*To find diamonds you have to dig somewhere everyone else isn't digging.* (Fred Hoyle)

# Astronomy and Cosmology
Section I. An analysis of the red shift and the Big bang
Section II. Calculating the finite Universe
Section III. Conservation Rules in a finite Universe

**Introduction.** Einstein surmised, that the electron is the most important particle of the Universe. We have found this is because its wave structure extends throughout the Universe and every electron is inter-connected with every other electron or charged 'particle'. The IN and OUT waves of the charged 'particles' are the mechanisms of their inter-connection. The electron's immense importance is also seen from Principle II, derived from Mach's Principle, which makes it clear that matter and the Natural Laws on Earth could not exist without the presence of other matter of the Universe   Suddenly these inter-connections open a new window of application for the WSM – Astronomy and Cosmology. It now becomes possible to understand the behavior of cosmological events such as gravity, general relativity, and the red-shift that were formerly only perplexing puzzles arising out of the former discrete particle model of matter. Understanding these with the new vision of the WSM is the purpose of this article.

We discuss only a few puzzles below but there are dozens more that you the reader will probably think of as you read on. We join you to enjoy your future explorations in this fascinating arena!

## Section I. An analysis of the red shift and the Big bang
### Introduction.
**The Big bang**. The red shift that led to the big bang **w**as discovered by Edwin Hubble 90 years ago. It is the simple and surprising observation that spectral lines in the light from different stars shift their wavelength towards longer wavelengths (toward infra-red) in proportion to the distance of the star from the Earth. He measured the fraction of wavelength shift and star's distance **d** and then defined a constant **H**,
$$v = H\ d$$
Where **v** is the apparent velocity, of a star and **d** is its distance from us. The velocity is obtained using the assumption that **v** produces a Doppler wavelength shift – the *red shift*. Some theorists believe it is caused by an expansion of the space of the Universe. Hubble did not believe this notion of expansion stating that he felt that unknown factors were involved. The distances **d** and the red shifts are firm experimental facts for most stars, but no one knows if an expansion exists. Nevertheless, an expansion of the Universe after an initial "Big-bang" beginning makes popular reading regardless of its fantasy fiction origin and lack of evidence. It has become a widespread concept! This Section seeks to find real evidence for the truth of the red shift.

The reciprocal of **H** is a time T = 1/**H,** which is often assumed to be the age of the universe. It is imagined that if time began at T=0 with a Big Bang that this was the beginning and origin of all matter of the Universe. If light travels for a time T it will travel a distance **R**=cT, often called the 'Hubble distance'. This **R** also represents the

largest distance from which we can receive information by light transmission if our cosmological age is T.

Below, we investigate Hubble's constant **H** and the origin of the red shift by using the concept of the Wave Structure of Matter (WSM). WSM replaces the ancient notion of matter as discrete 'particles'. The WSM has been very successful in most puzzles of modern physics and it offers new insights. For this reason it is expected that the WSM can also clarify the meaning of Hubble's **H** and the true origin of the red shift. This will set aside the Big bang yarn as a possible explanation, and shed light on the origin of the Universe.

The meaning of the red shift and Hubble's **H** have been mysterious controversies since Hubble's discovery. There is more to it than the speculative, big bang notion that actually has very little evidence for it. Rather than accepting the big-bang notion, other calculations here suggest a close relationship between the Hubble constant **H** and fundamental properties of the *space* of the cosmos. This is the main purpose of this article

We will find a surprising new relationship indicating that all matter: you and I, living things, and the Earth itself are interconnected with all other matter of the Universe. We do not exist separately but are part of one whole Universe. Hubble's constant **H** will be related to the properties of the electron because the waves of the electron dominate space. These are derived below.

