Basic Concepts of the Dynamic Universe Theory

by Bob Day

Whenever a difficulty has been encountered with our theory of cosmology, it has always been resolved either by simply accepting it as an unexpected implication of the theory or by modifying the theory to accommodate the difficulty. For example, in the past decade or so evidence has accumulated that the universe seemingly is expanding at an accelerating rate. This discovery was unexpected and surprising. But it was accepted by the mainstream of cosmological physicists without a whole lot of debate. It was little questioned that there might be a problem with our model of the shape of the universe, which requires the actual data we obtained, the actual measurements we made, to be interpreted as an acceleration. Then, to explain the acceleration, Einstein's Theory of General Relativity was patched by re-introducing the "cosmological constant". The cosmological constant was an idea of Einstein's that he ultimately rejected as, he said, "the greatest blunder of my career".

Today, as we have done in the past, we are continuing along the road of adapting and patching our theories to accommodate new facts and results. In the past, this road has always come to an end. We have always come to a point where a theory has become so overburdened and unwieldy that it is obvious it is no longer tenable. It is not at all clear that we are approaching that point with our current cosmological theories. Perhaps the theories we have are, finally, "the perfect theories", which, at most, will just need a little bit of tweaking and adjusting of constants. But, just in case, it's always good to be thinking about fundamentally new ideas…

A new theory, called the Dynamic Universe theory (DU), has none of the difficulties that relativity has encountered. For example, in the DU there is no tradeoff between space and time; force is simply a force, not a "curvature in space"; and the expansion of the universe is decelerating, not accelerating. The DU was conceived by Dr. Tuomo Suntola (http://www.sci.fi/~suntola). In this essay, I will I try to explain the basics of Dr. Suntola's theory in a simple, easy to understand way, so that it will be accessible to those who have an interest in theories of the universe but don't have much background in physics or mathematics. The ideas presented in this essay are totally those of Dr. Suntola. I have added nothing. In the process of explaining his ideas, I hope I haven't done any serious damage to them. Any errors of course are mine.

Dr. Suntola shows that the Dynamic Universe theory unifies physics: The DU gives all of the results of general relativity, cosmology and electromagnetic theory, and is consistent with quantum electrodynamics. Here are some specific examples of phenomena that the DU models at least as well as general relativity:

- The tradeoff between mass and energy
- The rotation of the perihelion of mercury
- The bending of light around stars
- The slowing of clocks in a gravitational field
- The brightness vs. redshift of type Ia supernovae (In the DU, no assumption of an accelerating expansion of the universe is needed to model this.)

The goal of this essay is not to derive how the DU models all of these phenomena. It only goes as far as to show that the DU gives, as accurately as it's possible to measure, the same relationship of mass to energy as relativity does, and in doing that, to introduce the concepts upon which the DU is based. As good a theory as relativity is, it will be seen that it does not have exclusive dominion: the DU demonstrates that it is possible that other theories based on entirely different root concepts can explain the phenomena in our universe at least as well as relativity, and perhaps even better.

1. Assumptions and Definitions

a) The root idea that lies at the bottom of everything else in the Dynamic Universe theory is that our universe is the three dimensional surface of an expanding four dimensional sphere.

b) This essay begins with a time when the universe had a small radius in four dimensional space ("4-space") and when matter (mass) was spread evenly, homogeneously, over the surface of the 4-sphere (that is, in "3-space") in a very fine mist or dust. (Dr. Suntola goes back a little farther and explains the nature of matter much more deeply.) In this essay, 3-space, the space that we live in and perceive, will be referred to more simply as just "space". A direction perpendicular to space (in the direction of the radial expansion of the 4-sphere) will be referred to as the "imaginary" direction. Directions in space are along the surface of the 4-sphere and are called "real" directions. Thus, our space can also be referred to as "real space".

