1,1 Relativistic Effects in Cosmology

Adrian Bjornson (May 2009)

The Cosmology Enigma

In 1929, astronomer Edwin Hubble discovered the expansion of the universe. Recent astronomical data show that the universe is expanding at a rate of about 20 km/sec per million light-years of galaxy distance. The "Hubble Law" is an idealized description of this expansion, which assumes that the expansion rate is constant throughout the universe, and has been constant over time. Using the Hubble Law to extrapolate to great distances shows that galaxies should recede at the speed of light (300,000 km/sec) at a distance of 15 billion light years, and so cannot be seen. Hence the radius of the "observable universe" is often considered to be about 15 billion light-years. Using the Hubble Law to extrapolate the universe backward in time shows that the whole universe should have been contained within an extremely compact body 15 billion years ago. Hence the age of the universe is often considered to be about 15 billion years.

The Hubble expansion is the primary issue that must be addressed in a cosmology theory. There are four major concepts for explaining the Hubble expansion, which are as follows.

(1) The Big Bang Theory. This concept postulates that the universe began as an extremely dense body about 15 billion years ago, which exploded with a "Big Bang", and has been expanding ever since. There are countless variations of this concept, which differ greatly in the early stages of the expansion.

(2) The Steady-State Theory. This theory was proposed is 1948 by the astrophysicist Fred Hoyle, and others. It postulates an infinitely old universe, in which diffuse matter is created throughout space, thereby forcing the universe to expand. The rate of creation of matter that is required to offset the universe expansion is only two hydrogen atoms created per year within a volume of one cubic kilometer. This creation rate is far too small to be measured directly.

(3) The Apparent Expansion Theory. The Hubble expansion is determined by measuring the spectral redshift of the light received from a galaxy, and assuming that this redshift is a Doppler effect caused by the receding velocity of the galaxy. However, other effects can produce a redshift. A number of cosmology theorists believe that the universe is not expanding, and that the Hubble Redshift is an ***Apparent*** effect that is unrelated to galaxy velocity.

(4) The Oscillating Universe Theory. This concept assumes that the universe oscillates between very dense and very diffuse states. The universe will continue to expand until gravitational forces finally offset the momentum of expansion, thereby halting the expansion and then causing the universe to contract. When the universe has contracted to a small size, an unspecified force converts the contraction into expansion, and the oscillation process continues.

Discussion of Basic Cosmology Concepts

The Oscillating Universe Theory. No viable hypothesis has been proposed to explain how the universe could change from contraction to expansion, unless the universe contracts to a single body with sufficient density for interaction forces within that body to halt the contraction momentum, and convert it into expansion momentum. However, if this is the case, the Oscillating Universe theory merely becomes a variation of the Big Bang theory. Many Big Bang theorists have proposed an oscillating process, in which a universe-contraction phase preceded the "Big Bang".

The Apparent Expansion Theory. There are many effects besides a receding velocity that can produce appreciable spectral redshift. However, in order for a spectral effect to mimic an expansion of the universe, it must be uniform in all directions, and it must provide a spectral redshift that is roughly proportional to galaxy distance. Paul Marmet [1] has given evidence to show that a photon loses a small amount of energy whenever it collides with a hydrogen molecule, and this causes a small redshift. There is an appreciable amount of diffuse matter throughout the universe, mostly in the form of hydrogen atoms. This matter could produce a redshift proportional to distance that would be uniform in all directions. However to achieve our measured Hubble redshift constant, the density of inter-galactic hydrogen would have to be about 1000 times greater than is indicated by astronomical measurements. ***Hence, the Marmet redshift effect cannot explain the Hubble redshift, and the author does not know of any other non-Doppler redshift effect that can.***

The Big Bang Theory. An enormous amount of research effort has been spent in developing explanations for the Big Bang theory. The theorists have explained in minute detail how the universe must have expanded since the start of the Big Bang, 13.7 billion years ago, when the whole universe was microscopic in size. However, this explanation is little more than a collection of arbitrary hypotheses. The Big Bang theory, with its countless variations, is riddled with contradictions.