**Puzzles of the Big bang.** Many books have been written describing these puzzles. A good reference is *The Big-bang that never happened"* by Eric Lerner  (1992), a NY Times best seller. Lerner shows that the big-bang (BB) notion makes tremendous demands on credulity. To name just a few:
1) The BB assumes the laws of physics are unchanged throughout the violent process. Is this possible when initial matter was concentrated a billion, billion times more dense than today?
2) What happened before T = 0? Can time really just turn on and off?
 3) It is well known that mathematics goes awry at points of infinity. How can one believe mathematics at an infinitely small T=0 and when density is infinite?
3)  4) There are no cases of infinities occurring in Nature (physics).
5) Attempts were made to justify the BB by calculating the quantity of hydrogen and helium atoms in the universe formed from initial energy. The calculations were in error by factors of 100X or more! So these calculations were patched by assuming several more 'super-inflations.' No logic was provided for the patching; just fix-up.

**The Meaning of the Hubble Distance in an infinite Universe.** Einstein and other philosophers of science argued convincingly that both time and distance in the Universe must be infinite (no Big-bang) otherwise there would be *discontinuities* in the structure of space and time. And in fact, there is no evidence for discontinuous borders of any fundamental object in Nature. Thus the questions are raised: *"What is the meaning of the Hubble Distance R? Why does this special finite distance exist in an infinite Universe?"* We will try to answer these questions using knowledge of the Wave Structure of Matter (WSM).

**The Wave Structure of Matter removes the puzzles.** The puzzles of the red shift and the big bang arise partly because of the assumption that matter is discrete material particles like grains of sand, as originally proposed by the Greek Democritus. These puzzles disappear   if you discard the notion of discrete particles and replace it with the proposals of Clifford  (1870) and Schrödinger (1937) that the Universe consists of wave structures in *space* and our observations of natural laws and the particles are the appearances of the waves.  Think abut this deeply and simply to realize: Waves in space have no discontinuities. Particles are inherently discontinuous. William Clifford was a famous mathematician and astronomer in Cambridge University who is remembered for *Clifford Algebras*. Erwin Schrödinger was a co-discover of quantum theory and is best known for the *Schrödinger Equation* used to describe wave functions of the hydrogen atom.

Those who believed in discrete particles followed the view of Niels Bohr's Copenhagen group that Schrödinger's wave functions were only the probability of finding the particle somewhere inside the wave functions. Both Einstein and Schrodinger disagreed with Bohr. Expressing his disagreement, Einstein made his famous remark, "God does not play with dice". Today, most of the physics community agrees with Bohr. Nevertheless as Tolstoy observed, "*Wrong does not cease to be wrong because the majority share in it*."

### Review of the Wave Structure of Matter.

The following is a short review of the Wave Structure of Matter (WSM) that is necessary to understand the Hubble H, the red shift and the big bang. Another description of the WSM is on the websites:

SpaceandMotion.com

**http://redshift.vif.com/JournalFiles/V13NO2PDF/V13N2HAR.pdf** An animation of an electron is at:

http://ryanhagan.net/mike/StandingWave3D/StandingWave3D.htm

   At small dimensions, experimental data of the electron, for example in optical fibers and chips, displays wave properties. Especially, energy exchanges appear to be between *wave-structured electrons* in a quantum *space* medium, rather than between discrete particles. Such structures must obey a 3D wave equation in 3D space. The solutions of the wave equation are found to be the origins of electrons, all the natural laws, and the whole of Nature, as proposed by Clifford and Schrödinger.  All wave structure is based upon two principles:

**Principle I** describes the wave medium using a Wave Equation. Its solutions are *two* spherical waves of the electron or positron. The wave-rules of electron-wave combinations and quantum spin determine the Atomic Table that underlies all molecular matter: metals, crystals, semi-conductors, and the molecules of life. These are the simple origins of natural laws. Below is a summary of the math in Chapter 2 and the math appendix:

**Principle I** is written:

*Quantum matter waves exist in space and are solutions of a scalar wave equation:*
$$\nabla^2 \Phi - (1/c^2)\partial^2 \Phi / \partial t^2 = 0 \tag{1}$$
Where $\Phi$ is a scalar amplitude, c is the velocity of light, and t is the time.

