Chapter 14

Cosmology II – The Big Picture

In chapter 3 we determined the changes in energy, force, voltage, etc. that are required to keep the laws of physics constant in different gravitational potentials where there is a difference in the rate of time. The "normalized" coordinate system of chapter 3 used the equation $L_o = L_g$. This does not imply that L_o and L_g are constant over time. It is now proposed that both of these units of length are simultaneously contracting as the universe ages. This simultaneous contraction maintains $L_o = L_g$ in the CMB rest frame according to a midpoint observer.

Now we are attempting to understand the evolution of the universe. To do this I propose that it is most convenient to use a coordinate system based on the properties of Planck spacetime when $\Gamma_u = 1$. Even though the universe has always had flat spacetime, there has been a continuous increase in Γ_u since the Big Bang. As previously explained, the current value of Γ_u is about $\Gamma_{uo} \approx 2.6 \times 10^{31}$ and this number continues to increase. This affects many things including our rate of time, our length standard and our energy standard. The best reference we have to quantify these changes is to use a coordinate system based on the conditions that existed when $\Gamma_u = 1$. Another way of saying this is that we should reference the conditions that existed at the start of the Big Bang when we had Planck spacetime.

Relative to the spatial and temporal coordinate system that existed at the Big Bang when $\Gamma_u = 1$, there has been a decrease in the rate of time and a decrease in a standardized unit of length such as one meter. As will be explained, this combination keeps the laws of physics unchanged. This has some similarities to the gravitational effects previously discussed in chapter 3. However, with the universe the background gravitational gamma (Γ_u) is continuously increasing. One of the few indications that anything is changing in the universe is that light that was emitted a long time ago from distant sources has undergone obvious changes in wavelength and intensity.

Spacetime Transformation Model: A model of the universe based on a continuously increasing Γ_u represents an alternative to the Big Bang model. What we perceive as an increase in the scale of the universe is actually due to an increase in the background Γ_u of the universe changing the spatial and temporal dimensions of spacetime. This is a change in the properties of spacetime that has an effect on everything in the universe. The radius of an atom or the rotar radius of a rotar would decrease relative to coordinate length $\mathbb{R}$. An increase of Γ_u results in the following: 1) the hybrid speed of light of the universe decreases; 2) proper length contracts relative to coordinate length; 3) the rate of proper time decreases relative to the rate of coordinate time; 4) the total energy density of the universe remains the same (total energy includes vacuum energy).

Perhaps most surprising of these is that the spacetime transformation model says that the coordinate energy density of the universe has remained constant since the beginning of the universe (since the Big Bang). The coordinate energy density utilizes coordinate length $\mathbb{R}$ and coordinate rate of time dt to quantify coordinate energy density. The observable energy density of the universe (measured in proper units of energy) has decreased by a factor of roughly 10^{120} since the beginning of time (since the Big Bang). However, including the waves in spacetime responsible for vacuum energy, it will be shown that the spacetime transformation model of the universe sees no change in the coordinate energy density of the universe. This also eliminates the famous 10^{120} discrepancy between the "critical" energy density of the universe derived from general relativity and supported by observation compared to the calculated energy density of the universe derived from quantum mechanics and quantum chromodynamics.

This spacetime transformation model might seem like an unnecessary contrarian view that is fundamentally equivalent to depicting the universe as expanding. However, it will be shown that this model is not equivalent to the Big Bang model. This proposed model gives the same redshift and the same increase in proper volume as the Big Bang model, but the spacetime transformation model offers different predictions about the future of the universe. Probably the most controversial difference is that the spacetime transformation model purports to eliminate the need for dark energy and a cosmological constant.

Observable Universe from Planck Spacetime: As previously stated in chapter 13, Planck spacetime had spherical Planck energy density. Most importantly, Planck spacetime had $\Gamma_u = 1$ and all the dipole waves in spacetime had ½ Planck energy (about 10^9 J) and $\hbar$ angular momentum. This means that 100% of the energy in Planck spacetime was "observable" (had quantized spin). The value of $\Gamma_u = 1$ also means that the rate of time was the highest possible and the proper volume of the universe was the smallest possible. $\Gamma_u = 1$ also implies that a unit of energy such as one Joule was the highest possible value when measured on the absolute energy scale which uses coordinate rate of time and coordinate length. In comparison, it will be shown that one Joule today is a vastly lower energy on the absolute energy scale because today $\Gamma_{uo} \approx 2.6 \times 10^{31}$. Also, the transformation of spacetime that has taken place since the Big Bang has resulted in a decrease in the percentage of the energy in the universe that possesses quantized angular momentum. Today, only about 1 part in 10^{122} of the energy in the universe is "observable" (possesses quantized angular momentum)

All the energy required to form our current universe (including vacuum energy) would be contained in a sphere of Planck spacetime about 15×10^{-6} meters (~ 15 microns) in radius. This radius is calculated by reducing the current distance to our particle horizon (~ 46 billion light years or 4×10^{26} m) by a factor of $\Gamma_{uo} = 2.6 \times 10^{31}$. Our current universe has $\Gamma_{uo} \approx 2.6 \times 10^{31}$ which greatly reduces both our current standard of energy and the fraction of the energy in the universe that is "observable energy"

It is presumed that the universe currently extends far beyond our current particle horizon. This means that the original volume of Planck spacetime was far bigger than the 15 micron radius spherical volume required to form everything (including vacuum energy) within our current particle horizon. This original volume of Planck spacetime might not have been infinite, but it is presumed to be effectively infinite because there is no detectable difference as far as a model of the universe is concerned. It is also presumed that there are galaxies, dark matter, etc. beyond our particle horizon that have a similar appearance and density to our observable universe.

The spacetime transformation model of the universe has a fixed (not expanding) coordinate system. For example, two distant galaxies are considered to be separated by a constant distance when measured in units of coordinate length $\mathbb{R}$. The coordinate grid used by the spacetime transformational model has similarities to the coordinate grid used by the Λ-CDM model. Both grids correspond to the CMB rest frame at all locations in the universe. However the difference is that the Λ-CDM model has a grid that expands with the proper volume of the universe and the spacetime transformation model has a grid that remains stationary. In the spacetime transformation model, the expansion in the proper volume of the universe is accommodated by the change in Γ_u over the age of the universe.

Hubble Parameter and Shrinking Meter Sticks: Today, astronomers do not realize that their meter sticks are contracting due to changes in spacetime. The term "meter stick" represents any means of length measurement. Astrophysicists calculate that the distance to distant galaxies is increasing. However, this distance is measured using contracting meter sticks (contracting units of length). The distant galaxies that are stationary on the static coordinate system appear to be receding at a velocity given by the Hubble parameter.

In astronomical terminology, the Hubble parameter is often expressed as about $\mathcal{H} \approx 70.8$ km/s/Mpc where Mpc is mega parsec, a unit of length used in astronomy equal to about 3.09×10^{22} meters. Converting the Hubble parameter to SI units we have $\mathcal{H} \approx 2.29 \times 10^{-18}$ m/s/m. The seconds used here are today's proper seconds. The common interpretation of the Hubble parameter is that this is the current expansion rate of the universe. The spacetime transformation model interprets the Hubble parameter differently:

$$\mathcal{H} = \frac{\frac{da_u}{d\tau_u}}{a_{uo}} = \frac{\frac{d\Gamma_u}{d\tau_u}}{\Gamma_{uo}} \quad \text{or} \quad \mathcal{H} = \frac{\dot{a_u}}{a_{uo}} = \frac{\dot{\Gamma_u}}{\Gamma_{uo}} \qquad \text{note the dots representing time derivative}$$

The dots are shorthand for time derivatives. Therefore, the Hubble parameter $\mathcal{H}$ equals the rate of change of Γ_u divided by the current background value Γ_{uo}. Also a_{uo} is the current scaling factor of the universe which is equal to Γ_{uo}.

A meter stick (1 meter long) is contracting at a velocity of about 2.29×10^{-18} meters/second when compared to a hypothetical meter stick that is not contracting (a meter stick with fixed coordinate length in units of $\mathbb{R}$). As explained in chapter 13, the Hubble sphere is a 13.7×10^9 light year (1.3×10^{26} m) radius imaginary spherical shell where galaxies and space itself are calculated to be receding away from us at about the speed of light. However, it is proposed that we are using a contracting unit of length, such as a contracting meter stick, as reference for this calculation. The proper distance between us and a galaxy at the edge of the Hubble sphere is indeed increasing by 3×10^8 m/s, but that is because we are measuring the distance using a contracting meter stick. Our meter stick is shrinking at the rate of 2.29×10^{-18} meters/second so we obtain an increase in proper distance of 3×10^8 m/s (obtained from 2.29×10^{-18} m/s/m $\times$ 1.3×10^{26} meters). This is not the same as saying that the galaxy is physically receding from us at the speed of light. The spacetime transformation model says that the calculated speed is erroneous because it is obtained when we measure a fixed distance using shrinking meter sticks.

The reasonable explanation is that spacetime is undergoing a transformation that changes the coordinate speed of light while keeping the laws of physics unchanged (including a constant proper speed of light). This is similar to the covariance of the laws of physics in different gravitational potentials as discussed in chapter 3. However, with the universe Γ_u increases with time but the laws of physics remain unchanged. One observable effect is that it takes longer for light to travel between galaxies as the universe ages. Since we measure no change in the proper speed of light we interpret this as indicating an expansion. However, the alternative explanation proposed here is that the change occurring in the properties of spacetime produces a dimensional contraction. In chapter 3 we saw how the rate of time can change at different elevations of a gravitational field without being detectable locally. Gravity also was shown to affect proper volume which implies a difference in the unit of length. The universe is also producing an omnidirectional gravitational effect that is continuously increasing. One result of this is what we perceive to be the cosmological increase in the volume of the universe.

It was shown in chapter 3 that gravity affects many of the units of physics in a way that keeps the laws of physics unchanged. It is proposed that something similar is happening with the entire universe except that there is an important difference. With the universe at any instant the value of Γ_u is uniformly increasing everywhere. This is the opposite of the gravity assumed in chapter 3 which was static and had a gravitational gradient. The continuous increase in Γ_u causes changes in various units of physics (energy, force, voltage. etc.) which together preserve the laws of physics. Only when we look at distant galaxies do we obtain a hint that change over time is occurring.

No Cosmic Event Horizon: The Λ-CDM model considers the accelerating expansion of the universe to have a cosmic event horizon. This is defined as the largest comoving distance from which light emitted now can ***ever*** reach the observer in the future[1] According to the Λ-CDM model, galaxies that we observe as having a redshift greater than $Z = 1.8$ are currently beyond

[1] Bergström, L.; Goobar, A.: "Cosmology and Particle Physics", *WILEY* (1999), p. 65.ISBN 0-471-97041-7

our cosmic event horizon. Light that is currently being emitted by these galaxies will supposedly never reach us because cosmic expansion of space is adding volume at such a fast rate that the distance increase exceeds the speed of light. Even the expansion of our Hubble sphere cannot overcome the accelerating expansion of the universe. Photons being emitted now by galaxies with $Z > 1.8$ will be swept away from us by the accelerating expansion of the universe. The only reason that we can see those galaxies today is that we are seeing the light emitted from a long time ago before they crossed our event horizon. Once again, that is the Λ-CDM model interpretation.

