, and multiply the moduli*." By the simple step of letting $r = 1$ and $\theta = \pi$, equation (A10.6) exposes a mysterious and beautiful relationship between the five foundational factors upon which mathematics is built: **0**, **1**, π, **e** and **i**. It was first written in the form of (A10.7) by the brilliant **18th** century mathematician, Leonhard Euler (1707 - 1783)[3]

$$e^{i\pi} + 1 = 0 \qquad \text{(A10.7)}$$

To many, Euler's equation is believed to say something deep and profound about the universe? The discovery of the relationship derives from the mathematical laws that govern the interaction of space, time and inertia. Given Euler's equation as an initial condition, does an expanding universe follow?

[3]Both Roger Coates (1682 - 1716) and Abraham De Moivre (1667-1754) had independently discovered the corresponding trigonometric relationships.

Appendix A-XI

Quantum Vorticity

The existence of quantized vortices ω_Q was first predicted by Richard Feynman in 1955 in connection with his investigation of liquid helium. The vortical average taken over a small region of fluid equals the circulation **Γ** around the boundary divided by the area **A**. Notionally. vorticity at a point is the limit as the area approaches zero:

$$\omega_Q = d\Gamma/dA$$

A vortex "Line" is defined as everywhere tangent to all local vortices. In real fluid flows, viscosity causes diffusion away from any small region of discrete vorticity into the general flow field. But for an inviscid medium, the vortex flux (the integral of velocity over a cross section of the flux tube), is the same everywhere along the tube (vorticity has zero divergence). In the absence of friction and viscosity, the vortex flux is spatiotemporal.

A void characterized as 4 dimensional dynamically elastic spacetime suggests a super fluid similar to those commonly used to model Type II superconductors and liquid helium. The angular momentum quantum is

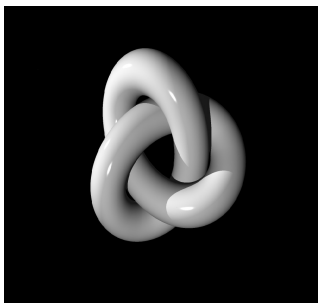
$$\int v \cdot dl = \frac{\hbar}{m} \cdot \oint_C \nabla f \cdot dl = \frac{\hbar}{m} \Delta f$$

Where "**m**" is the mass of the particle and $\nabla\varphi$ is the phase around the vortex. For one revolution $\nabla\varphi = 2\pi$ so the circulation **Γ** reduces to $2\pi\hbar/m$. Taking $m = H\hbar/2c^2$ for a spatial vortex:

$$\Gamma = (2c^2/H)/(\pi R^2) = 4\pi c^2/H, \quad \text{and} \quad \omega_Q = H$$

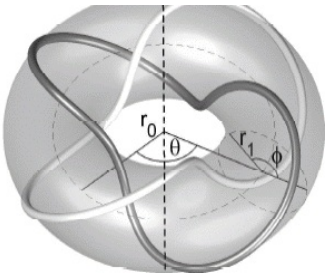
Adaptions of artistic works to illustrate 3-D spatial angular momentum quantums

The trefoil continuous enveloping flow



Mutually inter-coupled orthogonal flows

Torus created by self linking flows



Appendix A-XII

Notes on Cosmic Numerology

Certain natural magnitudes can be combined to form dimensionless ratios that exhibit cosmological significance. The beginnings of such numerology date back to Babylonians and Pythagoreans—indeed one of the most surprising relationships was arrived at by Archimedes who adopted a grain of sand as his natural unit of volume. Using what he estimated to be the then known size of the universe, Archimedes calculated its volume to be $\mathbf{10^{63}}$ grains of sand. The unexpected correspondence is that this amount of sand has approximately the mass as the observable universe.

Although Archimedes effort led to an amazing coincidence, ratios based upon fundamental quantities often reveal an underlying salience. The **L**arge **N**umber **H**ypothesis of Dirac is one such example. The gravitational and electrical force are related to size. The ratio of the time required for light to traverse the universe divided by the time required for light to traverse a subatomic particle is proportional to the ratio of the electrostatic and gravitational force i.e.,

$$\frac{F_E}{F_G} = \frac{r_o c^2 m_o}{2c^2 (m_o)^2 / 4\pi R} \Rightarrow K\frac{R}{r_o}$$

Therefore:

$$\frac{F_E}{F_G} = \frac{k_e (q)^2 / d^2}{G(m_o)^2 / d^2} \Rightarrow K\frac{R/c}{r_o / c}$$

Working backwards, one could use the numerology to estimate the cosmic radius $\mathbf{R_d}$ at the time the cosmic mass equaled that of an electron $\mathbf{m_o}$. Then $\mathbf{m_o = [(4\pi)(R_d)^2](kgm/m^2)\}}$, and taking $\mathbf{m_o = 9.1 \times 10^{-31}\ kgm}$, the corresponding cosmic radius $\mathbf{R_d \approx 2.7 \times 10^{-15}\ meters.}$ The gravitational force acting upon an electron sized universe is approximately equal to the electric force.

A second numerical curiosity involves the subatomic fine structure constant $\boldsymbol{\alpha}$ which plays a crucial role in quantum theory in that it relates electromagnetism (via $\mathbf{k_e}$ and $\mathbf{q}$) to Planck's constant $\mathbf{h}$ and the velocity of light $\mathbf{c}$. Physically, $\boldsymbol{\alpha}$ defines the ratio of the velocity of the electron $\mathbf{v_1}$ in the first Bohr orbit of radius $\mathbf{r_1}$ to $\mathbf{c}$ (as reproduced in Appendix XVIII), but as developed in Chapter VI, the value of $\boldsymbol{\alpha}$ is first and foremost the ratio of two angular momentums $\mathbf{m_o c r_o / h/4\pi}$ i.e.,[4]

$$\boldsymbol{\alpha = v_1/c = k_e q^2/\hbar c = 1/137.033 = 2m_o c^2 r_o/\hbar c = m_o c r_o/(\hbar/2)}$$

[4]Niels Bohr's 1913 planetary-like model of the Hydrogen atom was founded upon the Coulomb force exerted by a central proton on an orbiting electron. By imposing the condition that the permitted orbits must have an integral number of de Broglie wavelengths in order avoid losing energy by radiation (a consequence of centripetal acceleration in classical theory). he was able to explain the spectral emission lines of the hydrogen atom (See Appendix XIV-F).