   Its solutions in Figure 1 are a *pair* of spherical in/out waves:
$$\text{Outward wave} = \Phi_{out} = \Phi_0 \exp(iwt - ikr)$$
$$\text{Inward wave} = \Phi_{in} = \Phi_0 \exp(iwt + ikr) \tag{2}$$
There are only *two* combinations of these two waves. They have opposite spins that form the electron and positron:
$$\text{electron} = \Phi_{in} - \Phi_{out} + \text{CW spin}$$
$$\text{positron} = \Phi_{out} - \Phi_{in} + \text{CCW spin} \tag{3}$$
The variety of molecules in the universe is enormous, but the building bricks are just *two*. Thus Nature has built a binary universe.


**Mach's Principle** concerns our human frame of reference for observing motion of objects. He asserted (1883): *"Every local inertial frame is determined by the composite matter of the universe.* His deduction arose from two different methods of measuring rotation. First, without looking at the sky one can measure the centrifugal force on a rotating mass m and use the inertia law $\mathbf{F} = m\mathbf{a} = mv^2/r$ to find circumferential speed v and position, as in a gyroscope. The second method is to compare the object's angular position with the fixed (distant) stars. Surprisingly, both methods give the identical result. Thus the inertia law must depend on the fixed stars.


**Principle II - Space Density Principle.** This principle is a quantitative version of Mach's Principle and determines the density of the quantum space medium:
*Waves from all particles in the universe combine their intensities to form the wave-medium density (space) at each point in space,*
$$\text{Space density} \propto mc^2 = hf \propto \sum_1^N \left[ \Phi_n / r_n \right]^2 \tag{4}$$

 That is, the frequency f or mass m of a particle depends on the sum of squares of all wave amplitudes $\Phi_n$ from the N particles inside the "Hubble universe'. The number of particles in the Hubble universe is large $N \sim 10^{80}$ thus the space density is nearly constant everywhere and we observe a nearly constant speed of light. But close to a large astronomical body like the Sun, its added waves increase space density to produce a curvature of the paths of light or matter waves. This is the origin of the force of gravity and of Einstein's General Relativity.


Note that we have assumed that the entire Universe is contained in a sphere with the Hubble distance **R** as its radius. Without this assumption density becomes infinite and the WSM with it! We will discuss this later in connection with the red shift.


**Minimum Amplitude Principle III (MAP).** A third very useful principle can be obtained from Principle II [Haselhurst 2005].
   *The total amplitude of particle waves at every point always seeks a minimum.*
$$\sum_1^N \Phi_n = \text{ a minimum}$$

**MAP** is the disciplinarian of the universe. **MAP** is seen in situations like the leveling of water in a lake and the flow of heat that moves from a hot source to a cold sink; MAP is the origin of the *entropy principle*.

There are two immediate observations:

1. *Space*, described by these two principles, underlies all the natural laws of science.
2. When mass is accelerated, an energy exchange takes place between waves of the mass and the surrounding space medium. Thus the space medium, created by the mass of the Universe is observed as the inertial frame of **F**=m**a** as Mach asserted.

### The meaning of Hubble's Constant in Cosmology

The WSM reveals a new meaning of the Hubble distance because R is involved in basic mathematical relationships (below) describing properties of matter and space. All of them suggest that R is a finite distance in an infinite Universe, related to our ability to see into the depths of space. If these relations are true, and it is highly improbable that they all occur by coincidence, this clear meaning of the red shift appears. The need for a bizarre explanation like the big bang disappears.