The Steady-State Theory. The Steady State theory became very popular until the 1960's. However, when Cosmic Microwave Background Radiation was discovered in 1964, the Steady State theory was unable to explain it. The Big Bang theory had predicted this radiation, although it predicted a blackbody temperature varying from 5 to 30 degrees Kelvin, much greater than the actual measured value, 2.73 degrees Kelvin. After the discovery of Cosmic Microwave Background Radiation, the support for the Steady-State theory rapidly declined.

Finally, Fred Hoyle, the primary supporter of the Steady-State theory, abandoned this theory to endorse what he called the "Quasi-Steady-State" theory. Along with Geoffrey Burbidge and Nayant Narlikar, he wrote a book titled, *A Different Approach to Cosmology* [2], which described his new theory. This new theory is really an Oscillating Universe theory, which postulates an ***undefined process*** that suddenly converted universe contraction into universe expansion, when the universe was about one-tenth of its present size. The mathematical formulas for the theory derived from General Relativity may look impressive. However the authors completely failed to explain the mysterious process that could abruptly convert universe contraction into universe expansion. Without this explanation, the Quasi-Steady-State theory has little credibility. One wonders why Hoyle did not devote his efforts to patching up his original Steady State theory. He could readily have added postulates to that theory that would be at least as plausible as those used to support the Big Bang theory.

Reason that Cosmological Theories Have Failed

Despite an enormous amount of research devoted to the study of cosmology over the past half century, there is no explanation of the Hubble expansion (outside of this website) that even begins to agree with astronomical evidence. Nearly all of the funding for theoretical and experimental studies pertaining to cosmology has been devoted to the Big Bang theory. The ***Alternative Cosmology Group*** (see, www.cosmology.info) is a collection of scientists who oppose this narrow focus of cosmology funding. This group has proven that the Big Bang theory is loaded with severe contradictions, but they have not been able to propose an alternative to the Big Bang theory that is any better.

A look at this enormous research effort may lead one to believe that there is tremendous variety in the various approaches, but this is an illusion. The theories are monolithic. A fundamental premise accepted by essentially all of these theories is that the Einstein gravitational field equation is absolutely valid. This equation is used to specify Einstein's General theory of Relativity. As this website will prove, the Einstein gravitational field equation is seriously flawed.

Am I claiming that the Einstein General theory of Relativity is wrong? Absolutely not! The principles of that theory are very sound. However, it is well known that Einstein did not derive his gravitational field equation by rigorous analysis. This equation was his best guess, after other guesses were found to be inadequate.

Scientists knowledgeable with the General theory of Relativity usually insist that the Einstein gravitational field equation is synonymous with the General theory of Relativity. After all, the way to apply the General theory of Relativity is to solve the Einstein gravitational field equation.

This simplistic logic ignores the intensive 11-year research process that Einstein followed to develop his gravitational field equation, during which he struggled to establish the principles of his theory. To develop a gravitational field equation that would specify his theory, he derived constraints that this equation should satisfy. From these constraints he attempted the extremely difficult task of deducing the actual equation. He tried a number of approaches that failed. Finally he obtained his official equation. Although he was unable to solve this equation himself, Karl Schwartzschild, who was working with Einstein, obtained a solution that worked. This solution provided the predictions for experimental tests that were used to verify the Einstein theory. In 1919 and 1922, tests during solar eclipses accurately verified Einstein's prediction of the bending of light beam by the sun's gravity, and Einstein became famous.

Since 1922, many tests performed within our solar system have supported the accuracy of the Einstein gravitational field equation. However, the relativistic effects of the sun's gravitational field are tiny, and so these tests tell us little about the accuracy of this equation in cosmology applications.