Once the electron is expressed in terms of its mechanical properties (Chapter IV) the canonical nature of the *alpha* as the ratio of two angular momentums answers the question of why the velocity **v** in the first Bohr orbit has the value **c/137**. Bohr had assumed the electron orbits would be limited to integer multiples of **h** for an angular rotation of **2π** to fit de Broglie's relationship $\lambda = \mathbf{h/m_o v}$ into an seamless standing wave, specifically, for the electron mass $\mathbf{m_o}$ the angular momentum of any orbit would be **n(h/2π)**. When **n = 1**, the orbital angular momentum $\mathbf{m_o v r_1}$ corresponded to a radius $\mathbf{r_1 = 0.528 \times 10^{-10}}$ **meters**. But since **α** is also the ratio of the electron eye angular momentum to the orbital angular momentum, $\mathbf{m_o c r_o/h/4\pi}$, then

$$\mathbf{v^2/c^2 = 2(r_o/r_1)}$$

from which:

$$\mathbf{v/c = 7.2 \times 10^{-3}\ which\ is\ approximately\ 1/137}$$

Dimension-less ratios such as alpha tell us something about the universe, but they do not tell the whole story. It cannot be determined from alpha alone what went into the ratio that gets cancelled and lost. In the above example, the underlying cardinality of alpha is revealed as a ratio of angular momentums. Once the orbital velocity dependence upon $\mathbf{r_o}$ is correctly perceived, the mystery abrogates. The same lesson can be applied to Planck's natural units in the light of Dirac's large number hypothesis. The gradual diminution of the gravitational parameter based upon the dimensions of the universe, should discredit any theory of fundamental dimensions based upon natural units derived from the assumption of constant **G**. In Dirac's theory, at least one constant must vary in order for the electro/gravitational force ratio to equal the cosmic/subatomic size ratio. **G** is the most likely parameter to change as the universe expands. Notwithstanding, modern physics has been taken-in by Planck numerology, and the idea that the combination of **c**, **h** and **G** will lead to some deep cosmological meaning substructured upon fundamental dimensionality

The first set of natural units were derived by George Johnstone Stoney in 1847 based upon **G**, **c** and the electron charge **e**.[5] These lead to slightly different values for length, mass, and time than those arrived at by Planck. Why would one set of units based upon Planck's constant be any better than units based upon charge?[6] Steven Weinberg has discovered another relationship that involves **G**, **H**, **c** and **ħ**. The value arrived at by combining these factors is very close to that of the Pion

$$\mathbf{Mass = [(\hbar)^2(H)/Gc]^{1/3}}$$

In Chapter V, a unit of mass $\mathbf{m_x = Hh/4\pi c^2}$ was discussed. We leave this appendix with the question: *Why should the formation of one dimension from a combination of other factors be any better or more fundamental than any other combination?*

[5] George Johnstone Stoney was an older distant cousin of the famous mathematician and code breaker, Alan Turing and the uncle of George Fitzgerald who proposed the contraction of space in an attempt to explain the Michael-Moreley experiments.

[6] *"...there is no belief, however foolish, that will not gather its faithful adherents who will defend it to the death."* **Issac Asimov**

Appendix XIII

The Standard Model vs Acquisition by Expansion

The "so called" standard model derives from the work of Robert Wagoner, William Fowler and Fred Hoyle.[7] It tells the evolutionary story of the universe from a time when the density of matter was considered as approximately equal to the present density of the atomic nucleus. This paradigm relies upon expansion as a fact and the three degree Kelvin background as a remnant of the "Big Bang." The standard model begins with all mass in existence. In order to create the concentrations of energy required for particle formation in the early universe, the theory requires unimaginable expansion forces and enormous velocities to overcome the gravitational force that would tend to cause an immediate collapse (While inflationary theory predicts this can occur if the universe entered a state of false vacuum, there is no rationale for why inflation begins and why it ends). By contrast, vorticity is a natural result of negative pressure created by spatial expansion. Because the initial circulations are massless angular momentums (e.g., photons), the requirement of ultra Luminal expansion velocities is abrogated, there is no **G** force to cause an early collapse. Critical density is the illusion created by the fact that gravity is the result of inertia. The decrease in the gravitational parameter **G** is compensated by the increase in the volume of the field. Negative gravitational energy is always equal to the positive energy of inertial mass. Fine tuning is a mirage that follows misinterpretation of the universe as having constant mass and constant gravity. Inertia (resistance to acceleration) became an operative force creating factor when angular momentums were defined by 3-D circulatory fields. Once enabled, reactionary **g** fields followed.

So while inertia and gravity jelled from the reactive complications of **3-D** angular momentum, circulatory spatial flows were interacting in the manner now denominated as electric attraction and repulsion. The influence of rotational angular momentum distends to the Hubble limit, except where nullified or moderated by the superposition of a counter circulatory field. There will thus be locales where circulations reinforce and others where the rotations interfere. And it is this aspect of enhancement and interference that leads to a causal connection between the nuclear force and spatial rotation. As illustrated in Appendix XV, circulatory sources can be adapted to describe much of what is known about the strong force, starting with the actions summarized below:

1) The force between two protons follows the Coulomb inverse square law at large distances. At approximately 2-3 fermi, there is a sharp break in the potential curve and the force becomes attractive to a very short distance which reveals a repulsive inner core.

2) There is no force between a proton and a neutron at large distances. At about 2-3 fermi, the force becomes sharply attractive with evidence of a repulsive inner core.

3) The force between two neutrons is similar to the attractive force between two protons but there is no Coulomb force at large distances.

---

[7] The *Standard Model* envisioned by Wagner and Fowler differed from the *Steady-State* model championed by Hoyle. Hoyle's premise of a temporally invariant universe required that elements heavier than Helium be synthesized in stars rather than Big Bang nucleo-genesis as proposed by Lemaitre, Gamow and others. It is one of the ironies of cosmology that Hoyle developed a stellar theory that correctly explained the formation of the heavier elements only to have the *Steady-State* theory ultimately discredited by discovery of the **CBR** predicted by Lemaitre and Gamow.

Appendix XIV

Particle Formation in the early universe

In the Cosmodynamic syllogism, matter is synthesized from expansion stress. Angular momentum quantum(s) **h/2π** form in pairs that correspond to photons which combine to proto electrons and positrons each defined by three dimensional angular momentums **h/4π**..

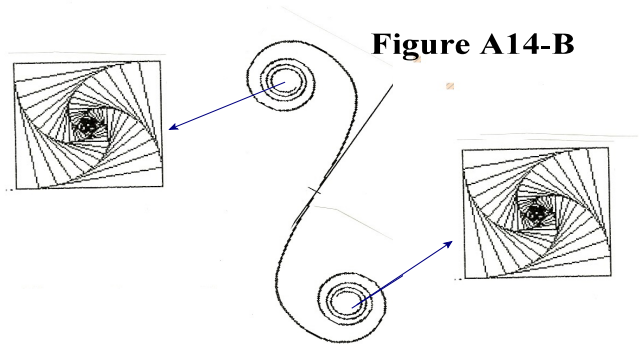


Figure A14-A Artistic rendering of spatial vorticity created within a symmetrical stress field. The negative pressure of expansion transitions contracts into a local circulatory collapse resulting in an electron-positron proto-pair. These asymmetry(s) are deemed to create an quantum angular momentum plenum throughout the expanding volume in the first instant of '**c**' velocity expansion. The tangent velocity '**c**' is a spatial consequence at all radii so the circulatory field similitudes as vortical wrt its affect upon the reference frame defined by the non-expanding eye (radius $\mathbf{r_o}$). Inwardly directed centripetal forces thus diminishing as **1/r**. Specifically, if $\mathbf{F_r}$ is the inwardly directed radial force, then the effective velocity for purposes of relating particle angular velocity to momentum of momentum created by spatial circulation is $\mathbf{v = c(r/r_o)}$. The Coulomb force is therefore:

$$\mathbf{F_r = v^2/r = (cr/r_o)2/r = c^2r^2/r_o^2r = [c^2/r_o^2]r}$$

Space as origin of angular momentum structures fits the pro forma composition of matter as circulatory fields. Our interest here (and in Appendix XV which follows) will be to offer a credible chronicle of how these circulations interact at long ranges (greater than 3 fermi) to create electrical forces and how they function in the short range (less than 3 fermi) to hold nucleons together. To that end, it will be necessary to explore the standard theory and briefly discuss the reasons behind the commonly voiced assertions that electrons and positrons cannot be nuclear constituents.