**Equation of the Cosmos.** In order for an electron energy transfer to 'appear' to be a 'particle at a point', the electron waves must propagate non-linearly at the central region. This produces the *coupling* between two resonances that allows energy transfer. We observe this process and call it "charge." Thus the density of the waves of an electron, inside a radius $r_e$ from the wave-center, must be equal or larger than the density of background waves from all the rest of the matter of the universe. The result of this assumption can be found by setting:

**Electron wave density at $r_e$ ~ wave density of the Universe.**

Evaluating this equality yields

$$r_e^2 = R^2/3N$$

This is called the ***Equation of the Cosmos***, a relation between the size $r_e$ of the electron and the size R of the Hubble Universe. Astonishingly, it describes how all the N particles of the Hubble Universe create the "charge" region $r_e$ of each electron. The largest dimension of the Universe determines the smallest!

Can this Equation be tested? Yes. The best astronomical measurements, $R = 1.3 \times 10^{10}$ light-years, $N = 10^{80}$ particles, yields re = $6 \times 10^{-15}$ meters. This should be near the classical radius, $e^2/mc^2$, of an electron, which is $2.8 \times 10^{-15}$ meters. This is a close match thus the test is satisfied by astronomical measurements. The simplicity of this result is surprising only because we under estimate the simplicity of Nature. When we speculate, we are often led down the primrose path of complex theories and difficult mathematics. In this situation, measuring the size of the Universe, only a finite R makes sense.

**Olber's Paradox.** Olber pointed out that if the volume of space were infinite, the number of stars would be infinite, and we should see the entire sky with the light intensity of the surface of a star like the Sun. We do not see this, thus the *observable* universe must have a finite R. Is this because the real Universe is infinite and our depth of vision is limited? This appears to be the case. Below we will see that the WSM results in

a finite observable Universe and yet allows an infinite Universe to exist as thought by Einstein. But there is little we can know about the infinite Universe; it is unobservable.

**The 'In-wave Paradox'.** This is the same situation as Olber's paradox. If the number of particles (wave centers) were infinite in the Universe, their contribution to the in-wave of each wave individual center would be infinite. This would make the density of every wave-center (electron) infinite. Even worse, the density of space would be infinite. Neither of these is observed thus the effective volume of contributing wave-centers must be finite. The conclusion is inescapable; our vision into distant space is limited.

## Origin of the Red shift.

Having found that the Hubble Constant H, or Hubble distance R = c/H, are intimately involved with many of the relationships of the Universe, it is clear that the Hubble constant plays a more fundamental role than just an explanation of an apparent expansion of space. We will deduce below that red shift and R are a result of a fundamental property of space, specifically that the range of astronomical seeing is limited by the WSM. And the range of the in/out waves that inter-connect the Universe is finite.

**Scattering of Quantum IN-Waves.** The WSM provides an explanation of the Hubble distance R by showing that the range of the quantum in/ out-waves must be limited. Consider a single wave-center WC (a particle). Its IN-waves are formed by a Huygens's combination of waves from other wave-centers in the Universe (See Wheeler and Feynman's *Response of the Universe*, 1945). However, all of the out-waves from the distant universe cannot reach that wave center if they are blocked, absorbed, or scattered by intervening centers. The reduction of wave intensity of the in-coming out-waves from the Universe can be calculated using the ordinary formula for exponential reduction of a source in an absorbing/scattering medium:

Choose a sphere in space with radius R around a given wave center. Space in this sphere is filled with particles (wave centers) whose density is **n** particles per cubic meter. Incoming waves are scattered, blocked or absorbed by each WC inside the sphere. Thus the initial wave intensities $I_o$ entering the sphere are reduced along the radial line r. The result is much like the reduction of light from the headlights of an oncoming car in a fog. At a certain distance, the headlights appear and brighten as they approach. If we assume that the range r of the WCs inside the sphere is given by the Equation of the Cosmos, the resulting in-wave intensity is exponentially reduced:

$$I = I_o \exp^{-r/(4\pi R)}$$

Where R is the Hubble radius of the universe. Thus $4\pi R$ is analogous to the distance when the car lights appear. We deduce that the in-waves to a wave-center arise from only a nearest region whose radius is less than about $4\pi R$. Thus wave-communication is drastically reduced between very distance objects. This limitation on the size of R is the new fundamental meaning of the Hubble Universe; a finite observable Universe.

