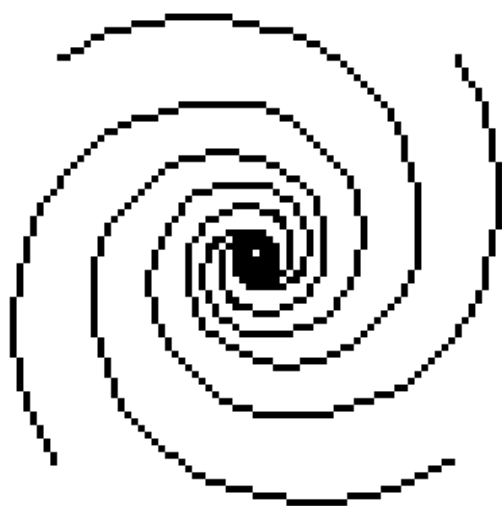


# The Spiral Universe



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## Abstract

We solve the riddle of the spiral shape and flat rotation curves of galaxies, prevalence of dark matter in galaxy dynamics and the source, uniformity and Planck satellite anomaly of the cosmic microwave background.

Wiki calls these “unsolved problems of physics.” They are shown to be a consequence of this model of the dynamic universe. The age, radius, mass, expansion rate and density of the universe also come from this model and are unambiguously shown to apply to a black hole and are in the range or magnitude of mainstream values frequently quoted.

This paper postulates that light will orbit any great enough mass. The mass which light orbits is a black hole. We know that gravity deflects light from numerous cases of gravitational lensing so it is not too big a step to see that a deflection of light with one mass could become an orbit of light with the much greater mass of the Cosmos.

This simple classical model, of energy and light in orbit, shows the black hole, galaxy and the Cosmos in dynamic equilibrium.

There are no infinities, singularities or free parameters which might be adjusted to reflect a point of view. “The positive evidence in favor of the theory depends upon ‘parsimony’: an economy of assumptions. A good theory is one that needs to postulate little to explain a lot. [1]”

## Key Words

Spiral universe, orbiting light or energy, black holes, expanding and rotating universe, gravity, dark matter, cosmic microwave background, unsolved problems in physics, black hole universe, black hole formulas

## Authors Note

This document was written with Latex <http://latex-project.org/ftp.html> and TexStudio <http://texstudio.sourceforge.net/>, both of which are excellent, open-source and free. The PDF pages it produces can be read in two page view and printed two pages at a time in landscape to save paper or make a book.

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# 1 Hubble (age, radius, radial velocity)

Edwin Hubble [2] determined from the linear doppler redshift of galaxies that they are receding at a rate proportional to distance. It is called doppler because of the familiar frequency shift of sound with the velocity of the sound source. Here the frequency shift is in the light toward the red with increasing velocity of recession. The velocity of recession at a certain distance divided by that distance is a constant. In our examples:

$$\text{Hubble's constant} = H_0 = \frac{\text{velocity}}{\text{distance}} = 65 \frac{\text{km}}{\text{s} \cdot \text{Mpc}} =$$

Kilometers per second per million parsecs, in smaller units this is:

$$H_0 = \frac{\text{velocity}}{\text{distance}} = \frac{m}{s} \text{ per meter} = 2.11E-18 \frac{1}{s} \quad (1.1)$$

Meters per second per meter equals one over seconds.

Using these smaller more familiar units may lead you to wonder if the expansion is also local. Does the Hubble expansion extend to the galaxy, to the solar system and to atoms? How do you measure expansion if you expand at the same rate? If the local expansion exists, was it missed because the size of the expansion is so small? Hubble's constant has units of 1/seconds which is frequency, angular velocity or 1/age. The reciprocal of Hubble's constant is:

$$\frac{1}{H_0} = 4.74E17 \cdot s = 15 \cdot \text{billion} \cdot \text{years} = \text{age} \quad (1.2)$$

We will use 15 billion years as the age in our examples. Hereafter, called the age of the Cosmos [3]. Hubble's constant can be written:

$$H_0 = \frac{1}{\text{age}} = \frac{c}{c \cdot \text{age}} = \frac{c}{15 \cdot \text{billion} \cdot \text{light years}} \quad (1.3)$$

This implies that the Cosmos, our dynamic unit which is a subset of the Universe, is expanding at the speed of light at its current perimeter,

$$r = c \cdot \text{age} = 15 \cdot \text{billion} \cdot \text{light years} = 1.42E26 \cdot m \quad (1.4)$$

the current radius of the Cosmos [4]. This paper does not require space-time, the expansion of the vacuum of space or inflation so the radius is the radius.

Hubble decreases with age, the radius increases with age but the radial velocity of expansion,  $v_r$ , is constant at  $c$ , with distance divided by age at the perimeter of the Cosmos.

$$v_r = \frac{\text{radial distance}}{\text{travel time}} = \frac{r}{\text{age}} = \frac{c \cdot \text{age}}{\text{age}} = c \quad (1.5)$$

This is age, radius and radial velocity based on the expansion rate, not an affirmation of a creation event 15 billion years ago.