The circulatory model of charge sheds new light upon the objection that nuclear magnetic moments are too small be viewed as incorporated electrons and positrons. Electric and magnetic fields are distributed functions, not confined to the dimensions of particle but to all space beyond the eye. In fact all objections to the electron-positron model are obviated by the circulatory model of space. By like reasoning, the fact that the force at short range does not have a strong effect upon electrons is also inapplicable to a situation where the force itself is defined by the radius of the eye.

The complexities of quark theory can be tackled from the perspective of mutually entangled orthogonal spin planes. A confined **3-D** circulatory complex can well define a single electron or positron in free space with unrestricted asymptotic freedom. Three quarks make one charge **q**, as do three orthogonal planes of rotation. If the three quark symposium can be modeled as one **3-D** vortical complex, the theory of circulatory space will find its place as the place saver on our trip to unification.

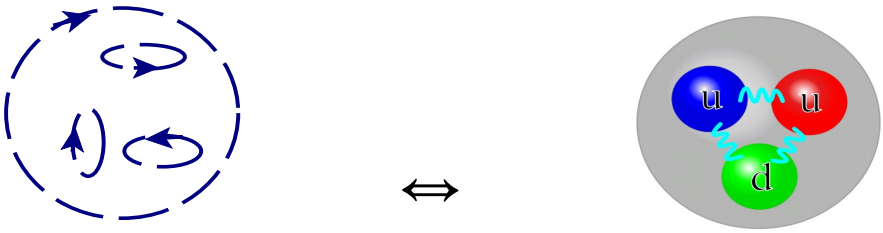


Figure A14-2

Proton modeled as a dismembered positron manifest as a three quark complex. The angular momentums of a single positron engage to create an elastic resonance, with linking defined by the pseudo charge spin combinations as (+2/3), (+2/3) and (-1/3).

Quarks exist in their proton defining role as distorted spatial spins having internal charge **q** equal to one positron. Circulatory entanglement effects the coupling between spin planes to be elastic-like; retentive force increases with displacement. Rotational fields repel as they are brought closer, until captured, then reinforce to resist disassociation.[8] The idea of linked circulatory energies as subatomic forces is continued in Appendix XV (Page 2).

[8]If quarks are dimensionally separated electron or positron spin planes, the corralling force will increase with distance. Circulations extending beyond the proton scale $\mathbf{r_p}$ will repulse except where the **3-D** rotational complex embraces at least two counter spins that cause attraction in two of the three dimensions. This accounts for the observed aspects of nucleon bonding and it suggests why bound neutrons do not disintegrate as do free neutrons, Internal stability follows from the fact that the composition always requires an equal or greater number of neutrons.

Appendix A-15

The Extension of Classical Mechanics to Quantum Mechanics

Development of circulatory coupling cannot be justified without supportive experimental evidence. What is offered here is a way to look at subatomic forces from a classical perspective. The promise if any, lies in the fact that multiple **3-D** circulations can combine in many ways to achieve different outcomes. To propose a vortical alternative to the standard theory is a project defining statement. Our methods are superficial and inadequate to explain anything but the skimpiest internal structure. They relate only net divergences and/or rotations taken over otherwise impenetrable surfaces. The consolation, if any, is that it is unnecessary to break apart the container in order to assess what is entering or leaving. Breaking bound entities into free particles my lead to erroneous conclusions as to how they function as force producing nucleons.

Protons and Neutrons are composite, community dependent particles, and despite the fact they exhibit attractive forces for their own kind at short distances, (Appendix XIII) neither will bind to their own in the absence of at least one of the other. This fickle affinity between nucleons can be understood in terms of vortical spatial interaction.

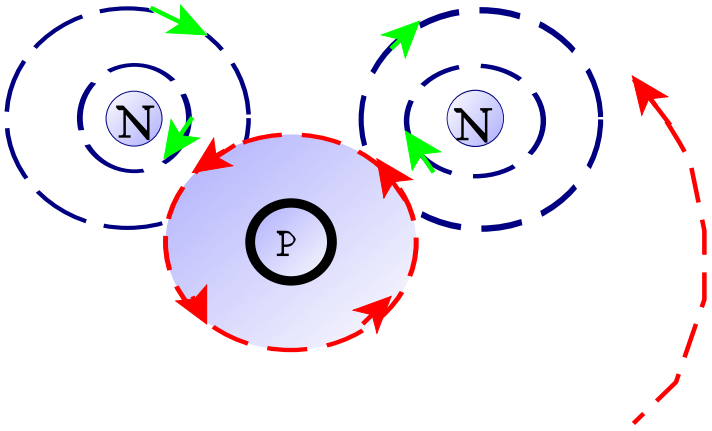


Figure A-15: The circulatory angular momentums of the two **N** systems oppose (green arrows) . The geometric relationship to the **P** system (red arrows) reinforces the circulatory strength of all three systems in the near field (Red arrows-green arrows parallel) to effectuate nuclear bonding. At larger distances (red arrows-green arrows antiparallel) the **P** field cancels the **N** field circulations, so the effective strength of the attractive force falls off rapidly. In, theory, each circulation will be three dimensional, and the strength of the near field bonding will depend upon the density and dimensions of eye.

Appendix A-16

Quantums Of Space

In classical physics, the idea of force is fundamental. In subatomic physics the concepts of momentum and energy are important. Instead of motion, one deals with probability amplitudes that affect phase and waves. To relate quantum energies and angular momentums to classical physics, is to embrace the notion of rotation and physical size.

The model of the electron put forth in Chapter IV as spacetime circulation furnishes a partial explanation of the puzzling "two-Slit" experiment. The idea of a single electron passing through two openings becomes a plausible self interfering phenomena when modeled as vortical space. Electrons are angular momentum complex observed as particles or waves depending upon the experiment.