## A Finite Spherical Universe within an Infinite Space.

When people first consider the Wave Structure of Matter there is a common mistake of thinking of just one wave-center, a spherical standing wave, as being alone in infinite

space (which is clearly not how reality is, as there is obviously matter all around us). That thought leads to imagining incorrectly that the spherical standing wave structure extends to infinity.

However, the correct way of thinking (matches reality of what we experience) is that the Hubble space around us has lots (and lots!) of other matter in it. And the calculation above shows that although you may be in an infinite space (as a wave-center) there is only a finite amount of other matter that directly contributes to your in-waves. So we see that each wave-center 'particle' is really the center of its own universe. (You and me, are each the center of our own universe - what a nice thought). And this applies to any matter, wherever you are in an infinite space. So the fact that an electron has a finite mass, and the fact that the Universe has a finite observable range, are two sides of the same coin.

When matter is close to other matter, their universes (of in and out waves) overlap and you get matter interactions. For us on Earth, matter that is a 1,000 billion light years away is outside our Finite Spherical Universe and we can't interact with it – or see it. It does not contribute its OUT-waves directly to our IN-waves - it is hidden behind other matter.

So the WSM Cosmology explains how we each exist at the center of our own Finite Spherical Universe within an Infinite Space. I exist at the center of mine, you at the center of yours. But if it happens that our centers are close together, because we are both on the Earth, we share 99.9999% of a common universe - which is why we can interact with one another, write to each other on the internet.

### Cause of the Red shift.

And if you think about it, you will realize that this must also cause a red-shift with distance, because distant matter shares less of a common universe, thus less wave interactions, thus less energy exchange (which we see as a red-shift with distance). Any smart mathematician can deduce this - just work out how the volume of two overlapping spheres changes as you move them apart - this should lead to red shift with distance - another meaningful deduction from the WSM.

**Most scientists will deny new truths.** The red shift is bound up in controversy and beliefs have condensed around a few opinions. Only a few of the people who regard themselves as scientists are able to face truth when they do not understand it. Sadly, the typical scientist reacts as Churchill wrote: *Most of us often encounter the truth but we usually pick ourselves up and pretend it did not happen.* Instead they choose to find reasons to deny the truth as was recognized by Maeterlinck: *"At every crossroad on the way that leads to the future, each progressive spirit is opposed by a thousand men appointed to guard the past." (Count Maeterlinck, 1911 Nobel Prize Winner – Literature).* Truth is no match for emotions.

A remarkable example is the current Standard Model of the Universe used by particle physicists. It models matter and the laws of nature on the assumption that discrete matter particles exist. It denies the obvious, that matter and the laws are inter-connected throughout the universe as evidenced by Mach's Principle. This model contradicts the

reality of laser gyros in *space* that guide most of the commercial aircraft today. It assumes that quantum space is a fiction in order to support the Bohr interpretation of Schrödinger's Quantum Equation who claimed that its solutions are statistical probabilities of finding particles. Schrödinger himself of course denied this interpretation. That the Equation, mathematically, does not require such an interpretation, is ignored. The unproven fantasy of the Big Bang is a sacred part of the Model. One can wonder if the Standard Model is a new religion and the big bang is the chalice on it's alter.

**Conclusions from this Section:**
1. The Hubble distance H is the maximum finite distance we are able to observe an infinite Universe.
2. The big bang never happened because instead the red shift is a consequence of the limited range of in/out waves in the observable universe.
3. Einstein was correct that the Universe is infinite in extent.
4. Schrödinger, DeBroglie, and Clifford were correct that all matter is wave structures in a space medium.
5. The theory of Neils Bohr and Max Born that discrete particles exist as as probabilities within a Schrödinger wave function is wrong. Instead the wave functions themselves *are* the matter we observe. Discrete particles do not exist.