c) The surface of the 4-sphere is such that it constrains all matter that is on it from leaving it, and gravity acts strictly along the surface of the 4-sphere, never through it. This assumption makes sense because, as we actually observe, gravity decreases with the square of the distance as the distance from an object increases; if gravity acted in four dimensions, it would fall off as the cube of the distance. All matter is moving "outward", along the 4-radius, at exactly the speed of the expansion of space in the fourth dimension, (because it is confined to the surface of the 4-sphere).

d) The speed of expansion in the fourth dimension decreases over time, because gravitation between matter in space is constantly slowing the outward expansion of the 4-sphere.

e) A mass is "at rest" when it is not moving along the surface of the 4-sphere, only moving outward with the expansion of the 4-sphere. Because space is expanding, we perceive objects at rest to be separating at velocities approximately proportional to their distances from each other (Hubble's law).

f) There is a "zero energy balance" between the gravitational energy and the energy of mass at rest in space. That is, the sum of the (negative) gravitational energy and the energy of mass at rest is zero at all times. This sounds a little strange, but remember, mass at rest in space is moving with space outward at the speed of expansion in the fourth dimension. The energy of motion of a mass at rest will be referred to from now on as its "internal energy", and its momentum at rest as its "internal momentum". The zero energy balance applies not just to the total of all mass; it applies also to any individual mass object. Thus, for any given mass object, its internal energy is a conserved quantity.

g) An immediate consequence of the zero energy balance is that the speed of expansion in the fourth dimension defines the speed of light. In other words, the speed of light, c, is the speed of increase of the radius of the 4-sphere. (Dr. Suntola derives this result.)

h) In sharp distinction to relativity, the space and time dimensions are separate and independent of each other. Time is absolute and the same time scale applies throughout the universe. Time and space do not interact and there is no tradeoff between them. (Don't even think of applying the Lorentz transformation!)

i) We define the energy of an object to be the speed the expansion of space in the fourth dimension (i.e., the speed of light) times its momentum, in accord with the energy of electromagnetic radiation.

j) In the text that follows, R" denotes the current radius of the 4-sphere, and M" denotes the equivalent mass of the universe, the mass at the center of the 4-sphere that would be needed in order to have the same gravitational effect as the mass uniformly distributed over the surface of the 4-sphere. (For geometric reasons beyond the scope of this essay, but which Dr.

Suntola explains, M" is somewhat less than the sum of all mass in space.) The symbol "double prime" ("), denotes an imaginary quantity, a single prime (') denotes a real quantity, and an asterisk (*) denotes a complex number.

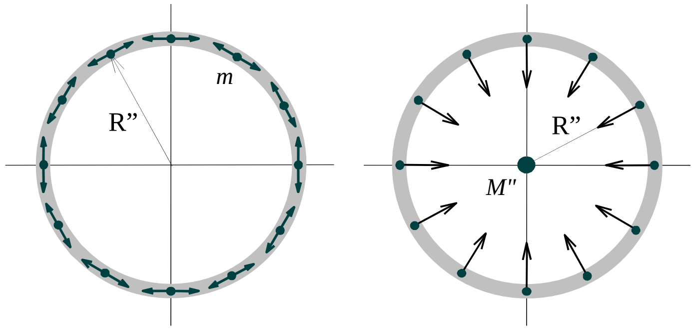

Figure 1. The tangential shrinking force due to the gravitation of uniformly distributed mass in space is equivalent to the gravitational effect of mass equivalence M” at the center of 4-space.

2. The Zero-energy Balance of Motion and Gravitation

One of the principal postulates of the DU is that there is a zero-energy balance between the energies of motion and gravitation. That is, the (positive) total energy of motion is at all times exactly equal and opposite to the (negative) total energy of gravitation. Consequently, the sum of the total energies of motion and gravitation is always zero. Let’s now explore the see how this balance is maintained.