Matter is made of electrons and electrons are made of rotation implicated as angular momentum. Electron-positron annihilation conserves angular momentum $\mathbf{h/2\pi}$ as a coaxial condition of motion. The photon energy, however, is deemed to exist in a non-inertial form to rationalize the instantaneous promotion to **c** velocity.[9] The characteristic electrical charge vanish and therewith also, the magnetic field and **3-D** angular momentum.[10]

The factor $\mathbf{c^2/R}$ has reappeared as an answer to numerous interrogatories: the radial acceleration divergence as Hubble flow (1.4) and (5.6), the dynamic bulk modulus of empty space (2.9), the coefficient of **G** (1.12), the Newtonian transform that relates global force per unit mass to global acceleration (3.4), and the pseudo centrifugal force (2.24) and (3.16). On the small scale, the same form defines the electric charge as $\mathbf{c^2/r_o}$. From de Broglie $\mathbf{\lambda=h/mv}$ and from Einstein $\mathbf{E = hf}$. Writing the photon angular momentum as $\mathbf{mcr = h/2\pi}$, then $\mathbf{f = c/r}$. As the effective radius **r** of the angular momentum space increases, the photon frequency **f** diminishes proportionately. This raises the question of whether the increase in the CBR wavelength can be attributed in whole or in part to an expanding spatial unit rather than the global stretching of a continuum as a whole? A meaningful answer to this question must await a clever experiment capable of revealing the granular nature of space, if indeed space is quantum in nature. What we have identified as stress would tend to imply linked elements or a continuum, but this too misstates our use of the term stress. Spatial stress is dynamic not static, we have yet to distinguish dynamic spatial stress from accelerated flow, in fact the dynamic spatial stress metaphor has been used interchangeably throughout to express the reactionary force that results from acceleration. For a conceptual physical model, the "*Inflow Theory*" of gravity must at some level be given serious consideration. This imposes granular space and even micro-black holes within all forms of matter to absorb the inrush. Or perhaps the spatial units can expand or contract as required by the local density conditions. The answer is in the space, and the motion of space.

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[9]Photons have momentum, the idea of massless momentum evokes questions as to our understanding of the physics of photons. Herein we make a distinction between three dimensional particles that manifest 3 dimensional angular momentum and two dimensional particles that always move at the velocity of light.

[10]Space obeys the laws of mathematics even though there is nothing substantive upon which the mathematics can operate. Out of the dimensions of space and time, through multiple incidents of uncertainty, the perfect symmetry that was, became the matter that is.

Appendix A-17

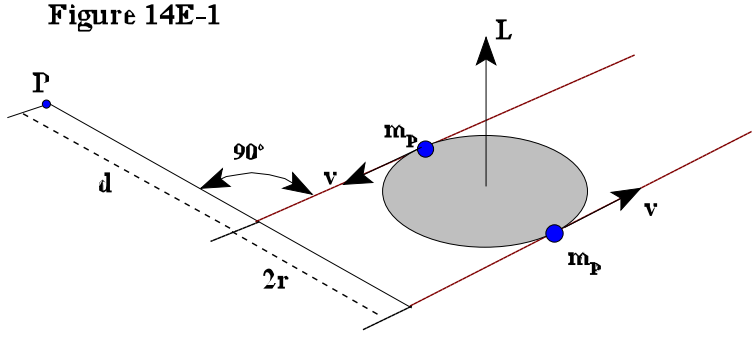
Angular Momentum Independent of axis

In our development, empty space embraces a wave-like density distribution of isotropic angular momentums **ħ/2** from whence come the measured electrical properties of capacity, inductance and impedance. These phantom vortices also determine the mechanical reactance identified as inertia. Being non-substantive, they are describable only in terms of their functional influence upon matter and one another

To this end, we illustrate in **Figure 14E-1** below the intrinsic nature of spin as a particle attribute, i.e., the moment of momentum is independent of the axis chosen for computation. This remarkable property of a symmetrical spinning object that rotates about an axis of symmetry can be proved by considering two equal masses $\mathbf{m_p}$ each a distance r from the center of a circle about which they rotate at a constant speed $\mathbf{v = r\omega}$. We calculate the total angular momentum relative to a point **P** arbitrarily chosen to be anywhere in the plane of rotation. Taking account of the angular momentum of one particle as positive and the other negative, then the total angular momentum $\mathbf{L_t}$ of the pair about the point **P** as determined by the projection of the positions of each particle upon the extended moment arm is:

$$\mathbf{L_t = m_p v(d+2r) - m_p vd = 2m_p vr}$$

Figure 14E-1



This, however, is the same as the angular momentum about the spin axis. Accordingly, any point in the universe can be used to calculate the angular momentum of a symmetrical rotation. The totality of spin momentum(s) throughout a Hubble Universe can be calculated at any Hubble center.

Appendix A-18

The Bohr Model

The quantum theory of the hydrogen atom was first developed in 1913 by Niels Bohr. His derivation is a hybrid between classical physics and wave mechanics; it depends from the particle aspect of the structure inasmuch as it assumes the proton to be a central source of attraction at rest relative to the electron which moves about it, but it relies upon quantum postulates to explain the spectra in terms of orbital-energy transitions:

Bohr begin by setting the Coulomb force between the electron and proton equal to the centripetal force.

$$\mathbf{m_o v^2/r = k_e e^2/r^2}$$

The conditions necessary for resonant oscillations, i.e., standing waves ($n\lambda = 2\pi r$) fitted around the orbital circumference so as to join smoothly onto themselves. In doing this, we have, in essence, considered the stationary state of the structure as a non-radiating electron wave propagated in a circular orbit of radius r_n. If λ is the wavelength of a particular orbit then from de Broglie's equation:

$$\boldsymbol{\lambda = h/m_o v}$$

Substituting de Broglie's wavelength λ into the standing wave criteria ($n\lambda = 2\pi r$) then:

$$\mathbf{m_o v r_n = n(h/2\pi) = n\hbar}$$

There will thus be a tangential velocity v_n associated with each orbital radius equal to:

$$\mathbf{v_n = n\hbar/m_o r_n}$$

Therefore

$$\mathbf{m_o(n\hbar/m_o r_n)^2 = k_e e^2/r_n}$$

From which:

$$\mathbf{r_n = n^2\hbar^2/k_e m_o e^2}$$

The radius corresponding to n = 1) is accordingly:

$$\mathbf{r_1 = \hbar^2/k_e m_o e^2 = 0.528 \times 10^{-10}\ meters}$$

The orbital speed in the first Bohr orbit is therefore:

$$\mathbf{v_1 = n\hbar/r_1}$$

The ratio of $\mathbf{v_1}$ to the velocity of light **c** is represented by the symbol $\boldsymbol{\alpha}$

$$\boldsymbol{\alpha = v_1/c = k_e e^2/\hbar c \approx 1/137}$$

Appendix A-19

Einstein's Aether

It is an irony of physics that Einstein's two theories of relativity are based upon perceptual different ideas—the Special Theory denies the need for a propagation medium, whereas General Relativity demands that there be some form of spatial reality. In his 1920 address at the University of Leyden. Einstein stated:

"....to deny the ether is to ultimately assume that empty space has no physical qualities whatever. The fundamental facts of mechanics do not harmonize with this view. For the mechanical behavior of a corporal system hovering freely in empty space not only depends upon relative positions (distances) and relative velocities, but also on its state of rotation, which physically may be taken as a characteristic not appertaining to the system itself. In order to be able to look upon the rotation of the system, at least formally, as something real, Newton objectivises space. Since he classes his absolute space together with real things, for him rotation relative to absolute space is something real. Newton might no less well have called his absolute space "Ether." What is essential is merely that beside observable objects, another thing, which is not perceptible, must be looked upon as real, to enable acceleration or rotation to be looked upon as something real...."