## Section II. Calculating the finite Universe

Below we will see that the WSM and its astronomical partner GTR make it possible to find meaningful relationships between various dimensions of the Universe ranging from the size of the electron to the size of the Hubble Universe.

**Energy Exchange is the source of information.** All astronomical measurements have one thing in common. You cannot measure anything in Nature without an energy exchange that tells us something has happened. This is a requirement to find truth. Experience tells us that acquisition of knowledge of any kind occurs only with an *energy transfer*. Natural law describes energy exchanges. Storage of information, whether in a computer disk or in our brain, always requires an energy transfer. Energy is required to move a needle, to magnetize a tape, to stimulate a neuron. There are no exceptions. Thus finding the energy transfer mechanism between particles is part and parcel of understanding the electron and the natural laws. You cannot accept any statement about the measurement of a natural event unless you verify the energy exchange that allowed it. Skepticism is good for science. The WSM provides the mechanism of energy exchange.

**Everything from Nothing.** Edward Tryon made a calculation (1973) that shows it is possible that the sum of matter and energy of the universe is zero. At first, this seems ridiculous as we view the large positive matter of all the stars, but his analysis yields another view. His argument was that the total amount of matter (a positive quantity) is exactly balanced by gravitational energy between the stars (a negative quantity). He deduces that this would be true if the matter density of the universe today is exactly a critical value, as follows:

The energy of gravitation of a particle of mass m, acted upon by the rest of the mass $M_u$, of the universe, from a distance r, is

$$\text{Gravitational energy} = E_g = -m\, M_u\, G/r$$

If we set the mass of the universe equal to the mass contained within a sphere of Hubble radius, $R = c/H$ and density p, and choose density to be critical ($p = d_c = 3H^2/8\pi G$ from Einstein's General Relativity), and set the average distance to the mass to be half the Hubble distance, or $r = 1/2\, c/H$, then we get,

$$M_u = 4/3\, \pi\, R^3 \times 3H^2/8\pi G = c^3/2GH$$

And inserting these into the expression for the gravitational energy, we get

$$E_g = -mc^2$$

This is a bit amazing! We see that the gravitational energy of a mass particle is just equal to the negative of its mass energy as Tryon proposed. The reason gravitational energy becomes so large is because the Hubble universe is so large.

Think about what happens if all matter 'particles' are moved an infinite distance apart. Then, using the equation above, the gravitational force between them is zero and both gravitational energy and mass are zero. Where has the mass energy gone? It has gone to moving the matter apart, so that now the total energy is zero. This example suggests that the geometric meaning of infinity is a distance so large that one matter particle cannot affect another. We also have to conclude that the constant of gravity is determined by the mass of all the atoms existing in the observable Hubble universe.

**Gravity and the Mystery of Dirac's Large Numbers.** Is there a relation between properties of the particles and the Universe? Nobel laureate Paul Dirac who developed much of the quantum theory of the electron was never satisfied with its mathematical origin. He hoped that there were more fundamental ways to derive the quantum properties of the electron whose behavior dominates the most satisfying applications of quantum mechanics. In particular he hoped to find a relation between the properties of the universe as a whole and the properties of the electron. His hopes were stimulated by Mach's Principle, which mysteriously seems to show that the inertia of each micro particle is created by the mass of the universe. Following this philosophical goal, Dirac was constantly searching for relationships between the universe and the basic particles.

**Dirac found Relationships Between the Laws and Particles.** He realized that the concept of the universe and its laws are meaningless without particles to populate it. Laws would be meaningless, because the particles are the objects of the laws. Second, the actual concept of Universe is the sum of the matter in it. Therefore, he anticipated a relationship of the laws to the electron and proton, which make up 99% of the matter in the universe. This particle-universe relationship is manifest like Mach's Principle. Dirac must have been motivated by this concept, although he never expressed it. He searched for relations of the type of Mach's Principle and found two that are discussed below.