The spacetime transformation model of the universe makes a prediction that is different than the Λ-CDM model. The proper distance between us and the $Z > 1.8$ galaxies is indeed increasing faster than the speed of light. However, this is because of the current rate of increase in Γ_u is causing our meter sticks to shrink. The galaxies are actually stationary on the proposed coordinate grid. The prediction is that light currently being emitted from those galaxies will eventually reach us but at a slower hybrid speed of light than today. Even though the universe appears to have accelerating expansion, the spacetime transformation model says that there is no event horizon at a distance corresponding to $Z = 1.8$ or at any other distance in the foreseeable future.

We can obtain a better insight into the properties of the hybrid speed of light with a numerical example. Since $\boldsymbol{C} \equiv d\mathbb{R}/d\tau_u = c/\Gamma_u$, therefore the current value of the hybrid speed of light is:

$$\boldsymbol{C} = c/\Gamma_{uo} = {}^{c}/_{2.6\ x\ 10^{31}} \approx 10^{-23}\ m/\mathrm{s}$$

This is the current hybrid speed of light where the units m/s are coordinate meters ($\mathbb{R}$) divided by proper comoving seconds (note use of italic in coordinate units). The hybrid speed of light is decelerating every second at a current rate of:

$$\boldsymbol{C}\mathcal{H} \approx 10^{-23}\ m/\mathrm{s} \times 2.3 \times 10^{-18}\ \mathrm{s}^{-1} \approx 2.3 \times 10^{-41}\ m/\mathrm{s}^2 \qquad \text{deceleration of } \boldsymbol{C}$$

Finally, the current rate of time ($d\tau_{uo}$) is about 2.6×10^{31} times slower than the coordinate rate of time (dt) which assumes $\Gamma_u = 1$.

Constant Coordinate Energy Density: The energy density of this $15 \times 10^{-6}\ m$ spherical volume is equal to spherical Planck energy density: $U_{ps} \approx 5.5 \times 10^{112}$ J/m³. At the beginning of time (the Big Bang) this energy was in the form of dipole waves in spacetime with the unique properties of Planck spacetime previously enumerated. Today the characteristics of the dipole waves in spacetime that form both vacuum energy and the observable mass/energy in our universe have changed their characteristics compared to Planck spacetime. Almost all the energy in the universe today is in the form of vacuum energy – dipole waves in spacetime that do not possess angular momentum. Only an extremely small part is in the form of observable energy that possesses angular momentum. However, it will be shown that not only the proper energy density (including vacuum energy) but also the coordinate energy density of the universe today is still the same as Planck spacetime. There have been changes relating to the distribution of quantized angular momentum, the rate of time, proper length, etc. but the total energy density has not changed even when measured using coordinate energy density that assumes $\Gamma_u = 1$. Therefore, it is possible to adopt a coordinate system based on these coordinate values that does not expand over time. This is the stationary coordinate system of the spacetime transformation model.

It might seem that the Big Bang model is ultimately equivalent to the spacetime transformation model with its stationary coordinate system. However, this is not a case of simple coordinate transformation. For example, the two models make different predictions about the existence of an event horizon as previously noted. Also, the Big Bang model cannot accommodate the fact that new volume being added to the universe must also possess the vacuum energy with energy density exceeding 10^{112} J/m^3. Where did this additional energy come from? The spacetime transformation model can accommodate this requirement as will be explained later in this chapter.

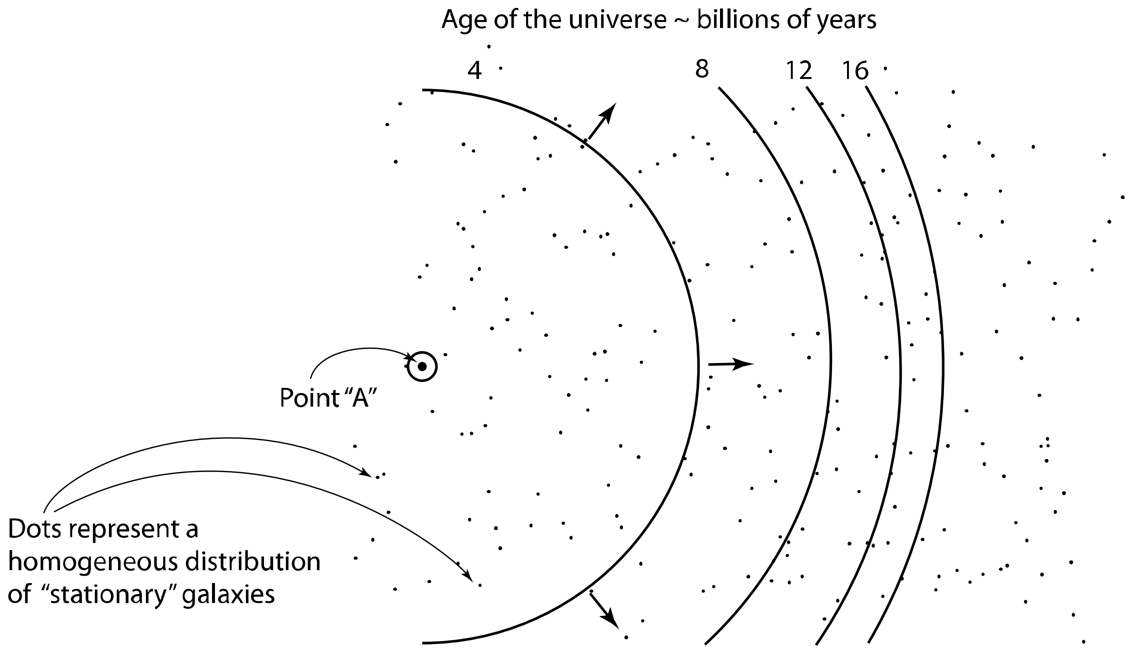

FIGURE 14-1 This Figure is drawn assuming the dimensional contraction model which uses coordinate length and assumes a homogeneous distribution of stationary mass (galaxies). The gravitational influence of energy at a point spreads at the coordinate speed of light which is decreasing with time as Γ_u increases.

Illustration of Slowing Hybrid Speed of Light: Figure 14-1 illustrates the concept of a stationary coordinate system with a slowing hybrid speed of light. This figure uses coordinate length, therefore the distance in coordinate length units between Point A and the furthest curved surface (16 billion years) is roughly 10^{-5} *m*. Point "A" can be imagined as initially a Planck sphere within Planck spacetime at the beginning of time. This sphere contained about a billion Joules, so when time began to progress the gravitational influence of this energy began to propagate away from point A at the proper speed of light c. However, the rate of propagation as measured using the hybrid speed of light decreases as Γ_u increases. After 4 billion years the gravitational influence had reached the propagating particle horizon designated 4 billion years. (The term "propagating particle horizon" is used here to designate the expanding sphere of influence of a point of mass/energy) Similarly, the propagating particle horizons for 8, 12 and 16 billion years are shown.

The purpose of this figure is to illustrate the slowing rate of propagation as indicated by the decreasing distance separating the curved surfaces as time progresses and Γ_u increases. There is no tendency for this progression to be swept backwards by cosmic expansion. The rate of progress will continue to decrease, but there is no event horizon where the progress is stopped. It is speculation whether Γ_u ever reaches such a large value that a quantum mechanical transition occurs. The spacetime transformation model of the universe predicts that for the foreseeable future, we will continue to see new, more distant galaxies appear in the sky. The galaxies that we currently see will get dimmer (less photons per second per m^2) but also paradoxically be less redshifted than today.

Redshift: The spacetime transformation model is also the best model to see why an increasing background Γ_u produces a redshift on the light that we see from a distant galaxy. The presence of a redshift in cosmology is counter intuitive when it is realized that the spacetime transformation model claims that the rate of time was <u>faster</u> when the light was emitted $(d\tau_{em})$ than when the light is observed ($\Gamma_{em} < \Gamma_{obs}$ and $d\tau_{obs} < d\tau_{em}$). For example, Schwarzschild assumed a single stationary mass in an empty universe. This assumption presumed a "mature gravity" condition (no time dependence). Under these conditions, light propagating from a location far from the mass (small gravitational Γ) to a location near the mass (large gravitational Γ), undergoes a "gravitational blue shift". This was previously discussed and shown that a distant observer using a single rate of time perceives no change in the energy of the photon. The locally observed apparent increase in energy is due to the slow rate of time in gravity (large Γ).

When the background Γ_u of the universe increases uniformly everywhere, this is completely different than a photon propagating from a location with a small value of Γ to a location with a larger value of Γ. It will be shown below that an increase in the background Γ_u of the universe produces a redshift which includes an increase in proper wavelength and a decrease in proper frequency and a decrease in proper energy.

Coordinate Wavelength Constant: When the background Γ_u of the universe is increasing homogeneously throughout the universe, this means that the hybrid speed of light is decreasing homogeneously as: $\boldsymbol{C} = c/\Gamma_u$. Light in flight just slows down homogeneously everywhere. This homogeneous slowing maintains the same coordinate wavelength for a light wave. The entire wave just slows down without changing its size when measured using coordinate length. If the light in flight is constant wavelength when measured in units of coordinate length, what result will we obtain when we measure the wavelength in units of proper length using a contracting meter stick? We will obtain the result that the light is increasing its wavelength relative to the contracting meter stick. In other words, we would see a redshift (an increase in wavelength).