"It is true that Mach tried to avoid having to accept as real something which is not observable by endeavoring to substitute in mechanics a mean acceleration with reference to the totality of the masses of the universe in place of an acceleration with reference to absolute space. But inertial resistance opposed to relative acceleration of distance masses presupposes action at a distance; and as the modern physicist does not believe that he may accept this action at a distance, he comes back once more to the ether, which has to serve as a medium for the effects of inertia. But this concept of the ether to which we are lead by Mach's way of thinking differs essentially from the ether conceived by Newton, by Frensnel and by Lorentz. Mach's ether not only conditions the behavior of inert masses, but is also conditioned in its state by them"

"Recapitulating, we may say that according to the general theory of relativity, space is endowed with physical qualities; in this sense therefore, there exists an ether.....space without the ether is unthinkable, for in such a space there would not only be no propagation of light, but no possibility of existence for standards of space and time nor any spacetime intervals in the physical sense. But this ether may not be thought of as endowed with the qualities of a ponderable media...the idea of motion may not be applied to it"

It is indeed a puzzling and bazaar medium that is modifiable but nonetheless immoveable, that acts upon and reacts to matter, that communicates electromagnetic forces, propagates light, yet remains void, intangible and without form to a degree that makes measurement of absolute velocity impossible.

Although not the first to conceive of an ether, the 17th century mathematician Rene' Descartes became a strong advocate of the need for a physical something that would avoid the untenable thought that actions could propagate through nothing. Descartes had postulated that action could only be transmitted by pressure and impact, and that the effects at a distance between bodies could only be explained by a medium filling space which he called ether (in the original Greek had meant blue sky or upper air). Later investigators proposed a variety of compositions for the mysterious substance to account for an ever increasing range of phenomena. Until the latter half of the 19th century the ether remained a core element of physics though it reinvented itself with each new experimental difficulty.

The history of the ether was intimately tied to the propagation of light and gravity. Newton had eliminated the possibility of longitudinal waves carried by an ether after learning of Huygens experiments with Icelandic crystal.[11] But as to its precise nature he "let every man here take his fancy" As to both light and gravitation-- he did not want to pronounce himself as to the operative, although he conjectured that it would be absurd if gravitational effects could propagate without the mediation of an in-between substance. John Bernoulli (1710-1790) embellished upon the notion of a mechanical ether along the lines proposed by Descartes in suggesting a composition of tiny whirlpools that could never stray much from their average location. Leonhard Euler (1707 -1703) introduced the idea that the same ether served as a medium for both electricity and light. Thomas Young (1773-1829) provided support for the transverse wave theory of light with a series of experiments that explained reflection and refraction and Michael Faraday introduced the concept of a field as a stress in the ether. James Clerk Maxwell (1831-1879) inspired by Faraday's work, attempted to complete a mechanical picture of the ether as a solid. In 1860 he showed the propagation velocity of light to be a characteristic of the electrical properties of free space. In concluding that it travels at equal speed in all directions with respect to an "at-rest" medium having the measured permeability and permittivity that defined its velocity, he set the stage for the experimental endeavors that were to follow, specifically the many attempts to measure the earth's motion with respect thereto.

The first and most well known if these experiments were performed by Albert A. Michelson in 1881 and later, in collaboration with E.W. Moreley in 1887, a more precise version of the tests were conducted. In both investigations, the apparatus comprised an interferometer having two equal length perpendicular arms. Light from a source stationary with respect to the laboratory was split into two beams so that each traveled parallel to one of the arms. Mirrors at the end of the arms reflected the light to a point where they were combined, and the interference pattern viewed through an eyepiece. If the earth moved with respect to the medium, the interference pattern would be expected to shift when the orientation of the apparatus was changed. Observations were made day and night and during all seasons, but the expected amount of shift was not observed. Theorists searched for an explanation that would save the ether hypothesis.

[11].Huygens had observed that light refracted once through a first piece of Icelandic crystal could be seen or not seen depending upon the orientation of a second crystal. Newton correctly understood this as polarization (having properties dependent upon directions perpendicular to the direction of travel. He then concluded this was incompatible with a longitudinal wave.

The first such proposals involved the notion of ether drag, the premise being that all bodies carry an entrained ether layer with them, so there would be no relative velocity between the local ether and the earth frame in which the experiment was conducted. But the theory suffered from a fatal flaw; it had been known as early as 1727 that light from distant stars deviated from the orthogonal due to earth's orbital velocity around the sun. This effect, known as Bradley aberration, in honor of its discoverer, showed that light (and hence the ether) is not entrained by the earths motion. Other theorists suggested that the velocity of light was somehow connected to the velocity of the source (like a bullet fired from a moving gun). Since Michaelson and Moreley used a local light source, they proposed that its velocity be added to the free space propagation speed. These ideas, called emission theories, were soon discredited by Willem de Sitter and others based upon an analysis of light emitted by binary star systems.

The most successful attempt to prop up the ether was separately made by the Irish physicist Fitzgerald and the Danish physicist Lorentz, commonly known as the Lorentz-Fitzgerald contraction.[12] Lorentz originally derived the equations that formed the foundational bases for Special Relativity, but he viewed them as being applicable to an objects absolute motion with respect to the ether. According to Lorentz, the contraction resulted from a physical foreshortening brought about by changes in the electrical properties and spacing within material objects.

At this point, the proposals invented to salvage the ether in the light of the results obtained by Michaelson and Moreley could neither substantiate nor disprove the existence of an ether. Nor was there a bases for believing or disbelieving in the reality of a preferred reference frame, but the notion of the ether as a mechanical medium was definitely under attack by notables such as Joseph Larmor (1857-1942) and Henri Poincare (1854-1912). Larmor insisted that the either should be conceived as an immaterial medium and not a mechanical one having a concealed structure within. To Larmor, it was sufficient that having attained the exact dynamical correlation, we should be satisfied.. In 1899 Poincare declared that absolute motion with respect to the ether was undetectable by any means. The ideas advanced by Lorentz and others were being seen as *ad hoc* patchups. The universe was about to receive a theoretic overhaul.

[12] As to the reality of the FitzGerald Contraction, Arthur Eddington had this to say: "...You receive a balance sheet from a public company...it is certified by a chartered accountant. But is it really true? Many questions arise: the real values of the items are often very different from those that figure in the balance sheet...There is a blessed phrase "hidden reserves" and generally speaking the more respectable the company the more widely does its balance sheet deviate from reality. This is called sound finance ...the main function of the balance sheet is to balance and everything else has to be subordinated to that end. The writing down of lengths for balance sheet purposes is the FitzGerald Contraction. The shortening of the moving rod is true but its not really true. It is not a statement about reality (the absolute) but it is a true statement about appearances"

In 1905 Albert Einstein published a revolutionary paper entitled: *"On the Electrodynamics of Moving Bodies."* It had long been assumed that Newton's laws were invariant under Galilean transformations.[13] What was new about Special Relativity is that it extended the notion of invariance to the measurement of light. To Einstein's positivist way of thinking, the speed of light had singular significance–it would appear isotropic in every non-accelerating reference frame. The measurement of light speed was raised to the same level of importance as the measurement of inertia, energy, force and momentum. But was it justified? The Michael-Morley experiments had established the round trip velocity of light as constant in a moving frame, but the one way velocity had not then been measured and is today a subject of continuing dispute. Einstein adopted the one-way constancy of light in all frames as convention, and the Special Theory of Relativity was born.

While Lorentz had derived and published the same space-time transforms more than a year earlier, Einstein postulation regarding the invariance of light velocity imbued time with a startling new mien; objects in relative motion were predicted to age at different rates.