**Dirac's Large-number relationships (LNR).** Nobel Laureate Paul Dirac discovered two puzzling numerical relationships in astronomical measurements. The first relationship is:

$$e^2/Gm_eM_p \sim cT/(e^2/mc^2) \sim 10^{40}$$

The term on the left above is not a mystery; it is just the ratio of the electric to gravitational forces between an electron and a proton. It has a measured value of 0.23 $x10^{40}$ which shows how very much larger the electric force is compared to gravity.

On the right side, Dirac speculated that cT = R is the radius (size) of the universe; R is the reciprocal of Hubble's constant. The divisor is the classical radius (size) of the electron, $e^2/mc^2$. Dirac's mystery was: "*Why should the size ratio of the smallest and the biggest objects of the Universe also be the ratio of the gravity (smallest force) and electric (largest) force?*"

Many persons have tried to answer Dirac using the particle notion of matter but none have succeeded. However if you examine the Equation of the Cosmos above, from the WSM, you find that Dirac's LNR ratio is directly expressed in it. The WSM solves Dirac's first mystery.

**Dirac's second Large-number Mystery.** Dirac found by comparing data of astronomy, that approximately:
$$G r_u /H^2 \sim 1$$
Where $r_u$ =density of matter in the Universe and **G** is the gravity constant.
Dirac asked: "*Why should these enormous numbers yield the unlikely value of one?*" This mysterious large number ratio has lain unsolved for the last seventy years. It is surprising the Dirac did not notice that his ratio confirms a result from Einstein's General Relativity, namely that the critical density $d_c$ of a 'flat' universe is
$$d_c = 3H^2/8\pi G$$
Where H is Hubble's constant. If this is rearranged it becomes Dirac's ratio
$$G d_c /H^2 = 3/8\pi$$
where the approximate density $d_c$ from astronomical measures is the value used by Dirac except for a small factor of $3/8\pi$. You can find this result also from Principle II of the WSM. If you accept General Relativity and the WSM, Dirac's puzzle is solved.

**Mystery of the gravity constant.** The value of the gravity constant for the flat universe of Einstein's Relativity as above, is related to the Hubble constant:
$$G \sim 3H^2/d_c\, 8\pi$$
However there is no accurate evidence that the Universe is 'flat' since the astronomical measurements of density $d_c$ are very uncertain. But it is very interesting that the value of **G** agrees with the remarkable conclusions from Tryon's calculation above (Everything from Nothing). Namely: 1) that the energy of the Universe could have begun at zero with all matter initially at an infinite distance, and 2) that the gravity constant is determined by all the mass of the Universe.

### Origin of Newton's Law of Inertia, F = ma

His important law is the fundamental beginning of modern physics. Newton originally saw inertia as an *action-at-a-distance* paradox because he expected that a distant discrete body was the recipient of the energy transfer not knowing of the WSM. For the same reason, Mach's 1883 assertion was also first regarded as a paradox despite its obvious truth.

We have seen that its origin and mechanism is a property of *space*, the wave medium of the WSM. *Space* is a result of Principle II above that establishes the density of sp*ace* proportional to the sum of the all the waves from all other observable matter – i.e. the Hubble universe. Einstein's General Relativity does the same thing on an astronomical scale. In short, Newton's Law implies that *Space* and an accelerated particle m, exchange energy as if space were a 'force field' on m.

Let's calculate the resulting force: Visualize space as a potential field **M** that produces a force **F** on a mass m with an acceleration **a**. This is comparable to the electric force **E** that produces a force on a charge e. Energy is transferred between the mass and the surrounding space because the accelerated waves change relative frequencies. The resulting force and energy transfer appears instantaneous in agreement with astronomical observations and space missions.