Redshift – Wavelength Analysis: To analyze this we will assume that light is emitted in location #1 at an age of the universe t_1 and a background gravitational gamma Γ_1. The emission is at coordinate wavelength $\boldsymbol{\lambda}$ which can be converted to proper wavelength λ_1 at the time of emission. At a later time (age of the universe t_2 and background gamma Γ_2) the coordinate wavelength is still the same $\boldsymbol{\lambda}$ but the proper wavelength is λ_2 relative to the contracted meter stick. All we have to do is compare λ_1 to λ_2 which means that we need to convert $\boldsymbol{\lambda}$ which is always in units of coordinate length $\mathbb{R}$ into wavelength λ expressed in proper length at two different times. The coordinate wavelength $\boldsymbol{\lambda}$ does not change; it only slows down due to a change in the hybrid speed of light $\boldsymbol{C}$ when Γ_u increases ($\boldsymbol{C} = c/\Gamma_u$). Therefore we must convert between coordinate length and proper length at two different values of background gamma: Γ_1 and Γ_2. From chapter 13 we know that the conversion of units of coordinate length $\mathbb{R}$ to units of proper length is $L = \Gamma_u\mathbb{R}$. When we express this conversion in terms of wavelength symbols we have $\lambda = \Gamma_u\boldsymbol{\lambda}$. This says that a given wave appears to have a bigger wavelength (more units of proper length) when it is measured with the contracted meter stick used for proper length than when it is measured with the coordinate scale meter stick that is not contracted. Since $\boldsymbol{\lambda}$ is independent of the background Γ_u we have:

$\boldsymbol{\lambda}$ = wavelength of light when measured in units of coordinate length.
λ_1 and λ_2 = wavelength of light (proper wavelength) at time $\underline{\boldsymbol{t}}_1$ and $\underline{\boldsymbol{t}}_2$ where $\underline{\boldsymbol{t}}_2 > \underline{\boldsymbol{t}}_1$
Γ_1 and Γ_2 = background Γ_u of the universe at time $\underline{\boldsymbol{t}}_1$ and $\underline{\boldsymbol{t}}_2$ where $\underline{\boldsymbol{t}}_2 > \underline{\boldsymbol{t}}_1$
a_{em} = cosmological scale factor at emission (a_{em}) at time = $\underline{\boldsymbol{t}}_1$
a_{obs} = cosmological scale factor at observation (a_{obs}) at time = $\underline{\boldsymbol{t}}_2$

$\boldsymbol{\lambda} = \frac{\lambda_1}{\Gamma_1}$ and $\boldsymbol{\lambda} = \frac{\lambda_2}{\Gamma_2}$ conversion of $\boldsymbol{\lambda}$ to λ_1 and λ_2

$\frac{\lambda_2}{\lambda_1} = \frac{\Gamma_2}{\Gamma_1}$ since $\Gamma_2 > \Gamma_1$ therefore $\lambda_2 > \lambda_1$ (wavelengths in units of proper length)

Since Γ_u is increasing with time, therefore $\Gamma_2 > \Gamma_1$ and $\lambda_2 > \lambda_1$. This all says that λ_2 is redshifted (longer wavelength) compared to λ_1. The amount of the redshift is: $\lambda_2/\lambda_1 = \Gamma_2/\Gamma_1$ which can also be expressed in terms of the ratio cosmological scaling factors at emission ($a_{em} = a_1$) and observation ($a_{obs} = a_2$) or in terms of redshift $1 + Z$.

$$\frac{\lambda_2}{\lambda_1} = \frac{\Gamma_2}{\Gamma_1} = \frac{a_2}{a_1} = \frac{a_{obs}}{a_{em}} = 1 + Z$$

Since λ_1 is the proper wavelength at emission (time $\underline{t}_1$) and λ_2 is the proper wavelength at observation (time $\underline{t}_2$), therefore the relationship can be written as:

$$\frac{\lambda_{obs}}{\lambda_{em}} = \frac{a_{obs}}{a_{em}} = 1 + Z$$

This answer, obtained from the spacetime transformation model agrees with the answer obtained from the Big Bang model that assumes cosmic expansion of the universe.

Redshift – Frequency Analysis: Therefore, it has been shown that looking just at wavelength there is the correct redshift when we presume that the redshift is caused by a change in the background Γ_u rather than an expansion of the universe. It is possible to work this same problem looking at the frequency of the radiation rather than at the wavelength. In this case we would expect a lower frequency at a later time when we express frequency relative to proper time.

We will start off by working this problem using coordinate values. As before, there is no change in wavelength expressed in terms of coordinate length between the emission and observation. The new symbols are:

C_1 and C_2 = hybrid velocity of light at times t_1 and t_2 respectively
$\boldsymbol{\lambda}$ = wavelength expressed in units of coordinate length – this does not change at t_1 and t_2
υ_1 and υ_2 = proper frequency of light at times t_1 and t_2 respectively
proper frequency has a redshift since $\upsilon_1 > \upsilon_2$ and $\Gamma_{u2} > \Gamma_{u1}$

Since υ_1 can be considered the frequency when the light was emitted ($\upsilon_1 = \upsilon_{em}$) and υ_2 can be considered the frequency when the light was observed ($\upsilon_2 = \upsilon_{obs}$), therefore the following is another way of stating these results:

$$\frac{\upsilon_{obs}}{\upsilon_{em}} = \frac{a_{em}}{a_{obs}} = \frac{1}{Z + 1}$$

Therefore the spacetime transformation model gives the same redshift (proper wavelength and proper frequency) as the Big Bang model. However, this analysis leaves one question unanswered. If the rate of time was faster in the past than it is today, why don't we observe a blue shift on light from distant galaxies? The answer to this question is not obvious in the previous analysis because that analysis used the "hybrid speed of light $C = d\mathbb{R}/d\tau_u$. This definition incorporates the proper rate of time in the universe ($d\tau_u$) which hides the question about the blue shift. This question can only be answered if we compare proper values to coordinate values. This comparison requires that we rework the problem using coordinate rate of time (dt), coordinate speed of light ($\mathbb{C}$) and coordinate frequency (υ_c).

To begin, we will return to the example previously stated and examine light emitted at location #1 at an age of the universe t_{u1} which had a background gravitational gamma Γ_{u1}. This light is later observed at location 2 with the age of the universe t_{u2} and background gamma Γ_{u2}. Again, the wavelength of the light measured in units of coordinate length is $\boldsymbol{\lambda}$. This coordinate wavelength does not change; the light merely slows as the coordinate speed of light decreases. The coordinate speed of light at ages of the universe t_{u1} and t_{u2} will be designated as $\mathbb{C}_1$ and $\mathbb{C}_2$ respectively.

$$\mathbb{C}_1 = \frac{c}{\Gamma_{u1}^2} \quad \text{and} \quad \mathbb{C}_2 = \frac{c}{\Gamma_{u2}^2}$$

We will now state the frequency of this light using the rate of coordinate time dt as our standard. Recall that $dt = \Gamma_u d\tau_u$. Frequency obtained using the coordinate time standard will be designated ν_c. The particular coordinate frequency produced by wavelength $\boldsymbol{\lambda}$ will be designated ν_{1c} when the background gamma is Γ_{u1} and ν_{2c} when the background gamma is Γ_{u2}. Therefore:

$$\boldsymbol{\lambda} = \frac{\mathbb{C}_1}{\nu_{1c}} = \frac{\mathbb{C}_2}{\upsilon_{2c}} \qquad \text{set } \mathbb{C}_1 = \frac{c}{\Gamma_{u1}^2} \text{ and } \mathbb{C}_2 = \frac{c}{\Gamma_{u2}^2}$$

$$\frac{c}{\upsilon_{1c}\Gamma_{u1}^2} = \frac{c}{\upsilon_{2c}\Gamma_{u2}^2}$$

$$\frac{\upsilon_{2c}}{\upsilon_{1c}} = \left(\frac{\Gamma_{u1}}{\Gamma_{u2}}\right)^2 \qquad \text{ratio of coordinate frequencies}$$

This says that using coordinate frequency results in a redshift proportional to the square of the ratio of gammas. This means that the correction due to the slowing rate of time does not produce an observable blue shift, but instead this blue shift is used to reduce a coordinate redshift that is proportional to $(\Gamma_{u1}/\Gamma_{u2})^2$ to a proper redshift proportional to just $(\Gamma_{u1}/\Gamma_{u2})$. This is shown by making the substitution $\upsilon_{1c} = \frac{\upsilon_1}{\Gamma_{u1}}$ and $\upsilon_{2c} = \frac{\upsilon_2}{\Gamma_{u2}}$ to obtain the ratio of frequencies expressed in proper frequencies υ_1 and υ_2.

$$\frac{\upsilon_2}{\upsilon_1} = \frac{\Gamma_{u1}}{\Gamma_{u2}} \qquad \text{ratio of proper frequencies}$$

Rotar's Frequency: Since photons lose proper frequency as Γ_u increases, why does the proper Compton frequency of rotars remain constant? To put this question in perspective, we should first acknowledge that on the coordinate time scale that assumes $\Gamma_u = 1$ the Compton frequency of a rotar does decrease. Therefore, all fundamental rotars are continuously slowing down on an absolute time scale. We do not notice this slowing because our cosmic clock is also slowing.

Therefore we are using a continuously slowing clock to time the frequency of a continuously slowing rotar such as an electron. This is a moving standard, but each second an electron is losing about 282 Hz if we measured the Compton frequency using the rate of time that existed in the previous second ($\omega_c \mathcal{H}/2\pi \approx$ 282 Hz/s).

Therefore, on an absolute time scale, why does a photon's frequency decrease proportional to $(\Gamma_{u1}/\Gamma_{u2})^2$ while a rotar's frequency scales with just $(\Gamma_{u1}/\Gamma_{u2})$? The answer is that the propagation rate of the rotar's dipole wave decreases proportional to $(\Gamma_{u1}/\Gamma_{u2})^2$ but this is partly offset by a decrease in the rotar's circumference (measured on the absolute scale of $\mathbb{R}$). The reduced circumference distance and reduced rotar radius (both measured on the absolute scale of $\mathbb{R}$) means that a dipole wave with quantized angular momentum propagates around the shortened circumference (measured in units of $\mathbb{R}$). The decrease in a rotar's circumference results in a rotar's frequency scaling with $(\Gamma_{u1}/\Gamma_{u2})$ which matches the rate of time decrease on an absolute scale. Therefore, the rotar's Compton frequency appears to be constant while the frequency of a photon decreases when measured using proper rate of time. The standard explanation of the cosmic redshift based on expansion of the universe is proposed to be wrong. Wavelengths are not being stretched. There are no point particles. Particles with finite dimensions are also affected by the transformation of spacetime. However the effects on particles are not noticeable because there are offsetting effects on the rate of time, on the standard of energy and on other units of physics.

Maintaining the Vacuum Energy Density: Throughout this book there have been numerous references to the energy density of the spacetime field being on the order of 10^{113} J/m^3 (times an unknown numerical constant near 1). The problem is that throughout the history of the expanding universe, the proper energy density of vacuum energy would have to remain constant. The expanding volume would appear to require a mechanism to continuously add a tremendous amount of new energy to the expanding universe. For example, the Hubble parameter of $\mathcal{H} \approx 2.3\times10^{-18}$ m/s/m indicates that each cubic meter in the universe is expanding and increasing its volume by $\sim 10^{-53}$ m^3/s. If the vacuum energy density required to fill this additional volume is $U_{vac} \approx 10^{112}$ J/m^3, then the additional volume generated by EACH cubic meter in the universe requires additional 10^{59} Joules/second. To put this in perspective, the $E = mc^2$ total observable energy of the Milky Way galaxy is also about 10^{59} Joules. Therefore it would appear that each cubic meter of volume in the universe must be supplied with about 10^{59} Joules of energy each second.