2.1 The Hierarchy and Tilting of local spaces

Initially, as we have said, matter is spread out homogeneously over the surface of the 4-sphere, i.e., throughout space, as a mist of fine particles. And initially, there is no motion of the particles within space because every particle is pulled equally in all space directions by other particles. All matter is at rest in space. The only motion is the outward motion of the particles in the imaginary direction, away from the center of the 4-sphere. In addition, the only gravity is toward the center of the 4-sphere because the lateral forces between the particles over the surface of the 4-sphere, that is, in space, all cancel each other out, leaving only a resultant central force.

Picture a mass m, a small mass, at rest in homogeneous space. The only gravitational force on mass m is in the imaginary direction, toward the center of the 4-sphere, as shown Figure 2 (a).

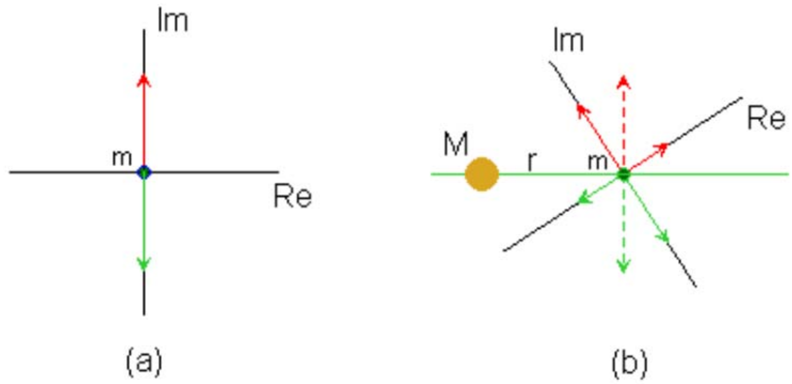

Figure 2. Illustrating the tilting of space by gravitation. The green vectors show the directions of gravitation; the red vectors show the directions of motion. (a) Initially, a mass m is moving vertically on the imaginary axis, away from the center of the 4-sphere. (b) The introduction of mass M in the vicinity of mass m causes space to tilt (see text). The vectors shown in dashes are the resultants of the vectors in tilted space. The dashed vectors have the same magnitude and direction as the ones in nontilted space.

Now let’s rearrange the matter in homogeneous space a little bit by creating a mass M by gathering up the particles in a spherical shell at a distance r from mass m. Let mass M be far larger than mass m, perhaps the size of the Moon, but far smaller than M”. Place mass M at a distance r from mass m. This divides M’’ into two masses, a negligibly reduced mass M''_r, whose force remains in the central direction and mass M, which exerts a lateral force on mass m that is perpendicular to the central force. The total gravitational force on mass m, $F''g_0$, has not changed, however, because none of the distances between mass m and any of the other particles has changed. But we’ve divided $F''g_0$ into two perpendicular vector components, $F'g_\phi$, which must be in the space direction because it runs between mass m and mass M in space, and $F''g_\phi$ which therefore must be in the imaginary direction because it is perpendicular to $F'g_0$.

The result of all this is that the presence of mass M causes the space around it to tilt! Here’s how: The vector components $F'g_\phi$ and $F''g_\phi$ must sum, vector-wise, to $F''g_0$, the original force on mass m in the original, imaginary, direction since, as we’ve said, the total gravitational force on mass m has not changed. Consequently, the space direction of mass m shifts, and its imaginary direction, which is always perpendicular to the space direction, shifts along with it. I.e., space tilts by an angle we will call ϕ. This is shown in Figure 2 (b).

The effect of this is to immediately give mass m a velocity in space. Not through any acceleration or change of force on mass m, but brought about only by the rotation of the coordinate system within which mass m resides.

The value of the angle by which the space around mass m is tilted is pretty easy to figure out, as well as other characteristics such as the speed of light in that space and mass m’s energy in space. The following equations refer to Figure 3.