There are two masses involved: One is m and the other is the equivalent mass $M_u$ of the Hubble universe. Since we know the radius of the Hubble universe, R= c/H we can find its average mass knowing its density. A density is given by the General Theory of Relativity as the critical density $d_c$ of a 'flat' universe,

$$\text{Critical density} = d_c = 3H^2/8\pi G$$

The vector mass field **M** acting on the accelerated mass m is

$$\mathbf{M} = \mathbf{a}mG/c^2r$$

Where r is the average distance to the sources of the local space. This is taken as half of the Hubble distance r = (1/2)(c/H). The equivalent mass of the Hubble universe is

$$M_u = \text{density x volume} = d_c \text{ x } (4/3)\pi(c/h)^3$$

Then the force between the mass field **M** and the mass m is

$$\mathbf{F} = \text{Force} = \mathbf{M} \text{ x } M_u = \mathbf{a}mG/c^2r \text{ x } 3H^2/8\pi G \text{ x } (4/3)\pi(c/H)^3$$

Surprisingly all the numerical factors above cancel and we are left with Newton's law

$$\mathbf{F} = m\mathbf{a}$$

Summarizing, we have used Principle II (from Mach's principle) that the *space* medium is established by all masses of the universe, and that the local medium exchanges energy with any accelerated mass. As a result, we obtain Newton's Law, predict a flat universe, and establish a mechanism for 'action-at-a-distance'.

## Section III. Conservation Rules in a finite Universe

**Are There Conservation Rules of the Universe?**
We would like to know if the conservation rules for matter here on Earth also apply to the entire universe. Remember that the Earth-bound rules apply to a definite amount of matter free of external forces, termed a closed system. In that closed system, energy, momentum, charge, etc. are always constant. Is this also true for the universe? Does it behave like a closed system?.

**The Zero Sum Idea.** We have found here on Earth that the values of some conserved quantities add up to total zero. For example, the total charge of ordinary objects like books, houses, etc. are zero; that is the objects are electrically neutral. This is because the +charge of each proton in a hydrogen atom is balanced by the -charge of the electron around it, and because the rule of pair production requires that a positron accompany

each electron created. All charges sum to zero. Similarly, we ask, is there is a zero sum rule for properties of the universe?

**Zero Sums of Momentum and Charge.** To say with certainty that the total momentum and charge of the universe are zero is beyond our capabilities, but it is consistent with existing measurements of radiation, spectra, and positions of celestial objects. In localized regions, charge or momentum may become non-neutral, but we can always identify a balancing charge or momentum change of opposite sign, somewhere nearby, that maintains overall neutrality. So tentatively, it is possible to presume their sum is zero.

**A Zero Sum of Matter, too?** As described above in Section II, Edward Tryon (1973) proposed that the sum of energy and matter is also zero in the universe. Let's push Tryon's idea further. Suppose the universe was very small and only a few kilograms of hydrogen existed in the universe. Now, the conservation of energy requires that the mass of the H atoms be very tiny to match the tiny value of gravity. We have to conclude that all the matter of the Universe could have begun to form in an empty Universe when its matter density was tiny and forces were also very small. This is almost pure speculation so please don't consider it without more evidence, especially until we have learned better what is the nature of *space* itself.

**'Turtles all the way down'** You have probably read the story of the Newtonian scientist who challenged the religious theory that the World was supported on the shoulders of Atlas: He asked, "What is Atlas standing on?" The reply was: "On a turtle." Then. "What is the turtle standing on?"
"Another turtle. There are turtles all the way down!" The physicist sneered and thought he had won his point.

But in the study of WSM physics, it is probable that we may find "Turtles all the way down" as follows: At first we feel lucky because the wave-structure of matter neatly avoids the need to find an ultimate smallest particle as the building block of matter; No discrete point particles. Space itself is the basic material of the WSM. A space resonance is the basic building block. Space neatly defines length, time and mass, the origin of laws and the 'particle zoo' is the appearance of higher resonances. Wave-particle duality and other puzzles simply evaporate. But knowing all this, one more mystery pops up, "What is space?" Now we have to understand why space provides all the properties that we thought we had so cleverly explained. We are back to square one, smaller of course, but there are still "Turtles all the way down". There is never an end to the questions.