Therefore, the problem of supplying the universe with dark energy each second is trivial compared to the problem of supplying the universe with new vacuum energy each second. This all seems to be impossible, so most physicists presume that there must be some mechanism that cancels out almost all the implied vacuum energy density in the universe. However, this hypothetical cancelation mechanism has several problems. 1) Zero point energy, vacuum fluctuations, and the uncertainty principle must remain and these all imply that vacuum energy has not been canceled. 2) The canceling mechanism must be careful to leave the one part in 10^{122} that constitutes our observable universe. 3) The effect capable of canceling 10^{113} J/m^3 must be equally as large. 4) No mechanism has been suggested that is capable of causing this enormous cancelation.

The spacetime transformation model says that there is no canceling mechanism. The enormous vacuum energy is present in spacetime. It is dipole wave energy that lacks angular momentum and therefore only interacts with our observable universe (fermions and bosons) through subtle quantum mechanical mechanisms. This vacuum energy is the most perfect superfluid possible. It forms the single universal field that is responsible for all other fields. It also gives the following properties to spacetime: Z_s, c, ε_o, μ_o, $\hbar$, G, l_p, t_p, etc.

New Transformations of Units: Recall that in chapter 3 we made a table of transformations of the units of physics showing the difference between a "zero gravity" location and a location with gravity. In chapter 3 we designated the "zero gravity" location as having $\Gamma = 1$. Now it is necessary to realize that this designation incorporated a simplification. We were ignoring any change in the background gravitational gamma of the universe Γ_u. Another way of saying this is that we defined a "zero gravity location" as having $\Gamma = 1$. Now that we are talking about the evolution of the universe it is necessary to be more precise. The length transformation was previously expressed as: $L_o = L_g$. However, to put this in the bigger perspective that incorporates Γ_u and $\mathbb{R}$, we can now say:

$$L_o = L_g = \mathbb{R}/\Gamma_u$$

This equation says that what we were previously calling L_o and L_g were both changing relative to our absolute length standard $\mathbb{R}$ that was present at the start of the universe when $\Gamma_u = 1$. When we are dealing with the universe and time scales where the effects of a changing background Γ_u are significant, then it is no longer possible to adopt proper length as the coordinate unit of length. A different coordinate length transformation is required to characterize the relationship between the units of physics when they are compared at the same location but at substantially different ages of the universe. The value of Γ_u increases with the age of the universe.

In chapter 3 we were able to obtain all the other transformations using dimensional analysis once we had the transformations for length, time and mass. Previously these three transformations were expressed as:

$L_o = L_g$	unit of length transformation
$T_o = T_g/\Gamma$	unit of time transformation
$M_o = M_g/\Gamma$	unit of mass transformation

In these transformations the symbols L_o, T_o and M_o represented coordinate (zero gravity) units of length, time and mass respectively. Now it is necessary to adopt new coordinate units to represent a unit of coordinate length, coordinate time and coordinate mass at the start of the Big Bang when the universe was one unit of Planck time old ($\mathcal{T}_u = 1$) and had $\Gamma_u = 1$. We have previously been using $\mathbb{R}$ to represent one unit of coordinate length in a universe where $\Gamma_u = 1$. However, now it is necessary to add a subscript "1" to this designation to conform to a pattern where all units of physics need to be specified when $\Gamma_u = 1$. For example, E_1, Q_1 and U_1 will be used to specify a unit of energy, charge and energy density respectively when $\Gamma_u = 1$. The symbols $\mathbb{M}_1$ and $\mathbb{T}_1$ will be used to specify a unit of mass and time respectively at the start of the Big Bang when $\Gamma_u = 1$.

In chapter 3 the subscript "g" was used to specify a location in gravity. The analogous condition when dealing with the evolution of the universe is to specify the unit of physics when it feels the effect of a background gravitational gamma that is greater than 1 ($\Gamma_u > 1$). This condition will be specified by the subscript "u". For example, a unit of length, time and mass when $\Gamma_u > 1$ will be designated as L_u, T_u and M_u respectively. For the evolution of the universe the time and mass transformations are similar to those in chapter 3 but with new symbols. Only the length transformation equation is not analogous to $L_o = L_g$ from chapter 3. The new length transformation equation needs to specify the fact that we are now recognizing the change in a unit of length that scales with Γ_u. Therefore we have:

$\mathbb{R}_1 = \Gamma_u L_u$ unit of length transformation

$\mathbb{T}_1 = T_u/\Gamma_u$ unit of time transformation

$\mathbb{M}_1 = M_u/\Gamma_u$ unit of mass transformation

In utilizing the mass transformation $\mathbb{M}_1 = M_u/\Gamma_u$, it is important to recall the assumption stated in chapter 3 that the same rate of time must be used to quantify both $\mathbb{M}_1$ and M_u. Mass is a measurement of inertia, which in turn involves force and acceleration. All of these imply the use of a rate of time. Mass is not synonymous with matter. In chapter 3 we often assumed that coordinate time would be used. However, in the current universe with $\Gamma_{uo} \approx 2.6 \times 10^{31}$, the rate of coordinate time on the Γ=1 clock is about 2.6×10^{31} times faster than the rate of time on the cosmic clock, so it might not be convenient to use coordinate rate of time. All that is important is that we remember that the transformation of units requires that we use the same rate of time to express both $\mathbb{M}_1$ and M_u or other units of physics at different ages of the universe with different values of Γ_u.

Because of the change in the length transformation, it is necessary to recalculate the other transformations using the dimensional analysis procedures established in chapter 3. Using the above transformations for units of length, time and mass we obtain:

Impedance of Spacetime Z_s : $Z_{s1} \rightarrow \mathbb{M}_1/\mathbb{T}_1 = \dfrac{\left(\frac{M_u}{\Gamma_u}\right)}{\left(\frac{T_u}{\Gamma_u}\right)} \rightarrow Z_{su}$

$Z_{s1} = Z_{su}$ impedance of spacetime transformation

Energy E: $E_1 \rightarrow {}_1\mathbb{R}_1{}^2/\mathbb{T}_1 = \dfrac{\left(\frac{M_u}{\Gamma_u}\right)(L_u^2\Gamma_u^2)}{\frac{T_u}{(\Gamma_u)^2}} \rightarrow \Gamma^3 E_u$

$E_1 = \Gamma_u{}^3 E_u$ units of energy transformation

Energy Density U: $U_1 \rightarrow {}_1/\mathbb{R}_1\mathbb{T}_1{}^2 = \dfrac{(M_u/\Gamma_u)}{(\mathrm{L_u}\Gamma_\mathrm{u})(\mathrm{T_u^2}/\Gamma_\mathrm{u}^2)} \rightarrow U_u$

$U_1 = U_u$ units of energy density transformation

Coordinate Speed of Light $\mathbb{C}$: $\mathbb{C}_1 \rightarrow \mathbb{R}_1/\mathbb{T}_1 = \dfrac{L_u\Gamma_u}{T_u/\Gamma_u} \rightarrow \Gamma^2\mathbb{C}_u$

$c = \mathbb{C}_1 = \Gamma_u{}^2\mathbb{C}_u$ coordinate speed of light transformation

These are the most important transformations and some of them will be used to determine the current vacuum energy density and analyze the 10^{120} mystery. First, the impedance of spacetime should be unaffected by a change in Γ_u. The fact that the transformation gave $Z_{s1} = Z_{su}$ shows that the length, time and mass transformations are correct. This acts as a check on the transformation process. Above we assumed the mass transformation was the same as chapter 3. In truth, this was not a foregone conclusion. However, the impedance of spacetime should remain constant. Assuming the length and time transformations, there is only one possible mass transformation that achieves a constant impedance transformation.

Energy and Energy Density Transformations: Next, the units of energy transformation $E_1 = \Gamma_u{}^3 E_u$ will be illustrated with an example. Suppose that there was an electron in a hypothetical universe with $\Gamma = 1$. The energy of the electron in the $\Gamma_u = 1$ universe would be 8.19×10^{-14} Joules measured locally which is the same energy we would measure for the electron in our current universe. However, the measurement in the $\Gamma_u = 1$ universe used a local clock that is running 2.6×10^{31} times faster than the cosmic clock in our current universe. Furthermore, a meter in the $\Gamma_u = 1$ universe is 2.6×10^{31} times larger than a meter in our current universe. Both of these factors combine to make 1 Joule in the $\Gamma_u = 1$ universe equivalent to $\Gamma_{uo}{}^3 \approx 1.8 \times 10^{94}$ joules in our current universe. Therefore, even though both electrons have the same energy measured locally, different standards of energy are being used. When we correct for this difference, the electron in the $\Gamma_u = 1$ universe has $\Gamma_{uo}{}^3 \approx 1.8 \times 10^{94}$ more energy.

Using the rotar model, suppose that we wanted to compare the energy density of the $\Gamma_u = 1$ electron and an electron in the universe today. The transformation of units of length is $\mathbb{R}_1 = \Gamma_u L_u$.

This says that a meter in the Γ=1 universe would be about 2.6 $\times 10^{31}$ times longer than a meter stick in our current universe because we are living in a universe with $\Gamma_u \approx 2.6 \times 10^{31}$. Therefore, the rotar radius of the electron in the Γ=1 universe would be 2.6 $\times 10^{31}$ times bigger and the rotar volume of that electron would be $\Gamma_{uo}{}^3 \approx 1.8 \times 10^{94}$ times greater than the rotar volume of an electron in our universe. The result is that both electrons would have the same energy density because the 1.8 $\times 10^{94}$ difference in the electron's energy is offset by the factor of 1.8 $\times 10^{94}$ difference in the sizes of the rotar volumes. The transformation of energy density is shown above and results in $U_1 = U_u$.

This illustrates how the proper energy density of the universe (including vacuum energy) remains constant even when the universe experiences a vast increase in Γ_u.

This is a fantastic result because it is a key component in solving the mystery of the 10^{122} difference between vacuum energy density and currently observed energy density. When the universe was Planck spacetime, it had energy density of 5.53 $\times 10^{112}$ J/m³. The spacetime transformation model of the universe views the current universe as the same size and same energy density as Planck spacetime. Therefore, the transformation $U_1 = U_u$ says that the proper energy density of the universe equals the tremendously large energy density of the universe obtained when the energy density is expressed in coordinate units. It is not necessary to add energy to the universe to keep the energy density of vacuum energy constant. Instead, nature uses two different standards for a unit of proper energy (in addition to different standards of length, force, the rate of time, etc.) This difference in energy standards exactly offset the change in proper volume thereby maintaining a constant energy density. The total proper energy density of the universe (including vacuum energy) has remained constant at 5.53 $\times 10^{112}$ J/m³ since the beginning of time (since the Big Bang). Today almost all of this energy of the universe is in the form of vacuum energy.