The Einstein General Theory of Relativity

Development of the Principles of General Relativity

Einstein's Relativity theory began with his 1905 paper presenting his basic theory of Relativity, which was later called ***Special Relativity***. The primary purpose of this theory was to explain why the speed of light is always exactly the same, regardless of whether it is measured relative to the light transmitter or the light receiver, even though there is a large velocity between the transmitter and receiver. Einstein explained this enigma by postulating that ***Reality is Relative***. When there is a velocity between two observers, a clock of the other observer appears to run more slowly, a measuring rod of the other observer appears to contract if held in the direction of the relative velocity, and two clocks that appear to be synchronized to one observer are not synchronous to the other observer.

These "apparent" effects explain why both observers measure exactly the same value for the speed of light. ***But these apparent effects are not an illusion; they are real***. Based on this concept, Einstein derived some profound physical principles, including his famous ($E = Mc^2$) formula, in which (c) is the speed of light, (E) is energy, and (M) is mass. This equation explained the source of the energy generated by the sun, and later was the foundation for developing the atomic nuclear bomb during World War II. The sun derives its energy by fusing two hydrogen atoms to form one helium atom. In this process, the mass decreases by 0.71 percent, and this reduction of mass (M) releases an enormous amount of energy (E) in accordance with the Einstein formula. The formula states that mass (M) and energy (E) are equivalent, and can be converted into one another.

Einstein concluded that time and spatial measurements are inter-related, and must be combined into a four-dimensional space-time specification. To any observer, time and space are entirely separate concepts. However, to compare the measurements made by observers moving at different velocities, time and spatial measurements must be combined, because a time difference between two events experienced by one observer can represent a spatial difference to the other observer.

This original Relativity theory was based on the principle that the speed of light is constant, independent of the velocity of the observer. But what happens when the velocity changes, when acceleration occurs? From approximate calculations, Einstein proved that acceleration causes the speed of light to change. Einstein concluded that the effects of acceleration and gravity are equivalent, and so a gravitational field must also change the speed of light. The relativistic effects produced by acceleration and gravity are tiny within our normal experiences, yet they are fundamental. These approximate calculations told Einstein that his basic Relativity theory is a "Special" case, and to achieve a complete theory of Relativity he must generalize his Relativity theory so that it includes the effects of acceleration and gravity.

Einstein concluded that the concept of gravitational force that is incorporated in Newton's theory of gravity is merely an approximation, and that a gravitational field is actually a curvature of four-dimensional space-time. To implement this concept, Einstein applied the sophisticated and rigorous mathematical theory of curved space that was published by the Italian mathematician Gregorio Ricci in 1901, with the help of his student, Tullio Levi-Civita. This mathematical theory was based on a mathematical principle that was presented in 1852 by the German mathematician Bernhard Riemann. Scientists discussing Einstein's General theory of Relativity have usually ignored the enormous contribution to General Relativity provided by Ricci and Levi-Civita. This mathematical theory of curved space is usually called "Riemannian geometry", even though the mathematical theory published by Ricci and Levi-Civita in 1901 was a highly extensive expansion of the basic Riemann principle. Besides, this is not a geometric theory; it is an analytical theory that applies calculus to curved space. Ricci and Levi-Civita called their mathematical theory "The Absolute Differential Calculus". I call it the ***"Ricci-Riemann calculus of curved space"***.

The Ricci-Riemann calculus of curved space was expressed in general form to apply to n-dimensions. Einstein implemented this theory in four dimensions, and he specified gravity and acceleration to be the curvature of this four-dimensional curved space.

According to Newton's theory, a body moves in a straight line at constant velocity unless a force is applied to it. The earth moves in a curved path around the sun because the gravitational force from the sun pulls the earth away from the natural straight-line trajectory. With the Einstein theory, there is no gravitational force. Instead, the gravitational field of the sun curves the space around the sun. Since no gravitational force is applied to the earth, the earth follows the equivalent of a straight-line path in this curved space, which is called a ***geodesic path***. In curved space, a geodesic path is the shortest distance between two points, just as a straight line is the shortest distance between two points in flat Euclidean space.