> **"If my Theory of Relativity is proven successful, Germany will claim me as a German, and France will declare I am a citizen of the world. Should my theory prove untrue, France will say I am a German, and Germany will declare that I am a Jew."**
>
> Albert Einstein

[13] Within a closed container traveling at constant speed, it is not possible to conduct an experiment that would reveal whether the container is moving. This is the essence of Galilean invariance.

Appendix A-20

The Twin Thing Again

Special Relativity is frequently extolled as a necessary consequence of physical unity. The underlying idea is that inertial systems equivalent from a mechanical perspective should not be distinguishable by optical measurements. But there is a fly in this ointment of affirmation–objects within a closed container are at-rest with respect to each other, whereas a source of light from a distant star is clearly not contained within the moving frame. It would seem an easy matter to confirm the speed of light relative to a moving frame, but the experiment will be self invalidating if light is in someway used to define the distance or the time that is used to calculate the result. Einstein postulated that the speed of light could be freely chosen as **c**. In the case of over and back experiments, the average velocity is indeed **c**, and the correction needed to explain all such over and back (Michaelson and Moreley) type experiments is a second order factor algebraically consistent with the round trip speed of light in all theories.[14]

Einstein claimed in Part IV of his 1905 paper that the stipulated constant velocity of light leads to the following peculiar consequence: "If at points **A** and **B**…. stationary clocks, viewed in the stationary system, are synchronous; and if the clock at **A** is moved with velocity **v** along the line **AB** to **B**, then on its arrival at **B**, the two clocks no longer synchronize, but the clock moved from **A** to **B** lags behind the other which has remained at **B** by $\mathbf{(\frac{1}{2})t(v^2/c^2)}$ ...**t** being the time occupied in the journey from **A** to **B**. It is at once apparent that this result still holds good if the clock moves from **A** to **B** along any polygonal line, and also when the points **A** and **B** coincide. If we assume the result proved for a polygonal line is also true for a continuously curved line, we arrive at this result. If one of two synchronous clocks at point **A** is moved in a closed curve with constant velocity until it returns to **A**, the journey lasting **t** seconds, then by the clock which has remained at rest, the traveled clock on its arrival at **A** will be $\mathbf{(1/2)tv^2/c^2}$ seconds slow."

The Special Theory explained the Michaelson-Moreley results by turning the failure to measure the earths absolute velocity into the postulate that "light speed is isotropic in all inertial systems." The clock difference was prophesied to be objectively real, and since clocks measure temporal durations, time must pass differently in relatively moving frames.[15] In courageously proclaiming temporal intervals as relative, Einstein upset centuries of strong conviction, but does nature really work this way?

[14] Einstein believed as did Poincare, that there was no way to measure light speed since one had to first know the distance between clocks, and to know this distance one first had to know how long it took for light to travel between the clocks, which is what was being sought in initially.

[15] Einstein had worked on the problem off and on since he was 16, starting when he was a student. For 10 years he tried and abandoned many fruitless attempts to find a solution, but in his own words, "the problem was always with me." Gradually he began to suspect time as the malefactor.

What is astounding about the reality of the conclusions drawn in Part IV of Einstein's 1905 paper is that the formalism is based upon observational inferences that were yet to be verified; there is no physics in the sense of real forces and reactions, but rather changes due to the measurement process. Special Relativity is founded upon Einstein synchronization, a convention he himself asserts can be freely chosen. Nonetheless, the theory is yet to be falsified despite many attempts and thousands of critical papers that claim the reasoning leads to paradoxical results. Was Einstein himself responsible for the confusion; until 1918 he gave no physical explanation for the asymmetrical aging between relatively moving inertial frames? The question to be answered is whether the 1918 paper clarifies the issue. Perhaps it was unnecessary, and even misleading. .

Shortly after the 1905 paper was published, Longevin anthropomorphized the aging quandary by introducing a pair of twins, one of whom makes a round trip to a far away planet and returns to earth to find his stay-at-home brother much older than himself. From a kinematic standpoint, one might reason the situation symmetrical since neither twin can determine whether he or his brother is actually moving. Longevin, like many others, resolved the apparent paradox by the fact that one twin experiences acceleration (at start-up, at turn around, and when coming to a stop on earth.) But as von Laue commented, the affect cannot be due to acceleration since time during uniform velocity can be made as large as desired by extending the length of the trip to swamp out the time accrued during periods of acceleration. Moreover, experiments show distance does not affect acceleration *time dilation* as such ..clocks subjected to centrifugal forces keep the same rate as if traveling at a uniform velocity $\mathbf{v} = \mathbf{r}\omega$. So why does the traveling twin return younger than his brother?

Einstein's 1905 paper predicted the correct time difference as verified by innumerable one-way experiments (particles put in motion relative to the earth accumulate less time when measured by earth clocks). But these experiments could not be used to verify reciprocity, the predicted slowing of earth clocks measured in the fame of the high velocity particle. The Special Theory seemed to lack a mechanism that would account for the age difference between travelers. If the asymmetry cannot be explained by acceleration, can a case be made for the affects of changing frames, and if so, how does it reckon time loss while moving in a continuous circular path?

Einstein's 1918 paper attributed age difference to pseudo gravitational acceleration. Many writers and physicists of international repute were quick to embraced the "turn around acceleration" as the solution [16] But was this mechanism or dialectic? Does the recognition of **G** forces at turn around really resolve the mystery? Is relativity truly relative?

[16] Einstein's Theory Of Relativity, Max Born, 1924, republished 1962 Dover Publications at page 356: "Thus the clock paradox is due to a false application of the special theory of relativity, namely to a case in which the methods of the general theory should be applied" Space and Time, Hans Reichenback, 1927, republished 1957 in English Dover Publications on page 193: "The mistake that led to the paradox therefore resulted from the fact that the considerable effects of gravitation were ignored." Physics, KR Atkins, 1964 John Wiley and Sons 1965 at page 509: "According to the principle of equivalence an acceleration is equivalent to a gravitational field, and in a gravitational field clocks are slow. The problem cannot therefore be satisfactorily discussed in terms of the special theory."

Let us reduce the problem to a pair of one-way trips. The time lost on the outbound journey to a destination clock "**B**" can be doubled to arrive at the round trip age difference (It is not necessary that the two twins be re-united in order to measure their relative age difference). In Einstein's description, the one way trip starts with two clocks initially at rest in the same frame and synchronized. Clock "**A**" is then moved with a velocity **v** until it reaches "**B**" where it is found to be slow by $\mathbf{(1/2)(v^2/c^2)}$. The acceleration involved in getting "**A**" up to speed is ignored in Einstein's 1905 paper, but not in his 1918 reasoning.