Additional Transformations: If we carry these transformations further, we obtain a few counter-intuitive results. For example, the transformations of charge (Q) and momentum (p) are:

$Q_1 = \Gamma_u Q_u$ unit of charge transformation
$p_1 = \Gamma_u p_u$ unit of momentum transformation

At first these transformations seem to be saying that neither charge (Q) nor momentum (p) is conserved when the universe ages and Γ_u increases. However, these are the transformations required to preserve charge, momentum and the laws of physics when measured locally (proper measurement) and assuming a CMB rest frame which has the distance between points increase with the Hubble flow. The momentum transformation ($p_1 = \Gamma_u p_u$) will be used to illustrate this point.

We will start with a thought experiment. Suppose that there is a hydrogen atom in an excited state that is at rest relative to the CMB and also at rest at the origin of a coordinate system. The hydrogen atom emits a photon in the +Y direction and the photon's momentum causes the hydrogen atom to recoil in the – Y direction carrying the opposite momentum. As shown in chapter 5, the momentum imparted to the atom by the emission of a photon results in the atom having a de Broglie wavelength that equals the wavelength of the emitted photon. If we view this from a rigid frame of reference that does not expand with the Hubble flow, then there is no loss of momentum over time. However, if we view both the recoiling atom and the propagating photon from a coordinate system that expands with the Hubble flow, then relative to this coordinate system there is a loss of momentum. Both the photon and the de Broglie waves of the atom undergo a redshift (lose momentum) relative to a coordinate system that expands with the Hubble flow. The coordinate system used by the spacetime transformation model is rigid but the effect of an increasing Γ_u produces effects similar to adopting an expanding coordinate system. Therefore the equation $p_1 = \Gamma_u \, p_u$ is merely expressing this difference in perceived momentum between the two coordinate systems. Similarly, the charge transformation $Q_1 = \Gamma_u Q_u$ keeps the proper laws of physics unchanged in both an expanding coordinate system and in the spacetime transformation coordinate system as Γ_u increases.

10^{120} Calculation: Now we are going to calculate the current ratio of vacuum energy density to observable energy density. A Planck sphere originally contained about a billion Joules measured using the coordinate energy standard of energy because the universe started as Planck spacetime with $\Gamma_u = 1$. The Planck sphere started with radius of Planck length and today the proper value of this radius has increased by a factor of $\Gamma_{uo} \approx 2.6 \times 10^{31}$ to 0.42 mm radius or a volume of 3.1×10^{-10} m^3. The 10^9 J of coordinate energy when $\Gamma_u = 1$ has had an apparent increase so that currently this much energy would appear to have increased by a factor of $\Gamma_{uo}{}^3$. The objective of the following calculation is to find the current vacuum energy density U_{vac}.

$10^9 \text{ J} \times \Gamma_{uo}{}^3 = 1.8 \times 10^{103}$ J conversion of coordinate energy to proper energy
$(4\pi/3)\, l_p{}^3 \Gamma_{uo}{}^3 = 3.18 \times 10^{-10}$ m^3 current proper volume of Planck sphere
$1.8 \times 10^{103} \text{ J} / 3.18 \times 10^{-10} \text{ m}^3 \approx 5.5 \times 10^{112} \text{ J/m}^3 = U_{vac}$

Ignoring vacuum energy, the current critical energy density of the universe depends on the value of the Hubble parameter used. Using $\mathcal{H} \approx 70.8$ km/s/Mpc the critical energy density of the universe U_{crit} is about 8.5×10^{-10} J/m^3 if we include hypothetical dark energy. If we exclude dark energy which represents about 72.1% of the total energy density, then we have observable energy density U_{obs} of about 2.36×10^{-10} J/m^3.

$U_{vac}/U_{crit} \approx 5.5 \times 10^{112} \text{ J/m}^3 / 8.5 \times 10^{-10} \text{ J/m}^3 \approx 6.5 \times 10^{121}$ ratio including dark energy
$U_{vac}/U_{obs} \approx 5.5 \times 10^{112} \text{ J/m}^3 / 2.4 \times 10^{-10} \text{ J/m}^3 \approx 2.3 \times 10^{122}$ ratio excluding dark energy

Either of these numbers qualifies as the famous 10^{120} discrepancy between the theoretical energy density of the universe and the observed energy density. Here is how we achieve spherical Planck energy density using one of the 5 wave-amplitude equations ($U = H^2\omega^2 Z/c$). Using the proper rate of time on the cosmic clock, the frequency appears to be Planck angular frequency ω_p. Furthermore, strain amplitude is a dimensionless number that does not change with Γ_u. Therefore we will insert $H = 1$. Finally we must insert the constant k' to convert from cubic to spherical with the factor of ½ associated with zero point energy.

$U = H^2\omega_p{}^2 Z_s/c$ set $\omega_p = 1.855 \times 10^{43}$ s^{-1}; $Z_s = 4.038 \times 10^{35}$ kg/s; $H = 1$ and add $k' = 3/8\pi$
$U_{ps} = k' H^2\omega_p{}^2 Z_s/c = (3/8\pi)\ 1^2\ (1.855 \times 10^{43})^2\ (4.04 \times 10^{35})/3 \times 10^8$
$U_{ps} = 5.53 \times 10^{112}$ J/m^3
$U_{ps} = U_{vac} + U_{obs}$

The spacetime transformation model of the universe proposes that over the age of the universe there has been no change in the total energy density of the universe. Today virtually all of the energy density of the universe is in the form of vacuum energy U_{vac} which lacks quantized angular momentum. However, at the start of the Big Bang all the energy density of Planck spacetime U_{ps} was observable energy density U_{obs} because all the energy possessed quantized angular momentum. Over time the transformation of spacetime has resulted in a dramatic decrease in the observable energy density of the universe and an equal increase in vacuum energy density of the universe. Today $U_{vac} \approx 10^{122} U_{obs}$ but the total energy density has not changed: $U_{vac} + U_{obs} = U_{ps}$.

Today we perceive the maximum frequency of the waves that form vacuum energy to be equal to Planck angular frequency. However, this is a proper frequency that has been slowed by a factor of $\Gamma_{uo} \approx 2.6 \times 10^{31}$ compared to the coordinate frequency that occurred when the universe was Planck spacetime. How is it possible for today's vacuum energy to possess virtually the same energy density as Planck spacetime if the current maximum frequency of the dipole waves is a factor of about 2.6×10^{31} times slower than the dipole waves that formed Planck spacetime? The answer to this question is analogous to the answer given previously in the section titled "Energy and Energy Density Transformations". There it was shown how the energy density of an electron remains constant even when there is a big increase in Γ_u. The energy scales proportional to $1/\Gamma_u{}^3$ but the volume also scales with $1/\Gamma_u{}^3$ so the energy density of the electron remains constant. . This holds true for any dipole wave in spacetime that has a specific frequency and strain amplitude. The highest frequency dipole waves have a proper frequency equal to Planck angular frequency ω_p and a proper volume that is Planck length in radius. However, this volume is $1/\Gamma_u{}^3$ times smaller than it was in Planck spacetime. The wavelets that form vacuum energy are continuously forming new wavelets as previously explained. These wavelets adapt to the changing scale of length.

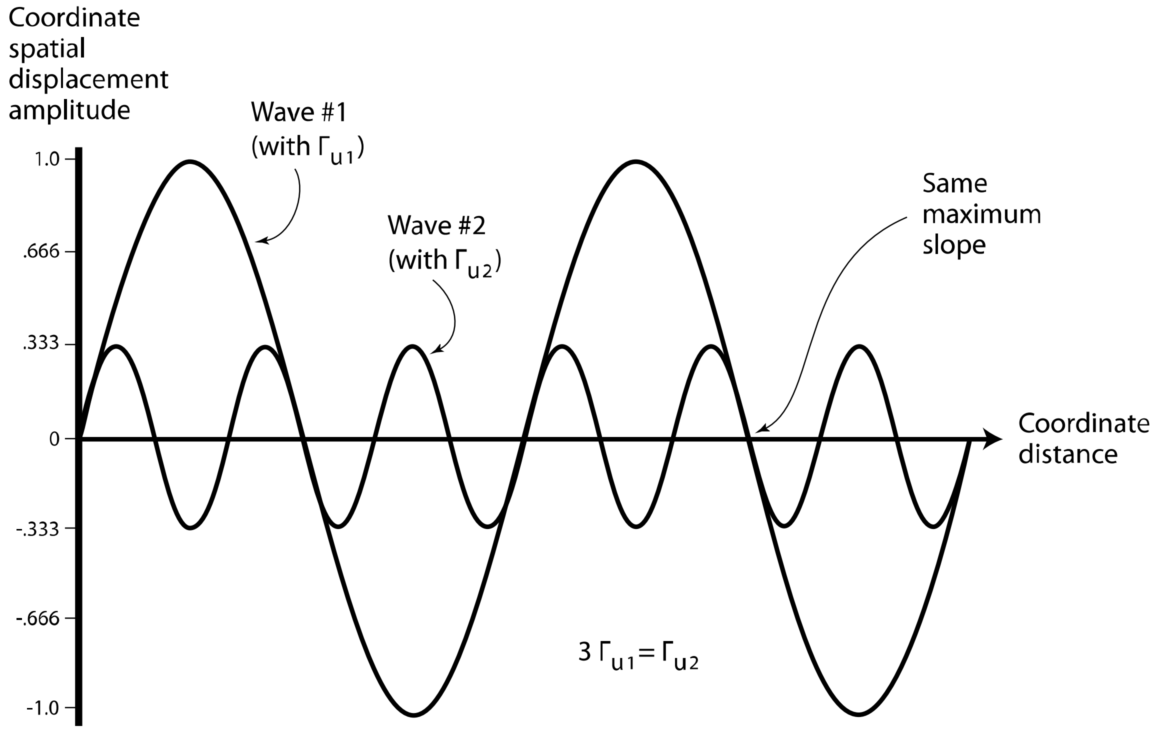

FIGURE 14-2 Two sine waves with different displacement amplitudes and different coordinate speeds of light but the same strain amplitude. The strain amplitude is ΔL/L and therefore related to the maximum slope.

Illustrations Showing the Effect of Γ_u on Waves: Next, we want to see what happens to the waves in spacetime that form vacuum energy when there is an increase of Γ_u. The mystery to be explained is how the wave structure of vacuum energy changes to result in an increase in proper volume as the universe ages. In figure 14-2 we have two sine waves designated wave #1 and wave #2. These are crude representations of the dipole waves in spacetime responsible for vacuum energy. Since the nonlinearity is particularly strong in the early part of the evolution of the universe, instead imagine these as representing vacuum energy at more recent times. In fact, wave #2 can be thought of as representing vacuum energy today with $\Gamma_{uo} \approx 2.6 \times 10^{31}$ and wave #1 representing vacuum energy when the comoving grid was $^1/_3$ its current size which is equivalent to $\Gamma_u \approx 10^{31}$. Therefore, it is important to remember that there is a factor of 3 difference between the value of Γ_u for wave #1 compared to the background gamma present for wave #2. This is written as $3\Gamma_{u1} = \Gamma_{u2}$.