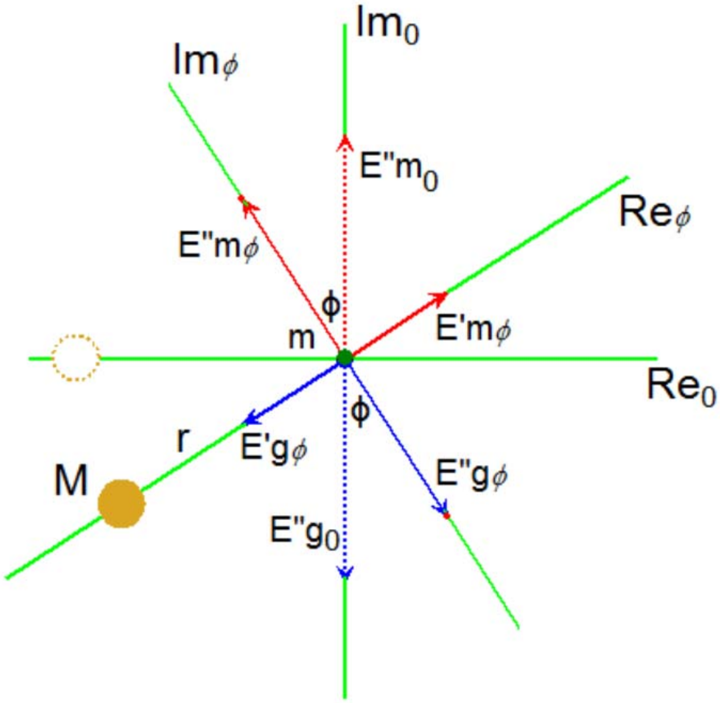

Figure 3. Showing the energy components of mass m in tilted space. The blue vectors show the directions of gravitation; the red vectors show the directions of motion. The tilt in space in the vicinity of mass m caused by the proximity of mass M, causes mass m to have energies, momentum, and velocity in space (real space, the space in our everyday experience). The vectors shown in dashes are the resultants of the vectors in tilted space. The dashed vectors have the same magnitude and direction as the ones in nontilted space.

The initial gravitational energy was all central:

$$E''g_0 = GM''m/R$$

Forming mass M reduced the central gravitational energy:

$$E''g_\phi = GM''m/R - GMm/r$$

and placing it at a distance r from m created a perpendicular lateral component of gravitational energy.

$$E'g_\phi = GMm/r$$

E"g_ϕ and E'g_ϕ are vector components in the tilted space of mass m whose sum, vector-wise, is E"g_0, the energy vector of mass m in untilted space. Consequently,

$$\phi = \arccos(E''g_\phi / E''g_0)$$

The speed of light is the speed of expansion of the universe in the imaginary direction. As a result of the tilt of the imaginary axis, the speed of light in space is reduced with respect to that in nontilted space:

$$c = c_0 \cos\phi$$

Due to the rotation of axes, the tilt gives mass m energy, momentum, and velocity in space.

This leads to the concept of gravitational frames. So far, mass m has been just a single object. But suppose mass m is made up of smaller masses. It then takes on a role similar to homogeneous space for the mass inside it, but with its real (space) and imaginary axes tilted with respect to homogeneous space. We say that mass m is a “frame” that is nested within the outer frame of homogeneous space. Being a “mass m” contained within a frame, it has a tilt, an energy, a momentum, and a velocity within that frame. But inside the “mass m frame” we don’t notice these things. You can think of a frame in the following way:

Suppose I'm driving in my car along a straight highway at 100 km/h. In the car are also some passengers, and everybody has their seat belt firmly fastened. The speedometer in the car is defective in a very weird way: it only measures speed perpendicular to the direction the car is pointing. So although the car is traveling at 100 km/h, the speedometer reads zero km/h. As it is traveling, the car encounters a very large patch of very slippery ice on the road (perhaps a nearby lake flooded and froze over the road). As it slides over the ice, the car slowly rotates 30 degrees on its axis, and then, because of the vagaries of ice, the car stops rotating but continues to slide on the ice at 100 km/h in its original direction. Because the car is now tilted at 30 degrees, its weird speedometer now reads 50 km/h (100*sin(30)), but that doesn’t affect the passengers at all – since they are firmly belted to their seats, they are all “at rest” with respect to one another.