To avoid the acceleration issue in all circumstances, we give one clock to the stay-at-home-twin Abel located at **A** and station a second clock **B** a fixed distance "**d"** to the East of **A**. We then synchronize clock **B** with clock **A** using Einstein's method.[17] The third clock **P** is carried by the traveling twin Paul, but instead of starting from Abel's location, Paul begins his journey at a point West of Abel and accelerates to his final velocity "**v**" just as he reaches Abel. As Paul passes Abel, he observes clock **A** and sets his own **P** clock to the same time **(**See **Figure A20–2)**. The Twin Paradox then reduces to the usual experiment that uses two separated synchronized clocks to measure the time lost by a third clock moving between them That is accomplished in the above scenario by having Paul continue at the same velocity **v** until he arrives at stationary clock **B**. As he passes **B**, and without slowing, Paul reads the time lapsed on the **B** clock and compares it with his own **P** clock. Since **A** and B are always in the same inertial frame and not moving with respect to each other, the time lost by the traveling clock is revealed when **P** arrives at **B**. If Paul discovers he is younger than Abel, then time dilation cannot be reciprocal.

If no time difference to be attributed to acceleration (no acceleration involved after Paul's **P** clock is set on the fly to the same time as Abel's **A** clock), why does Paul's **P** clock log less time than **A** and **B** clocks. The answer lies in the unification of space and time, specifically the way space and time were amalgamated by Minkowski into one spacetime composite. The spacetime interval between any two points located by space and time coordinates is constant in all frames. But that is not to say measurements will be the same irrespective of which frame is put in motion. When one of two synchronized frames is moving, it will have a different energy state, i.e., KE per unit mass relative to the rest fame of the universe will be different. Initially, both clocks measured time in the same state of potential and kinetic energy. A synchronized clock lowered into a gravitational potential runs slower based upon the escape velocity (The kinetic energy per unit mass required to escape) as analyzed in connection with (**Figure 8B**). A clock will run slower if its **KE** state is increased. Minkowski found in *Spacetime* a profound connection to the universe.

"In my opinion, the theory of Special Relativity was not yet complete, despite the wonderful physical insights of Einstein and the profound contributions of Lorentz and Poincare', until Minkowski provided his fundamental and revolutionary viewpoint, *spacetime"*

Roger Penrose, Road to Reality at page 406

[17] Einstein's synchronization involves sending a light beam from A to B where it is reflected back to A. The time on clock B is then set to ½ the time difference between emission and return

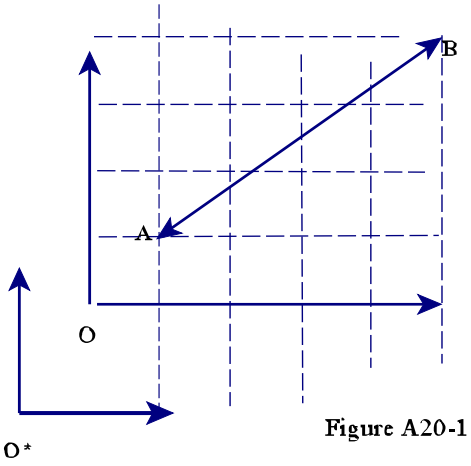


Figure A20-1

To see the how Minkowski's insight applies to relatively moving frames, we first consider the obvious unification of space-space intervals. The inertial reference frame is to relativity what the north-south/east-west grid is to a surveyor. The surveyor measures the coordinates of places in space; relativity is concerned with the specification of events in spacetime. For the Cartesian coordinate system with origin **O** shown in **Figure A20-1**, a journey beginning at **A** (coordinates x = 1, y = 1), and ending at **B** (coordinates x = 5, y = 4) will have a spatial separation $[(5-1)^2 - (4-1)^2]^{1/2} = 5$. For a different origin **O*** the point **A** has coordinates (x = 2, y = 3) and point **B** has coordinates (x = 6, y = 6). The distance between **A** and **B** will, however, remain the same $[(6 - 2)^2 + (6 - 3)^2 \}]^{1/2}. = 5$. The "*Invariance Rule*" states that the distance between **A** and **B** is independent of the origin or orientation of the coordinate system. The same is true for a spacetime coordinate system where the spatial axis **S** is oriented to coincide with the line connecting **A** and **B** as shown in **Figure A-20-2**. In a common situation, the problem is to determine the time lapse of a clock that moves at a uniform velocity "**v**" from **A** to **B**. Just as space intervals are independent of the coordinate frame for surveyors measuring only distance, Minkowski unification imposes the same invariance upon spacetime intervals measured in relatively moving frames.

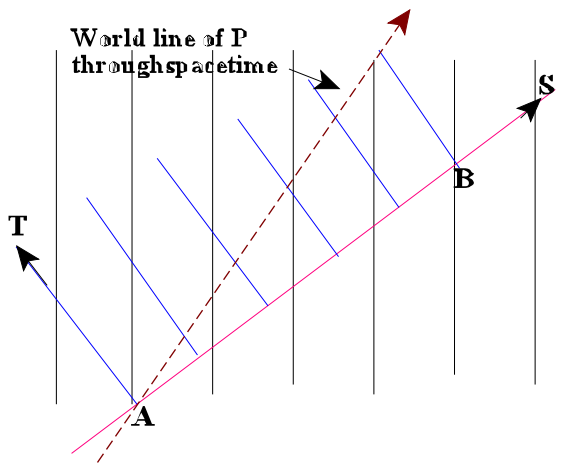


Figure A20-2 The XY composite between two points A and B is 5 as measured along the space axis S (red). Time increments (blue) are ⊥ to Space distances as measured by a non-moving clock at A or B.

The only difference between space intervals and time intervals is that the latter must be scaled when transformed as a distance–in the spacetime domain where all physical existence takes place, one second of time corresponds to a displacement equal to the distance light travels in one second. In other words, physical objects are space-time correlative, nothing stays-put in time and consequently, nor in space. To resolve the problem, a straightforward application of the principle of interval invariance reveals why the "at rest" twin is older. It occurs because relatively moving objects take different paths through spacetime. Since absolute motion cannot be measured, the determination of which clock logs the most time depends upon the experiment. In SR the choice is between which frame is chosen to be "*at rest*." From the cosmological perspective, the choice is between which frame experiences change. While either frame can be selected as the one which preserves its status quo, once chosen, it will take-on a preferred stature in that lengths and times measured therein will be commonly called '*proper'*. For example, if **d** is the distance between the **A** and **B** clocks that measure the beginning and end of Paul's trip in the earth frame, it is called "*proper length*" and the time measured for the trip in the earth frame will be called "*proper time*"

P--------V_p---------->A----------d----------B

Figure A20-4: **Separated clocks "A" and "B" are first synchronized using the Einstein method.**[18,19] **Paul accelerates to a fixed velocity "v" and continues from left to right synchronizing his own clock P to Abel's clock A as he passes. When Paul arrives at B, both P and B clocks are stopped and the readings sent to Able. Able subtracts the B clock reading from the reading recorded by A clock when Paul passed, and determines the difference Δt he has aged during Paul's journey to B. Since Able knows the distance "d" between clocks A and B and the relative velocity v between A and P, and can compute Paul's aging factor Δt***

[18]Einstein's initial condition (A and P at rest and synchronized) creates an asymmetry introduced when "P" clock changed frames (the acceleration that brings about the relative velocity between the frames). This leads to the erroneous idea of a physical cause. But there is no need to start the experiment by accelerating P - the sync can be made "on the fly" as the "**P**" and "**A**" clocks pass

[19]At the time the Special Theory was published there was no good evidence that would support or deny the existence of an ether, no reason to believe that the universe was expanding, no thought of cosmic background radiation—and no basis for believing or disbelieving the existence of a preferred reference frame. The Michelson-Moreley results required modifications as to how "lengths" and "times" should be viewed—the question as to what form these changes would take had been pondered by Lorentz, Fitzgerald, and others, but Einstein, like Poincare, asserted the absolute impossibility of measuring one's velocity with respect to a cosmological frame. True, the presumption of isotropic light velocity leads to the correct space time adjustments, but it is not necessary that the outgoing light pulse and the reflected light pulse both require the same travel time in order that the over and back average be constant. .