For example, consider motion across the surface of the earth. Because the surface is curved, one cannot move in a straight line over an appreciable distance. An airplane ideally travels along a great-circle route between two points, because that is the shortest distance between two points on the curved earth surface. A great-circle route represents the geodesic path for a spherical surface. A great circle (geodesic) path between two points on a sphere is the intersection between the spherical surface and a plane that passes through the center of the sphere and the two points. An aircraft ideally follows this geodesic path because it is the shortest distance between two airports on the curved surface of the earth.

Tensors Used in Ricci-Riemann Calculus of Curved Space

The Ricci-Riemann calculus is based on tensors. To understand the tensor, let us first consider the ***vector***. To specify the velocity (V) of an aircraft, we need its velocity components in three spatial dimensions: usually in the east, north, and vertical directions. We can express these velocity components as V_1 for the easterly velocity, V_2 for the northerly velocity, and V_3 for the vertical velocity (the climb rate). We can represent these velocity components by a general vector denoted V_a, in which the index (a) can take the values (1, 2, or 3).

The internal forces acting inside a body are called stresses, and are expressed in terms of the force that is applied to a unit area of surface within the body. These internal stresses are represented by a ***tensor*** that can be denoted S_{ab}, where the index (a) indicates the direction of the internal force, and the index (b) indicates the orientation of the internal surface to which the force is applied. The orientation of a surface is specified by the direction of a line that is perpendicular to the surface. A stress S_{11} represents a force in direction (1) applied to a surface area that is perpendicular to direction (1). This force is applied perpendicularly to the surface area, and is called a “compression stress”. A stress S_{12} represents a force in direction (1) applied to a surface that is perpendicular to direction (2). This force is applied parallel to the surface, and is called a “shear stress”.

To illustrate the use of the tensor, consider the construction of a concrete bridge. Concrete is strong in compression but weak in shear. Consequently, concrete structures generally contain steel reinforcing bars that can withstand high shear stress. A structural analysis of the strength of a bridge member can apply the tensor concept to separate the effects of compression and shear stresses within the member. This simple example should make the tensor concept more meaningful, and thereby help to dispel the great mystery associated with the tensor.

The stress tensor S_{ab} has two indices (a, b), each of which can have the values (1, 2, or 3). Hence this tensor has 3x3 or 9 components, which we also call “elements”. Relativity analysis uses four dimensions to specify space-time, and so each index of a relativity vector or tensor has four possible values. We use the index numbers (1, 2, 3) to represent the three spatial dimensions, and we use (0) to represent the time dimension. (Einstein used the numeral 4 for the time dimension.) Since a relativity tensor has two indices, each of which has four possible values, a relativity tensor has 4x4 or 16 elements.

The Metric Tensor (g_{ab}). The starting point of the Ricci-Riemann calculus of curved space is the ***Metric Tensor (g_{ab})***, which specifies the measurement properties of curved space. Einstein called this the “fundamental tensor”. If one knows the metric tensor for a physical model, one can readily compute many relativistic properties of the model, including variations in the speed of light, a clock rate, and a spatial dimension. One can also solve the ***geodesic equation*** and thereby determine the geodesic path (or orbit) of a star or another celestial body. The 16 elements of the metric tensor are generally expressed in a 4x4 array as follows, which is called a “matrix”:

$$\begin{vmatrix} g_{00} & g_{01} & g_{02} & g_{03} \\ g_{10} & g_{11} & g_{12} & g_{13} \\ g_{20} & g_{21} & g_{22} & g_{23} \\ g_{30} & g_{31} & g_{32} & g_{33} \end{vmatrix}$$

The four elements along the matrix diagonal (g_{00}, g_{11}, g_{22}, g_{33}) are called the ***diagonal elements*** of the tensor, and the twelve other elements are called the ***non-diagonal elements***. If all non-diagonal elements are zero, the tensor is called a ***diagonal tensor***.