The contents of the car – its passengers and everything else – can be thought of as a frame that takes on the role of a mass m. Before mass M is introduced, the passengers in the car are all at rest with respect to one another – they have no velocity, momentum, or kinetic energy inside the frame of the car. And that remains so after mass M is introduced and the frame of the car tilts and consequently takes on a velocity, momentum, and kinetic energy with respect to the axes of the tilted frame. But note that there has been no energy change in the objects in the contents of the frame. They have not been accelerated, and the resultant of their motions in their imaginary and real directions is not changed by tilting the axes of the car frame.

In the same way as the car frame is subsumed within an outer frame, a smaller frame could exist within the car frame. And in the DU that is how we conceive the structure of space – as a sequence of frames each subsuming the next, all nested inside one another like a Russian Matryoshka doll. The outermost frame is truly homogeneous space, the uniformly distributed fine mist of particles described earlier. The innermost frame is perhaps an atom, or even smaller. We proceed from homogeneous space to Super Cluster to Local Group to Milky Way galaxy to Solar System to Earth to atom. Of course, there may be more in the middle or at the ends. The frame we live in, the frame of our everyday experience, is the “surface of the earth frame”.

Within each frame, the laws of physics are the same. Each frame has a characteristic speed of light because as we proceed to successively to inner frames the speed of light in a frame is continually reduced due to the additional tilt of the frame. So we have to account for that and also for all quantities that contain the speed of light as a factor.

3. The Relationship between Mass and Energy

Now we’re ready to derive the relationship between mass and energy. We'll show that the equation we can derive from the assumptions of the Dynamic Universe theory is essentially the same as Einstein's equation. Relativity gives very good predictions of what we can actually observe, so if the DU theory holds any water, its predictions must be at least as accurate.

3.1 Velocity, Momentum and Energy in Space

So far, we have just considered objects at rest in space. As we have seen, an object that was at rest in its frame when its frame was untilted remains at rest in its frame when its frame becomes tilted. Although the object now has a velocity in the space of the outer frame, this velocity is invisible and unperceivable with respect to the objects inside the frame.

Consider an object, call it mass m again, that is not at rest in its frame. And to avoid the complications of further tilting, let it be in a constant gravitational field, for example on the surface of the earth. It got its velocity in one of the usual ways: something bumped into it, or it was pulled by a magnet. Maybe it was accelerated by radiation pressure. It doesn't matter how it got its velocity, but note that whatever causes an object to move, it all occurs in space; there is no action in an imaginary direction (in the fourth dimension). As an object moves in space, both components of its rest velocity remain constant. Its velocity, c, in the imaginary direction does not change, since space velocities are perpendicular to the imaginary direction. Its rest velocity in space doesn't change since it is set by the velocity in space of the frame within which it sits and is invisible to us. As a consequence, the rest velocity, internal momentum, and internal energy of mass m become conserved quantities.

We see that the space component of mass m's velocity has two parts: the invisible part, the space component of its rest velocity, and the visible part, the velocity it obtained via some kind of acceleration in space. To put the terminology in familiar terms, we use the term "kinetic" for the visible part of velocity in space. This applies to mass m's momentum and energy in space as well, so mass m's "kinetic energy" is the energy we're all familiar with.