Both of these waves would be exactly the same if they were drawn using proper units of length. The displacement amplitude of both waves is dynamic Planck length when the displacement of spacetime is expressed in units of proper length. However, figure 14-2 uses coordinate length for both the × and Y axis. Therefore, the spatial displacement amplitude of wave #1 is 3 times larger than the spatial displacement amplitude of wave #2 because of the factor of 3 difference between Γ_{u1} and Γ_{u2}. The displacement amplitude (Y axis) is set so that wave #1 has amplitude of 1. This makes the coordinate amplitude of wave #2 equal to 0.333. If the displacement amplitude was expressed using the absolute coordinate scale where Planck length equals 1 when $\Gamma_u = 1$, then wave #1 would have a displacement amplitude of 10^{-31}. This is because wave #1 is presumed to exist in a universe with a background value of $\Gamma_u \approx 10^{31}$. This large value of Γ_u contracts proper length compared to a unit of coordinate length $\mathbb{R}_1$.

The maximum slope of a sine wave occurs when the sine wave crosses the zero line. The arrow shows one of many points where the two waves have the "same maximum slope". This slope is a dimensionless number that is the strain amplitude of the sine wave. The point of this figure is to show that the maximum slope is the same even though the waves have a different scale. The strain produced by waves in spacetime is proportional to the maximum slope. Therefore both waves have a strain amplitude of $H = 1$. Naturally, the slope would also be the same if the waves were drawn using proper length because both waves would then be exactly the same in displacement, wavelength and maximum slope. The waves that form vacuum energy can maintain the same strain amplitude even when Γ_u is increasing. The frequency, measured locally, remains the same so the proper energy density also remains constant when Γ_u increases. The point is that the strain amplitude is always $H = 1$ for all values of Γ_u. This is a key component in maintaining the total energy density of the universe at 10^{113} J/m^3 throughout the age of the universe.

It is interesting to note what these waves would look like if they were plotted in the temporal domain rather than the spatial domain. The Y axis would be labeled "Coordinate Temporal Displacement Amplitude" and the × axis would be labeled "Coordinate Time". The figure would physically look the same as figure 14-2 except that the labels for wave #1 and #2 would be

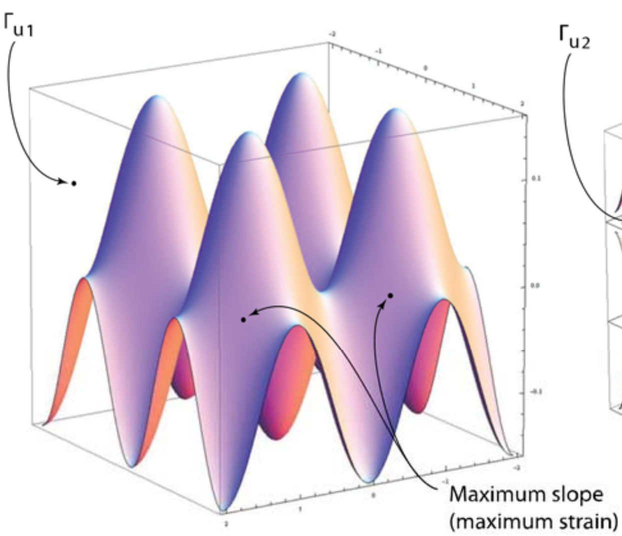

FIGURE 14-3

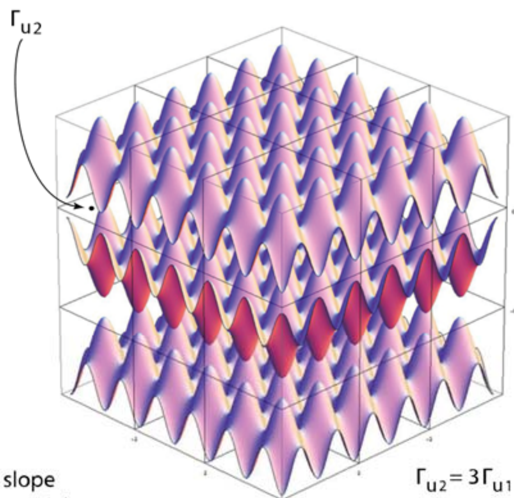

FIGURE 14-4

Figures 14-3 and 14-4 show a simplified representation of chaotic dipole waves in spacetime that form vacuum energy. These figures depict different ages of the universe when there is a factor of 3 difference in Γ_u.

reversed. Wave #2 (larger value of Γ_u) would have the larger temporal displacement amplitude when measured in coordinate units of time. This comparison helps to illustrate how a change in Γ_u exchanges the temporal properties of spacetime for the spatial properties of spacetime.

Figures 14-3 shows a 3-dimensional plot of wave #1 in figure 14-2 and figure 14-4 shows a 3-dimensional plot of 3 layers of wave #2 in figure 14-2 (original definitions of Γ_u). These two figures are oversimplified. The wave structure should be more chaotic and unsymmetrical. Imagine the waves in figure 14-4 as oscillating at $^1/_3$ the frequency of the waves in figure 14-3. The grid pattern in figure 14-4 is only $^1/_3$ the coordinate length so each grid cube has only $^1/_{27}$ the coordinate volume of the grid cube in figure 14-3. However, each grid cube also only contains $^1/_{27}$ the coordinate energy as the grid cube in figure 14-3, so the energy density is the same no matter whether it is assessed using the proper standard of energy density or the coordinate standard of energy density.

Quantum mechanics has been telling us that the vacuum energy density should be constant even as the universe ages and the proper volume increases. Now it is possible to see that the spacetime based model of the universe shows that this is possible. In fact, in order for the laws of physics to remain constant, it is necessary that the vacuum energy density remains constant. If the vacuum energy density decreased as the proper volume of the universe expanded, then the high frequency virtual particle pairs would eventually be lost and this would be detectable.

Does Dark Energy Exist? Dark energy is supposedly a homogeneous form of energy that forms as the volume of the universe expands. Everything about hypothetical dark energy conflicts with the concepts presented in this book. There is no single explanation for dark energy, but the simplest explanation given for the existence of dark energy that scales with volume is that dark energy is "the cost of having space". Each time cosmic expansion somehow creates an additional cubic meter of spacetime; this volume is supposedly left with an energy deficit of about 6×10^{-10} Joules of "negative energy" that is considered to be dark energy. In the early universe, when the energy density of matter and photons was higher, 6×10^{-10} J/m^3 was insignificant. However, today the proper volume of the universe has increased. The density of matter and light has fallen so that today dark matter supposedly makes up about 73% of the energy density of the universe.

In this concept, gravity is attempting to collapse the universe, but dark energy opposes gravity and causes an accelerated expansion of the universe. The exact mechanism used to accomplish this accelerating expansion is vague. If it is the opposite of gravity, then this creates a problem for the model of the universe. Recall that it was previously shown that gravitational acceleration requires a gradient in the rate of time. Therefore, anything that causes an anti-gravity repulsion must accomplish this by a rate of time gradient that opposes gravity. However, the observed redshift of galaxies would require a large scale gradient in the rate of time. The problem is that a large scale time gradient in the universe is incompatible with the concept that the universe is homogeneous both spatially and temporally on the large scale.

The Λ-CDM model does not respect the conditions that must be met to create a cubic meter of "new" space. Creating even a cubic meter of new space requires a lot of conditions to be met. This new space must have the impedance of spacetime $Z_s = c^3/G$ and the interactive bulk modulus of spacetime $K_s = F_p/\mathcal{A}^2$. The new space must be filled with zero point energy at energy density of 10^{113} J/m^3. Therefore, each new cubic meter requires more energy than the annihilation energy of entire observable universe. As before, the problem is in the physical interpretation of observations and equations. If the proper distance between galaxies increases, this can be interpreted different ways. The model proposed here is actually the simplest because it does not demand any new physics or new energy to be added to the universe. It does not require mysterious dark energy.

There is no direct experimental evidence that dark energy exists. Dark energy is a theoretical concept is postulated to explain the apparent acceleration of the expansion of the universe and also to explain that the energy density of the universe has fallen below the "critical density". Baryonic matter, dark matter and radiation only achieve about 28% of the energy density calculated to be necessary to achieve flat spacetime. However, this calculation depends on the accuracy of the model of the universe being used. The concept of "critical density" of the universe assumes that the universe possesses a gravitational gradient. This does not exist in the condition previously described as "immature gravity". It does not make any difference whether the immature gravity occurs in the low gravitational Γ of the dust cloud thought experiment or the high gravitational Γ_u of the universe. The important point is that immature gravity produces an increasing gravitational Γ_u and a uniform instantaneous rate of time in the CMB rest frame. If there is no large scale rate of time gradient from the midpoint observer perspective, then there is no large scale gravitational acceleration and nothing that demands an explanation that incorporates anti-gravity.

The concept of critical density of the universe assumes that there is a gravitational acceleration that is attempting to collapse the universe. If the universe is pictured as the homogeneous and static distribution of galaxies with proper volume increase because of the spacetime transformation of the rate of time and of proper length, then the universe is not struggling to expand against gravity. There is no such thing as a critical density. The dust cloud thought experiment did not meet the conditions of "critical density" and yet there was no gravitational acceleration in the first few milliseconds after gravity was "turned on".

As long as the universe has no detectable boundary (no edge), the mature gravity condition cannot be established. It takes a density change at a boundary to establish a rate of time gradient and gravitational acceleration. The proposed model of the universe started with Planck spacetime that had a uniform rate of time. At speed of light communication, we still have no detectable boundary. The rate of time has slowed down but there still is no large scale rate of time gradient. Gravitational acceleration and curved spacetime both require a rate of time gradient. Therefore, the universe has never possessed large scale curved spacetime or gravitational acceleration. New mass/energy will continue to appear on the particle horizon of the observable universe. The background Γ_u of the universe will continue to increase towards infinity and there will be no rate of time gradient on the scale of universal homogeneity unless one day we become aware of a large scale density discrepancy that is the equivalent of a boundary condition that gives an "edge" to the universe.

Dark Energy Not Needed: What is being proposed is that the spacetime transformation model does not require the invention of dark energy to provide the missing critical density and does not need any mysterious force with anti-gravity properties that is causing the apparent expansion of the universe to accelerate. When viewed from the proposed coordinate rate of time and coordinate unit of length, there is no expansion of the universe. No work is being done against gravity. The immature gravity condition previously discussed eliminates the tendency for the universe to have a gravitational contraction. The coordinate volume of the universe has never changed and the coordinate energy density (including vacuum energy) has remained constant at the large scale of 300,000 light years. At a smaller scale matter has formed stars and galaxies which distort the homogeneous energy density of vacuum energy. We call this distortion "curved spacetime". Our perception of the volume of the universe indicates continuous expansion. However, this is the result of a continuous increase in the background Γ_u of the universe. What we perceive as acceleration of the expansion is due instead to an acceleration in the rate of change of $d\Gamma_u/d\tau_u$.