The Ricci Tensor (R_{ab}). The Einstein Gravitational Field Equation is based on the Ricci tensor (R_{ab}), which describes the curvature of space. If a region of space has no gravitational field, and hence no curvature, all elements of the Ricci curvature tensor are zero. The Ricci-Riemann calculus of curved space provides very complicated equations for calculating the Ricci tensor from the metric tensor. If the metric tensor is not diagonal, these equations can result in millions of terms, and so cannot be solved analytically. A powerful computer is essential. Since powerful computers were not available during Einstein's lifetime, Einstein had to limit his application of General Relativity to very simple physical models that yielded diagonal metric tensors. Powerful computers did not become readily available until the mid 1960's. It was not until that time, a decade after Einstein's death, that the equations of general Relativity could be applied to reasonably complicated physical models that yielded non-diagonal metric tensors.

Forms of Tensors. Tensors have three different forms, called covariant, contravariant, and mixed, which are indicated by whether the indices are subscripted or superscripted. The ***covariant*** Ricci tensor is denoted R_{ab}, the ***contravariant*** Ricci tensor is denoted R^{ab}, and the **mixed** Ricci tensor is denoted $R_a{}^b$. The Ricci-Riemann calculus of curved space provides formulas using the metric tensor that allow any one of these forms to be converted into any other. The sum of the diagonal elements of a tensor is called the ***trace*** of the tensor. The trace of the mixed Ricci tensor $R_a{}^b$ is denoted R, and is used to form the mixed Einstein tensor $G_a{}^b$.

The Einstein Tensor ($G_a{}^b$). The diagonal elements of the mixed Einstein tensor $G_a{}^b$ are obtained by subtracting (R/2) from the corresponding diagonal elements of the Ricci tensor $R_a{}^b$. The non-diagonal elements of the mixed Einstein and Ricci tensors are the same. Einstein modified the Ricci tensor to form the Einstein tensor, because the "covariant derivative" of the Einstein tensor is zero, a property that Einstein needed for his gravitational field equation. The Einstein tensor is also a curvature tensor. If all elements of the Ricci tensor are zero, all elements of the Einstein tensor are zero, and vice versa.

The Einstein Gravitational Field Equation

The Energy-Momentum Tensor $T_a{}^b$. Einstein specified his General theory of Relativity by his gravitational field equation. The following is the usual form of this equation, which uses the mixed form of the tensors:

$$G_a{}^b = -8\pi T_a{}^b$$

The symbol $T_a{}^b$ denotes the ***Einstein Energy-Momentum tensor***, which describes the characteristics of matter and energy. The computation of this tensor is discussed in *1,2 Simple Explanation of Einstein Relativity Theory*. This tensor formula represents 16 separate equations of the forms: ($G_1{}^1 = -8\pi T_1{}^1$), ($G_0{}^2 = -8\pi T_0{}^2$), ($G_2{}^3 = -8\pi T_2{}^3$), etc. The tensors of General Relativity are all symmetric, meaning that ($G_1{}^2 = G_2{}^1$), ($G_0{}^3 = G_3{}^0$), ($T_3{}^2 = T_2{}^3$), etc. Hence six of these equations are redundant, and so the Einstein gravitational field equation represents ten independent equations.

True Tensors. Any tensor used in the Einstein gravitational field equation (or any equation applying the Ricci-Riemann calculus) must be a ***true tensor***. This means that when the coordinate system is changed, all tensors must change according to a precise formula that is specified by the Ricci-Riemann calculus of curved space. As explained in *Addendum* document *5,C Energy-Momentum Tensor*, Einstein specified the process for calculating his energy-momentum tensor $T_a{}^b$ in a manner that assures it is a true tensor. All tensors of the Ricci-Riemann calculus are true tensors. Einstein defined his Einstein tensor $G_a{}^b$ by the following tensor formula:

$$G_a{}^b = R_a{}^b - \tfrac{1}{2}\,\delta_a{}^b\,R$$

The symbol $\delta_a{}^b$ is called the Kronecker delta function, which is unity when the two indices (a, b) are equal, and is zero when the indices are unequal. The two indices are equal for diagonal elements, and so (½ R) is subtracted from the diagonal elements of the Ricci tensor ($R_a{}^b$) to form the Einstein tensor ($G_a{}^b$). The Kronecker delta $\delta_a{}^b$ is a very simple function, yet it is still a ***true tensor***, and so can be used in a tensor formula. Adding the true tensor ($\delta_a{}^b$) to the true tensor ($R_a{}^b$) yields a true tensor, and so the Einstein tensor ($G_a{}^b$) is a ***true tensor***.