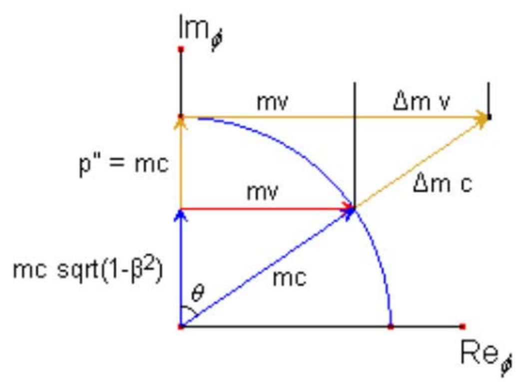

Figure 4. When an object, m, is accelerated in space, the momentum it acquires (mv) turns the imaginary rest momentum (mc) to the angle θ and becomes a portion of m's momentum in space. However, since space expands in the ϕ direction at the speed of light, c, m's velocity, and hence its momentum, mc, in the imaginary direction must be maintained. This requires a transfer of mass, Δm, from the accelerating object because mass is necessary to transport the energy that creates the momentum. (Note: the labels on the extended vectors refer to the entire length from the origin, not just to the extended portion.)

Let mass m be accelerated to a velocity v in space. When an object, m, is accelerated in space, the momentum it acquires (mv) turns the imaginary internal momentum (mc) to an angle θ and becomes a portion of m's momentum in space. However, since space expands in the ϕ direction at the speed of light, c, m's velocity, and hence its momentum, mc, in the imaginary direction must be maintained. This requires a transfer of mass, Δm, from the accelerating object because mass is always necessary to transport the energy that creates the momentum. Referring to Figure 4 below and letting β = v/c, we can write:

$$\tan\theta = \frac{(m+\Delta m)v}{mc} = \frac{mv}{mc\sqrt{1-\beta^2}}$$

Consequently, the momentum in space is

$$(m+\Delta m)v = \frac{mv}{\sqrt{1-\beta^2}}$$

The total momentum, the resultant of the imaginary and space momentums, is

$$p = \sqrt{(mc)^2 + ((m+\Delta m)v)^2}$$

Now, identifying m + Δm as the effective or relativistic mass, m_{eff} in Einstein's energy equation and multiplying p by c_0 to get energy, we have

$$E = c_0\sqrt{(mc)^2 + (m_{eff}v)^2}$$

And voila!! We have essentially Einstein's equation!

It is now easy to show that the DU definition of energy as the speed of light times an object's momentum (which has been assumed in the derivations in this essay) is consistent with everyday physics. The speed of light, c, in our local space is very close to c_0, and the velocities we normally encounter are far less than the speed of light, so we can write

$$E \approx c\sqrt{(mc)^2 + (mv)^2} = mc^2\sqrt{1+(v/c)^2} \approx mc^2(1+v^2/2c^2)$$

and finally

$$E \approx mc^2 + mv^2/2$$

This last form is Einstein's energy of rest mass (inherent in all mass) plus $mv^2/2$, the familiar approximation for kinetic energy of a moving object.

But we also have more! The rest energy of an object is its energy of motion in the imaginary direction of its frame. When an object is at rest in its frame, the magnitude of its rest energy is c_0mc. When an object starts in motion in its frame, its rest energy is reduced by the factor $\sqrt{1-\beta^2}$ (see Figure 4). Rest energy isn't just an abstract concept; it manifests itself in the real world. One manifestation is in the frequency of a moving clock. The ticking rate of a clock moving in a frame is proportional to its rest energy, and its rate when it is in motion is reduced by the factor $\sqrt{1-\beta^2}$ with respect to its rate at rest. Time does not flow slower for objects in motion but the rates of physical processes do.

Here are some Internet links to additional information about the Dynamic Universe theory:

Dr. Suntola's website: http://www.sci.fi/~suntola/

Dr. Suntola's book on the Dynamic Universe theory (available from Amazon):
http://www.amazon.com/Dynamic-Universe-Unified-Picture-Physical/dp/9526723600/ref=sr_1_2?ie=UTF8&s=books&qid=1247406456&sr=1-2

Introduction to Dr. Suntola's book on the DU (a 40 page free download):
http://www.physicsfoundations.org/society/DU_2009/book.html

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