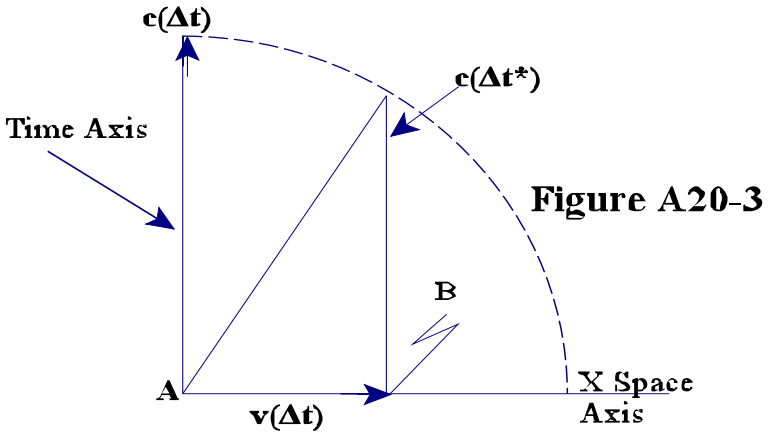


Figure A20-3

In Figure A20-3: Temporal intervals multiplied by "c" are plotted as vertical distances. The spatial distance d traveled by P at velocity v for the time Δt as measured in the status quo energy frame of the earth is the horizontal distance v(Δt) The Pythagorean composite of c(Δt*) and v(Δt) equals the length cΔt. The intersection of the arc length c(Δt) in the first quadrant therefore defines the vertical distance c(Δt*) as shown.[20]

The trip transit time **Δt** logged in the status quo frame is the difference between the **A** clock start time observed by Paul when passing **A** clock and then **B** clock where he sends a Stop signal to **B**.[21]

[20]It is customary to express interval invariance in the specialized language of the difference between the proper time and proper distance in each frame. In other words, the spacetime difference separating two events will be equal in all frames.

$$(\Delta S)^2 - (c\Delta t)^2 = (\Delta S^*)^2 - (c\Delta t^*)^2$$

From **P's** perspective, **ΔS*** is zero since **P** is not in motion wrt his own frame, consequently,

$$(C\Delta t)^2 = (c\Delta t^*)^2 + (v\Delta t)^2$$

where **vΔt** is the distance between the clocks in the rest frame i.e., the distance **P** travels in the rest frame. Once **P** knows the time **Δt*** he can calculate the distance **ΔS*** traveled if he is taken as the traveler.

[21]At the time the Special Theory was published there was no good evidence that would support or deny the existence of an ether, no reason to believe that the universe was expanding, no thought of cosmic background radiation—and no basis for believing or disbelieving in the existence of a preferred reference frame. The Michelson-Morely results required modifications as to how "lengths" and "times" should be viewed—the question as to what formthese changes would take had been pondered by Lorentz, Fitzgerald, and others, but Einstein, like Poincare, asserted the absolute impossibility of measuring one's velocity with respect to some cosmological frame. True, the presumption of isotropic light velocity leads to the correct correction for time dilation and space contraction, but it is not necessary that the outgoing light pulse and the reflected light pulse both require the same travel time in order that the over and back average always be constant. In fact, the constancy of the round trip time directly follows from Herman Minkowski's work in 1906.

The relative velocity of Paul with respect to Abel is "**v**" so the distance "**d**" traveled by Paul in his journey from "**A**" to "**B**" is equal **vΔt** measured along the **A-B** base line (the proper distance in the frame of measurement). Paul's new age is **Δt***. Abel's spatial motion **ΔS** with respect to the origin of the spacetime coordinate system is zero, but Abel has traveled in the temporal plane a distance **cΔt** during Paul's one way trip. From the distance **d** = **v(Δt)** traveled in the **A-B** frame then the time lapse **Δt*** follows from the invariance of the spacetime interval, that is

$$[(c\Delta t)^2 + (\Delta S)^2] = [(v\Delta t)^2 + (c\Delta t^*)^2]$$

and since $(\Delta S)^2 = 0$

$$\Delta t^* = \Delta t[1 - v^2/c^2]^{1/2}$$

Since velocity is relative, the reciprocal experiment performed with **P** at rest will result in the opposite outcome. Specifically, for a one way trip, the outcome will depend upon which frame experiences an energy change. In this sense, the Special Theory is the kinetic equivalent of the General Theory (**Figure 8B**).

In 1988 Hafele and Keating flew clocks in different directions around the earth and compared their rates to earth clocks. When flown eastbound (in the same direction as the earth is turning), the air-borne clock ran slow (the kinetic energy state of the flying clock was greater than the kinetic energy state of the rotating earth frame). By contrast, the westward flying clock ran faster than the earth clock (its kinetic energy state had been decreased when put in flight in the opposite direction which the earth is turning). Relative to a non rotating frame, earth clocks would be expected to run slow because they are traveling East to West at approx 1000 miles per hour. If the West bound clock travels at 1000 miles per hour it is constructively in the same energy state as a clock on the surface of a non rotating earth. Reduction in the absolute KE state of a clock causes it to run faster, increasing the KE state causes it to run slower. When flying west to east at 1000 mph., the rate would be maximum - it corresponds to the energy state of a clock on a non rotating earth. If the West to East plane begins to increase speed beyond 1000 mph, the on board clock rate will slow.

General Relativity teaches that a clock lowered into a **G** field will run slower based upon the ratio $(v_e/c)^2$ where v_e is the escape velocity. Special relativity teaches that clocks run slow based upon the ratio $(v_r/c)^2$ where v_r is the velocity relative to any inertial frame. Both formulations predict a time difference that reduces to KE/unit mass. The twin paradox arises from the postulation of inertial frame equality. And this has its origin in Einstein's assumption that the one way velocity of light is constant in all inertial frames. Its has never been verified. Until that happens, it is easier to explain the Twin Paradox in terms of changing energy frames. Real age difference is the result of different spacetime paths taken by different energy frames.

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Tycho Brahe (1546-1601) was a Danish Nobleman who made careful and continual observations of the planets using the utmost precision possible in a time before the invention of the telescope. After Tycho's death Johannes Kepler (1571-1630) inherited his observational data. Kepler was an imaginative and determined scientist. After many years of painstaking trial and error, he was able to fit Tycho's observational data to the orbit of Mars.

Would his work free science from epicyclical motion and its accompanying religious tyranny? There would be strong opposition to an elliptical theory, or any path through the heavens that did not conform to God-like spherical perfection. For Kepler, it was a personal triumph, as expressed in his own words:

"The die is cast, the book is written,
For now or for posterity, I care not which.
The book can await its reader,
Hath not God waited 6000 years for an observer."

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