The Einstein Pseudo Tensor for the Gravitational Field. Einstein tried different approaches before he settled on the final form of his gravitational field equation. The following is an earlier form of this equation that he considered

$$G_a{}^b = -\,8\pi\,[T_a{}^b + \{t_a{}^b\}]$$

The energy-momentum tensor ($T_a{}^b$) specifies the effects of matter and energy, and the quantity $\{t_a{}^b\}$ is ideally a tensor to specify the gravitational field. Einstein initially believed that his $\{t_a{}^b\}$ variable represented the "energy components of the gravitational field". (In this discussion, braces { } are placed around $t_a{}^b$ to distinguish this Einstein variable from the stress-energy tensor ($t_a{}^b$) of the Yilmaz theory.) Although this Einstein variable $\{t_a{}^b\}$ superficially looks like a tensor, it is only a ***pseudo-tensor***. Since it is not a ***true tensor***, it could not be used in the Einstein gravitational field equation. A discussion of the ***Einstein pseudo-tensor*** $\{t_a{}^b\}$ by the famous physicist Wolfgang Pauli is summarized in *Addendum* document *5,3 Aspects of Einstein and Yilmaz Gravitational Theories*, Section 3. The Ricci-Riemann calculus of curved space specifies the manner in which a ***true tensor*** must change when its coordinate system is changed. This is explained in *Addendum* document *5,C Calculation of Energy-Momentum Tensor*.

This discussion of the Einstein pseudo-tensor $\{t_a{}^b\}$ shows that Einstein apparently felt that his gravitational field equation needed a tensor to characterize the gravitational field. However, he could not derive a true tensor to describe the gravitational field. His gravitational field equation seemed to work without it, and so his final equation did not contain such a tensor. Nevertheless, as this website shows in the document *1,6 Limitations of Einstein Gravitational Field Equation*, the failure of the Einstein gravitational field equation to include a tensor characterizing the gravitational field is a severe limitation.

The Principle of Covariance. The primary principle behind Einstein‘s approach to his Relativity theory is that the laws of physics should be expressed in a ***covariant*** manner so that measurements can be translated unambiguously from one system of coordinates to another. Observers moving at different (but constant) velocities measure exactly the same value for the speed of light. When we use conventional computations, this appears to be an enigma, because we are not translating information in a ***covariant*** manner between the moving coordinates of the two observers. Covariance is achieved for the case of no gravity or acceleration by using the Special Theory of Relativity. To apply this theory, reality is specified in four-dimensional space-time coordinates. When gravity or acceleration occurs, we must use more general space-time coordinates that operate in curved space, because gravity and acceleration produce curvature in four-dimensional space-time. To specify a physical law in this four-dimensional curved space, the law must be described in terms of true tensors. A ***true tensor*** changes in a covariant manner when translated into different coordinate systems that may operate at different velocities, at different accelerations, at different gravitational potentials, at different orientations, etc.

If Einstein could find a gravitational field equation that satisfied these requirements, he would have truly generalized his Relativity principle. The gravitational field equation that he published in 1916 was his best guess for this ideal equation, but it was not the correct answer. Unfortunately, the scientists that have followed Einstein have enshrined this flawed equation as if it were a religious deity, using it to “prove” the validity of physically impossible concepts that Einstein never would have accepted. And as these scientists have worshiped Einstein’s flawed equation, they have completely ignored the fundamental covariance principle that Einstein was attempting to achieve.