All the factors that determine $d\Gamma_u/d\tau_u$ (the rate of change of Γ_u in proper time) are not known. This would be a function the age of the universe, but it probably also includes other factors relating to the composition and the observable energy density of the universe. For example, when the universe was radiation dominated, a substantial amount of the observable energy was being converted to vacuum energy. This process resulted in $d\Gamma_u/d\tau_u$ being proportional to $\underline{\tau}^{1/2}$. During the matter dominated epoch the electromagnetic radiation was a small percentage of the observable energy of the universe and $d\Gamma_u/d\tau_u$ was proportional to $\underline{\tau}_u^{2/3}$. Today we have an increase in proper volume that is acceleration. If this is viewed as an acceleration in the rate of change of $d\Gamma_u/d\tau_u$, then a mystery still exists, but it does not demand the invention of dark energy for an explanation. The solution is to be found in the properties of spacetime that create the acceleration of $d\Gamma_u/d\tau_u$ for the current condition of the universe.

Offsetting the Rate of Change of Γ_u: Returning to the increase in Γ_u, how fast would an object need to be raised in the earth's gravitational field in order for the decrease in the earth's Γ to offset the increase in Γ_u of the universe? In other words, what rate of increase in elevation achieves $(d\Gamma/dt)/\Gamma = \mathcal{H} \approx 2.29 \times 10^{-18}\ \mathrm{s}^{-1}$ in the earth's gravitational acceleration of 9.8 m/s²?

$$g = c^2\left(\frac{d\beta}{dL_R}\right) \approx c^2\left(\frac{d\Gamma}{\Gamma dL_R}\right) \qquad \text{set } \frac{d\beta}{dL_R} \approx \frac{d\Gamma}{\Gamma dL_R} \text{ weak gravity approximation}$$

$$\frac{d\Gamma}{\Gamma d\tau_u} = \left(\frac{g}{c^2}\right)\left(\frac{dL_R}{d\tau_u}\right) \qquad \text{set } \frac{d\Gamma}{\Gamma d\tau_u} = \mathcal{H} \quad \text{and } g = 9.8 \text{ m/s}^2$$

$$\left(\frac{dL_R}{d\tau_u}\right) \approx \mathcal{H}\frac{c^2}{g} \approx .021 \text{ m/s} \qquad \left(\frac{dL_R}{d\tau_u}\right) = \text{vertical velocity}$$

Therefore an elevation velocity of about 2.1 cm/s or about 75 meters per hour in the earth's gravity offsets the temporal effects of an increase in the Γ_u of the universe. Obviously this is only a temporary reprieve made possible because an object in the earth's gravity starts off at a lower energy state (larger total Γ) than the same object if it was isolated on the comoving coordinate system. Still, this example gives a physical feel for the rate of change that is currently taking place in the universe.

All physical objects are losing energy each second when measured with an absolute energy scale that does not decrease as Γ_u increases. For example, the sun is currently radiating about 4×10^{26} watts of electromagnetic radiation but the sun is losing about 1000 times this energy per second as the energy in the sun's rotar's is being converted to vacuum energy. This is an undetectable effect using the proper energy standard which does not acknowledge the effect of an increasing Γ_u on everything in the universe.

There is another interesting way of looking at the changing rate of time as the universe ages. An electron has two different rates of time in its two lobes as explained in chapter 5. These rates of time differ by $\alpha_\beta = 4.18 \times 10^{-23}$. How many seconds does it take for Γ_u to change by a factor of 4.18×10^{-23}? In other words, what difference in the age of the universe produces a rate of time difference equal to the rate of time difference in an electron?

$A_\beta/\mathcal{H} = 4.18 \times 10^{-23}/2.29 \times 10^{-18}\ \text{s}^{-1} = 1.8 \times 10^{-5}$ second

Time's Arrow: The equations of physics seem to be reversible in time. Except for entropy, it appears as if it should be possible to go backwards in time. However, if the background Γ_u of the universe is increasing continuously and all matter is converting energy into vacuum energy, then it is not possible to go backwards in time. Yesterday all the rotars and photons in the universe had more energy than they possess today (measured on the scale of coordinate energy). Also, the lower background Γ_u of yesterday also affects many other things such as the units of force, velocity, voltage, etc. Even though the laws of physics are the same today and yesterday, all the components that makeup the universe are different. The universe is undergoing a transformation and this makes Time's arrow only point one direction – to the future.

Black Holes: *The following discussion of black holes is more speculative than the rest of this book. Therefore the following should be considered just a few preliminary thoughts about black holes.*

Do black holes have a different structure in a spacetime based universe than they would have if the universe is populated by point particles? So far the general relativity analysis of black holes has indirectly assumed the standard model of particles. With the point particle assumption, a black hole has an accretion disk, an event horizon, a volume inside the event horizon and finally a singularity at the center. This singularity supposedly has infinite energy density (the same as point particles). The volume inside the event horizon supposedly has modulation of the properties of spacetime that would require in excess of 100% depth of modulation of spacetime. Clearly these conditions cannot be achieved by the spacetime based model of the universe proposed here. The event horizon of a black hole supposedly has a rate of time that is stopped and a coordinate speed of light equal to zero. It is questionable whether a complete stoppage of the rate of time and stopping the propagation of light can be achieved by the wave-based model of hadrons and bosons proposed here.

If your model of a fundamental particle is a point particle with no physical size and no structure, then such a particle would be able to survive the plunge past the event horizon of a black hole. However, if we assume the rotar model of matter, then a preliminary analysis seems to indicate a different answer. As previously explained, a rotar is just a slight distortion of spacetime that has a specific frequency, rotar radius, and displacement amplitude. It seems as if a spacetime based explanation of the universe cannot form a true black hole event horizon. This is because such an event horizon would eliminate the waves in spacetime required for its formation. If a mass collapsed to a degree that the rate of time is slowed down by an enormous amount such as 10^{20} or more (compared to the comoving rate of time), then externally this would be indistinguishable from a conventional black hole. In this scenario, after a black hole forms, all additional mass/energy that falls towards the black hole adds to the orbiting accretion disk and never reaches an event horizon. The spacetime wave properties of rotars and photons would have to be taken into consideration in order to properly characterize the accretion disk that never quite reaches an event horizon. If hadrons and bosons never quite reach a true event horizon, then this would explain how it is possible for information about the black hole's charge, magnetic field, mass and rotational direction can be communicated to the rest of the universe outside of the black hole.

Like any gravitational capture, mass must shed some energy in order to be captured by a pseudo black hole. This sheading of energy is done by the emission of radiation and by the energy emitted by the polar jets associated with black holes. The energy that is captured can change its form but its gravitational effect remains constant. Recall the example previously given of a planet in a highly elliptical orbit around a star. The total gravitational effect of the combination of the star and the planet is constant even though the energy in the planet changes form. Similarly, a photon falling into a pseudo black hole would appear to be blue shifted if the photon could be observed locally in a region with a high gravitational gamma Γ. A rotar would gain kinetic energy to offset the loss of internal energy associated with a high Γ. In neither case does the energy pass an event horizon where contact with the outside universe would be lost.

The model of spacetime currently accepted is that the effects of curved spacetime can somehow transcend an event horizon. We can obviously accurately measure the mass, spin and charge of a black hole. These are examples of communication that appears to be coming from inside an event horizon. The spacetime based model of gravity requires waves in spacetime to produce a nonlinear interaction in spacetime. When the energy density of matter and radiation approaches the energy density that would require 100% modulation of the spacetime field then we are approaching the conditions of a black hole. However, the spacetime based model never actually reaches 100% modulation of spacetime. Time never quite stops compared to coordinate time and length never quite contracts to zero compared to coordinate length. The singularity associated with the conventional black hole requires energy density in excess of Planck energy density. This is usually "explained" by saying that "the laws of physics break down". The spacetime based model of the universe never requires that the laws of physics break down.

I visualize the volume near the center of a wave based black hole to be primarily photons that have been highly blue shifted relative to the local rate of time. Matter falling into the accretion disk will undergo highly energetic collisions. While new particles would be formed, repeated collisions and decompositions would eventually result in a high percentage of the energy being photons. Therefore, photon density would increase with depth. There would be no event horizon, but energy in the accretion disk would cause the gravitational gamma Γ to approach infinity. For example, suppose that this energy density achieves a rate of time that is 10^{20} times slower than the surrounding volume of the universe. This would look like a black hole, but information about charge, mass and rotational direction could still be communicated to the surrounding space.

The Spacetime Transformation Model Versus The Inflationary Model: In chapter 13 we performed several calculations to find the value of Γ_{uo}. However, the same data can be rearranged to support the contention that the proposed spacetime transformation model of the universe is correct and that there was not an inflationary phase. Here is the reasoning. When we calculate the change in scale factor starting from one unit of Planck time ($\sim 5 \times 10^{-44}$ s) and ending with 13.7 billion years, we obtained scaling factors of 2.1, 2.6, 2.95 and an upper limit of 3.4 (all $\times 10^{31}$). These numbers are approximately the same yet they were obtained from diverse sources such as the currently observable energy density of the universe, the observed CMB temperature and the CMB photon energy density.

Now we will reverse the thought process and extrapolate back in time to when the universe was 5×10^{-44} seconds old (1 unit of Planck time). Starting with the currently observable energy density, CMB temperature and CMB photon energy density of today's universe we always arrive at the properties of Planck spacetime using an average value of $\Gamma_{uo} \approx 2.6 \times 10^{31}$. This extrapolation makes the assumption that there was no inflationary phase in the expansion of the proper volume of the universe.

However, suppose that we include inflation in this backwards extrapolation. Between about 10^{-35} seconds and 10^{-32} seconds we have to deviate from the radiation dominated condition that scales with $\underline{\tau}_u^{1/2}$ and insert the inflationary exponential scaling factor. This inflation factor is unknown, but it is usually considered to be in excess of 10^{25}. At an age of 5×10^{-44} second, including inflation implies that the energy per photon exceeds Planck energy by a factor of at least 10^{25}. Similarly the implied temperature exceeds Planck temperature by more than 10^{25} and the implied energy density exceeds Planck energy density also by a similar factor. These are impossibilities according to the known laws of physics. Therefore physicists casually disregard this by saying that the laws of physics must "breakdown" under these conditions. Even the idea that the inflationary expansion greatly exceeded the speed of light requires a breakdown of the laws of physics.

There is no experimental proof that it is possible for the laws of physics to "breakdown". This is merely a term used when a particular theory gives an impossible answer according to the known laws of physics. Instead, when a theory requires a breakdown in the laws of physics, this should be a strong indication that the theory is wrong. The beauty of assuming that the universe is only spacetime is that there should be no cases where the theory needs to revert to saying that the laws of physics must breakdown in order to explain a particular implied result.