The Yilmaz Theory of Gravity

Development of the Yilmaz Theory

During his PhD research at the Massachusetts Institute of Technology in the early 1950’s, Huseyin Yilmaz examined Einstein’s approximate calculation of the effect of acceleration and gravity on the wavelength of light. This analysis showed that when light rises in a gravitational field its wavelength increases, and so the light displays a redshift. If a clock is synchronized to this light wave, the clock-period increases when the clock is raised in a gravitational field, and so the clock-rate decreases. Yilmaz discovered that he could solve this problem exactly, and this gave him an ***exact*** formula for the decrease in clock rate when a clock is raised in a gravitational field. ***This analysis resulted in an exact formula for the metric tensor element (g_{00}), which specifies the effect of a gravitational field on a time measurement.***

Yilmaz then postulated that, ***“The speed of light measured locally in a gravitational field is independent of direction”***. With this postulate, and the assumption that the gravitational field is ***static*** (meaning that it does not change with time), Yilmaz proved (1) that the metric tensor is diagonal, (2) that the spatial elements of the metric tensor (g_{11}, g_{22}, g_{33}) are equal, and (3) that the product ($g_{00}\ g_{11}$) is equal to (- 1). With this analysis, Yilmaz derived an exact and rigorous formula for the metric tensor. Although this solution was restricted to a static gravitational field, all of the solutions that Einstein applied to verify General Relativity were also **static** solutions.

With his rigorous formula for the metric tensor, Yilmaz applied the equations of the Ricci-Riemann calculus of curved space to calculate the corresponding gravitational field equation. In this manner, Yilmaz calculated a ***rigorous gravitational field equation***, which Einstein spent years attempting to find. Unfortunately, Einstein died in 1955 before he was able to read the analysis achieved by Yilmaz. The basic static Yilmaz theory was published in the prestigious *Physical Review* in 1958. A simplified derivation of the static Yilmaz theory is presented by this website in *1,3 Yilmaz Theory of Gravity*.

In 1973, Yilmaz extended his basic static gravitational theory to achieve his much more complicated general time-varying theory. This is presented in Addendum document *5,5 General Time-Varying Yilmaz Theory*, which is supplemented by document *5,F Stress-Energy Tensors of General Yilmaz Theory*. The general time-varying Yilmaz theory proves that the simple static solution gives a very accurate approximation when the gravitational field changes slowly relative to the speed of light, a condition satisfied in nearly all practical applications.

The Yilmaz theory is a refinement of the Einstein General theory of Relativity that applies all of the principles of the Einstein theory except the flawed Einstein gravitational field equation. The resultant Yilmaz theory has extreme mathematical integrity.

If the Yilmaz theory is so profound, why has it been largely ignored for a half century? The problem is that countless scientists have based their professional careers on solutions of the highly complicated Einstein gravitational field equation. ***If the Yilmaz theory were given the recognition it deserves, this enormous research effort based on the flawed Einstein gravitational field equation would become irrelevant.***

Our proof that the Einstein gravitational field equation is flawed does not invalidate Einstein's General theory of Relativity. Instead, the Yilmaz theory of Gravity proves that the principles of the Einstein theory are correct, because the Yilmaz theory is a refinement of the Einstein theory. The slavish obsession of mainstream scientists with the flawed Einstein gravitational field equation has been destroying the principles of Relativity that Einstein strove to establish. That flawed equation has repeatedly been used to "prove" the validity of countless physically impossible concepts (like the Black Hole), which Einstein never accepted and never would have accepted.

Application of Yilmaz Gravitational Theory to Cosmology

A rigorous relativistic theory of gravity is essential for a meaningful study of cosmology. Since the Einstein gravitational field equation is flawed, it cannot satisfy this requirement. The Yilmaz gravitational theory is a refinement of the principles of General Relativity, and provides a solid and rigorous mathematical foundation for studying cosmology. The cosmology predictions derived from the Yilmaz theory are presented in *1,4 Application of the Yilmaz Theory to Cosmology*. Let me summarize these predictions.

What is Causing the Hubble Expansion?

The Big Bang theory has described in minute detail the steps that must have occurred in the evolution of the universe since the Big Bang, but it provides absolutely no information about the actual cause of the Hubble expansion. In contrast, the Yilmaz cosmology model gives the following simple and direct explanation for that cause:

> ***The Hubble expansion of the universe is caused by gravity; it is a natural relativistic process produced by the gravitational effect of mass throughout the universe.***

"How can this be?" you ask. "How can gravitational force, which always causes masses to attract one another, make the universe expand?" The answer is that gravity is not a force; it is a curvature of four-dimensional space-time. Although gravity acts approximately like a force within our solar system, over large cosmological distances, gravity must be regarded as a curvature of space-time.

The motions of celestial bodies caused by gravity are determined by calculating the ***geodesic equation***, which describes the paths of bodies in curved space. The Yilmaz gravitational theory can easily be applied to cosmology by assuming a simple physical model of the universe, which postulates that the universe has a constant average density of matter that extends to infinity and does not change with time. The static Yilmaz theory applies exactly to this model.

The resultant geodesic equation shows that galaxies must move away from the observer at a rate approximately proportional to distance, with an expansion rate proportional to the square root of the average mass density of the universe. Recent astronomical measurements indicate a Hubble expansion rate of 20 km/sec per million light years of galaxy distance. For this Hubble constant, the average mass density of the universe is predicted to be equivalent to 9.6 hydrogen atoms per cubic meter. This is in good agreement with recent astronomical measurements, which give average mass densities that are equivalent to 3.0 to 7.2 hydrogen atoms per cubic meter.

According to the geodesic equation, the apparent receding velocity of a galaxy should closely approach the speed of light at great distances, but should never exactly reach the speed of light. However, calculations derived from the metric tensor show that the speed of light becomes very small at great distances, and so the actual value of the receding velocity of a galaxy (in kilometers per second) becomes vanishingly small at very great distances. This shows that even though the universe expands about every observer, the over-all size of the universe remains constant. ***The analyses show that the universe expansion is an apparent relativistic effect, in which the over-all size of the universe remains constant, even though the universe expands about the location of every observer.***

The fact that the Hubble expansion of the universe is an ***apparent relativistic effect*** does not mean that the expansion is an illusion. Apparent relativistic effects are real. The famous Einstein formula ($E = Mc^2$), which provided the foundation for developing the atomic nuclear bomb, was the result of an apparent relativistic effect derived from Special Relativity.

Although our theoretical model of the universe predicts that the universe must expand, this model assumes that the average density of the universe does not change with time. To satisfy both requirements shows that matter must be created throughout the universe to offset the universe expansion. The rate of matter creation required to offset the universe expansion is far too small to be measured directly: only two hydrogen atoms created every year within a volume of one cubic kilometer.

This cosmology model predicted by the Yilmaz gravitational theory implies a universe that is infinitely old. It is similar in many respects to the Steady-State theory that was postulated in 1948 by Hoyle and others, but there are great differences. As will be shown, the Yilmaz cosmology model directly predicts Cosmic Microwave Background Radiation (CMBR) with better accuracy than the best estimate from the Big Bang theory. (The CMBR radiation was the primary reason for the demise of the Hoyle Steady-State theory.) The Hoyle Steady-State theory predicts a universe that grows steadily in size with time, but the Yilmaz cosmology model predicts that the universe size remains constant.

This website shows that the cosmology model predicted by the Yilmaz gravitational theory is remarkably consistent with astronomical data. Nevertheless, unlike the Big Bang cosmology models, the Yilmaz cosmology model does not have any arbitrary parameters that can be adjusted to match the measured data.

References

[1] Paul Marmet, "A New Non-Doppler Redshift", presented in Internet website: www.newtonphysics.on.ca.

[2] Fred Hoyle, Geoffrey Burbidge, and Jayant Narlikar, *A Different Approach to Cosmology*, 2000, Cambridge U. Press, England, ISBN 0-521-*66223-0.*