Cosmic inflation is an *ad hoc* solution required by a model of the universe that has point particles and forces carried by the exchange of virtual particles. If the universe is only spacetime, then it was only spacetime (the composite quantum mechanical and relativistic spacetime model) even at the beginning of the Big Bang. Extrapolating backwards from today results in the "Planck spacetime" homogeneous state. This is the highest observable energy density the spacetime field can support. The laws of physics never break down. For example, there are no singularities in this spacetime based model of the universe. All the steps are conceptually understandable and accessible to physicists today. Planck spacetime is as homogeneous as quantum mechanics allows, so there is no need for inflation to expand spacetime to achieve local homogeneity.

Unity and Entanglement Revisited: It was previously proposed that quantized waves in spacetime such as rotars and photons can have internal communication faster than the speed of light. This property also extends to communication between two entangled photons or rotars. No information can be imposed on this internal communication so there is no violation of the prohibition against faster than light communication. Still there is a question about how spacetime accomplishes the faster than speed of light internal communication. One possibility is that this internal communication might be taking place at the speed of light characteristic of

Planck spacetime. This speed would be about 2.6×10^{31} times faster than the proper speed of light. At this speed, internal communication within a photon distributed over one light year would only take about 10^{-24} second and a CMB photon generated 380,000 years after the Big Bang would collapse within about 10^{-14} seconds. The microwave photons that make up the CMB have a peak frequency of about 1.6×10^{11} Hz. Therefore a collapse with a time delay of about 10^{-14} s would meet the conditions of being virtually instantaneous. Perhaps the internal communication is actually instantaneous, but communication at 2.6×10^{31} times faster than c is indistinguishable from being instantaneous.

Are All Frames of Reference Really Equivalent? A basic assumption of relativity is that all frames of reference are equivalent. The CMB rest frame is clearly the preferred frame for cosmological purposes, but the laws of physics are presumed to work equally well in all frames of reference. Experimental observations have not detected any preference for frames of reference, but does this mean that ultra-relativistic frames relative to the CMB rest frame are equivalent? Recall that in chapters 4 and 11 the subject of the spectral energy density of zero point energy (quantized harmonic oscillators) was discussed. It was stated:

> "This spectrum with its ω^3 dependence of spectral energy density is unique in as much as motion through this spectral distribution does not produce a detectable Doppler shift. It is a Lorentz invariant random field. Any particular spectral component undergoes a Doppler shift, but other components compensate so that all components taken together do not exhibit a Doppler shift."

There is one problem with this concept. Vacuum fluctuations have a cutoff frequency equal to Planck frequency ω_p. If this cutoff frequency is symmetrical when viewed from the CMB rest frame, then there must be an ultra-relativistic frame of reference (relative to the CMB) where the asymmetry becomes obvious. An example will help to define this question. We can currently accelerate an electron to energy of 50 GeV. This is a relativistic Lorentz factor of $\gamma \approx 10^5$ relative to the CMB rest frame. However, a frame of reference with $\gamma = 10^5$ does not come close to testing the questions related to the limits of extreme ultra relativistic frames of reference. Imagine an electron with an ultra-relativistic speed with $\gamma \approx 2.4 \times 10^{22}$ as seen from the CMB rest frame. This is the Lorentz factor where the electron's de Broglie wavelength λ_d would be shorter than Planck length ($\lambda_d \approx \lambda_c/\gamma$ approximation valid when $\gamma >> 1$). This is very close to the speed of light but it does not equal the speed of light. Therefore, it is hypothetically a permitted frame of reference for an electron.

However, in the CMB rest frame the electron would have a de Broglie wavelength less than Planck length and de Broglie frequency exceeding Planck frequency. According to the premise of this book, spacetime is not capable of producing this wavelength and frequency. Also, in the electron's frame of reference there would be an extreme redshift in one direction of the dipole waves in spacetime required to stabilize the energy density (pressure) of the electron. This redshift would prevent the vacuum energy from exerting the pressure required to stabilize an electron in this frame of reference. If the universe is only spacetime, then this frame of reference is not permitted for an electron. Instability would appear as an electron approached the Planck length/frequency limit as seen from the CMB rest frame. The electron would exhibit properties in this ultra-relativistic frame of reference that the electron does not possess in the CMB rest frame. Other particles would exhibit unusual properties and instabilities at different ultra-relativistic frames relative to the CMB rest frame.

For another example, in chapter 9 we determined that photons are quantized waves propagating in the medium of the spacetime field. This implies that a photon is not permitted in any frame of reference which would appear to have a wavelength shorter than Planck length in the CMB rest frame. There is only one spacetime field for all frames of reference. This field is not capable of propagating waves shorter than the shortest wavelength wave in the field. The current record for the highest energy photon ever observed is a 12 TeV gamma ray ($\sim 2\times10^{-6}$ J) which has wavelength of about 10^{-19} m. This energy photon is permitted in our frame of reference, but it would not be permitted in any frame of reference which exceeded about $\gamma \approx 10^{16}$ relative to the CMB. The reason is that this photon would have a wavelength less than Planck length when viewed in the CMB rest frame and the energy would exceed Planck energy. This implies that the laws of physics change in these extreme frames of reference.

String theory is based on three starting assumptions which are expressed as mathematical equations. These are 1) Lorentz invariance, [the laws of physics are the same in all uniformly moving frames of reference] 2) analyticity [a smoothness criteria for the scattering of high energy particles after a collision] and 3) unitarity [all probabilities always add up to one]. The speed of light is the same in all uniformly moving frames of reference, but the laws of physics are not. Therefore the contention is that Lorentz invariance is not a valid assumption for all uniformly moving frames of reference. String theory incorporates this erroneous assumption and all the conclusions based on this assumption are questionable.

Lorentz Was Correct: Even though today we often assume that Einstein did not believe in the aether, he actually continued to refer to the aether or "physical space" until his death[2]. He merely declared that the aether must have relativistic properties with no preferred frame of reference. Lorentz also believed in the aether, but his calculations (Lorentz transformations) assumed that the aether had a preferred frame of reference. Lorentz transformations did not confer and detectable special properties to this preferred frame of reference since the transformations made the laws of physics the same in "all" frames of reference. However, Einstein and Lorentz disagreed about whether the aether had some special reference frame which served as the standard for all other reference frames.

[2] L. Kostro, *Einstein and the Ether*, (2,000) Apeiron, Montreal, Canada

The spacetime field can be thought of as a type of aether. Since all particles, forces and fields are made from this spacetime field, there is a conceptually understandable reason why experiments using currently technology cannot detect motion relative to the spacetime field. The particles and forces merely undergo the transformations required to achieve Lorentz invariance. However, Lorentz was correct. The spacetime field does have a preferred frame of reference. It is the CMB rest frame. No experiment capable of being performed using current technology would be able to experimentally prove this because it would require accelerating a particle to a speed where its de Broglie wavelength approaches Planck length. For example, an electron could be accelerated to a special relativity gamma of $\gamma = 2.4x10^{22}$ if the experiment is done in the CMB rest frame. The electron would then have $\lambda_c = L_p$. The electron's internal pressure would be equal to Planck pressure and the ability of the spacetime field to stabilize the internal pressure of the electron would be at its limit. All other frames of reference would not be able to achieve this value of γ because the electron would become unstable at a lower value of γ. Therefore, the spacetime field does have a preferred frame of reference, but it is currently undetectable.

The Fate of the Universe: The currently accepted model of the universe has mysterious dark energy becoming more dominant and accelerating the expansion of the universe until we lose sight of distant galaxies. In the most extreme extension of this process, a Big Rip eventually occurs when the expansion becomes so extreme that gravitationally bound objects such as galaxies and stars are dispersed by the expansion of space. Finally even atoms are ripped apart and the universe dies as subatomic particles are eventually converted to photons.

The model proposed here has not been developed sufficiently to have a clear prediction about the eventual fate of the universe. However, as previously explained, the near term (a few billion years) has distant galaxies getting dimmer but also the currently observed redshift of any particular distant galaxy will decrease. This counter intuitive prediction is actually a continuation of the process that has occurred throughout the history of the universe.

Over the longer term the spacetime transformation model of the universe offers an intriguing possibility. The total energy density of the universe (observable energy + vacuum energy) remains the same over the lifetime of the universe. Presently observable energy (including dark matter) represents only about 1 part in 10^{122} of the total energy in the universe. As previously explained, we only can observe and interact with waves in spacetime that possess quantized angular momentum (fermions and bosons). Furthermore, the fraction of the total energy that possesses angular momentum (10^{-122}) is dropping daily and the rate of change of $d\Gamma_u/d\tau_u$ appears to be accelerating.

If fundamental particles eventually decay into photons in the far distant future of the universe, then an intriguing possibility exists. When the quantized angular momentum of the photons becomes homogeneously distributed throughout the universe, then this condition of spacetime begins to look like Planck spacetime. The energy density is the same and the average distribution of the quantized angular momentum is the same. The major difference is that Planck spacetime has $\Gamma_u = 1$ and this final state of the universe has Γ_u approaching infinity.

Perhaps the energy in these photons becomes such a small fraction of the vacuum energy density of the universe that quantum mechanics allows the background gamma of the universe to round off to $\Gamma_u = \infty$. The rate of time would stop and the hybrid speed of light would stop. This is a discontinuity that would allow a rebirth of the universe. All that has to happen is that the background gamma of the universe has to change from $\Gamma_u = \infty$ to $\Gamma_u = 1$. No collapse is required because the universe is already at the required energy density. Also, the required quantized spin units would be preserved and evenly distributed. All that has to change is the rate of time and the spatial characteristics must revert back to the $\Gamma_u = 1$ condition. This would produce Planck spacetime and the universe would start a new cycle with a new "Big Bang".

Closing Thoughts: Einstein's greatest contributions to science happened when he combined insightful new assumptions with mathematical analysis. Later in his life he tended towards more advanced mathematical analysis of the same old assumptions and his contributions to science diminished. I see an analogy to all of physics. The greatest advances in physics occurred when insightful new assumptions were first introduced. This introduction of new ideas was followed by "golden ages" of physics. However, over time the pace of advancement slowed when the same assumptions were just mathematically analyzed in more detail. The objective of this book is to propose a series of new ideas based on the simplest starting assumption: The universe is only spacetime.

While working on the ideas contained in this book, there were times that I questioned whether I should be undertaking this large project. Was there really a conceptually understandable solution to a particular problem? Why should I be the one attempting to find this solution? At those times I thought about and received encouragement from the following quote by John Archibald Wheeler. Predicting a new revolution in physics, he said:

"And when it comes, will we not say to each other, Oh, how beautiful and simple it all is! How could we ever have missed it so long?"

–John Archibald Wheeler