### Vary Hubble's Constant

$$\begin{aligned} 130 \frac{km}{s \cdot Mpc} &= \frac{1}{7.5 \cdot \text{billion} \cdot \text{years}} = 2 \cdot H_0 \\ 70.4 \frac{km}{s \cdot Mpc} &= \frac{1}{13.89 \cdot \text{billion} \cdot \text{years}} = H_0 \text{ per WMAP satellite} \\ 67.15 \frac{km}{s \cdot Mpc} &= \frac{1}{14.56 \cdot \text{billion} \cdot \text{years}} = H_0 \text{ per Planck satellite} \\ 65 \frac{km}{s \cdot Mpc} &= \frac{1}{15 \cdot \text{billion} \cdot \text{years}} = H_0 \text{ per our examples} \\ 32.5 \frac{km}{s \cdot Mpc} &= \frac{1}{30 \cdot \text{billion} \cdot \text{years}} = \frac{H_0}{2} \\ 16.25 \frac{km}{s \cdot Mpc} &= \frac{1}{60 \cdot \text{billion} \cdot \text{years}} = \frac{H_0}{4} \end{aligned} \quad (1.6)$$

This suggests that at earlier times, Hubble's constant was bigger and the Cosmos was smaller. It is likely that some part of the Hubble constant is due to non-doppler redshift [7].

If half of Hubble's constant is due to non-doppler redshift then the doppler portion is  $32.5 \frac{km}{s \cdot Mpc}$  and the age is 30 billion years not 15 billion years.

The calculated age, mass and radius of the Cosmos increases with the decrease in the doppler portion of the redshift. Therefore, if all the redshift were non-doppler, the Cosmos would be infinitely old and massive.

## 2 The Cosmos rotates and expands

The Cosmos is expanding and rotating, which produces the spiral, in figure (1). See the animation at [13]. Each circle is a cross section of the Cosmos at a different time. Observers would look out in any direction and see the Cosmos expanding faster at greater distances.

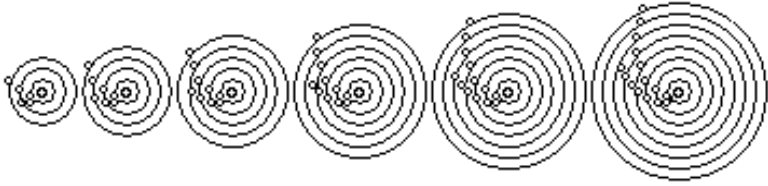


Figure 1: Expanding and rotating Cosmos

This is a Hubble expansion. Light orbits and has a radial velocity of  $c$ , at the perimeter of the Cosmos. As the Cosmos increases in size, light orbits farther out, the period increases so the rotation slows down. The rotational period is:

$$p = 2\pi \cdot r/v_t = 2\pi \cdot v_r \cdot age/v_t = 2\pi \cdot c \cdot age/c = 2\pi \cdot age \quad (2.1)$$

The Cosmos is rotating and blowing up like a balloon but very

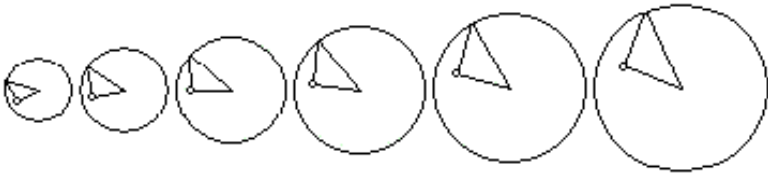


Figure 2: Triangular cosmic definitions

slowly in relation to its size as shown in figure (2). See the animation at [14]. Like a spinning ice skater slows her spin by extending her arms, the spinning universe slows in its rotation while expanding. We rotate with respect to that which is very far away and is outside our dynamic unit Cosmos.

The totality of everything is called the Universe. The part of the Universe which we can hope to understand is here called the Cosmos, a subset of the Universe or multi-verse. Some might call the Cosmos the visible Universe.

The triangles show the way it expands and rotates. The length of the hypotenuse of the triangle is the velocity of light times the age of the Cosmos, at that particular time, or  $r = c \cdot age$ . The hypotenuse expands and has a radial and tangent velocity, at the perimeter, of the speed of light,  $v = c$ . The base of the triangle expands and rotates at its fixed fraction of the Cosmos. This fraction,  $fr$ , is the cosine of the triangle. The circled point on the base of the triangle is where we might be located. The location stays at the same constant fraction,  $fr$ , of the radius of the Cosmos



$r = \text{fr} \cdot c \cdot \text{age}$ . The constant velocity is:

$v = \text{fr} \cdot c$ . Here fr at the location is .7 and the velocity is:

$v = \text{fr} \cdot c = .7 \cdot c$ .

This is a Hubble expanding Cosmos. Every location within this Cosmos has a constant tangent and radial velocity which are proportional to its radius. Since the velocity is constant, the acceleration is zero and no force and no power is required for it to continue on its journey. A location spirals out as the Cosmos expands and slows in its rotation.

### 3 The Virial theorem

says; “the kinetic energy equals half the gravitational potential energy” [5] or [6].

$$.5 \cdot m \cdot v_t^2 = \frac{.5 \cdot G \cdot m \cdot M}{r} \dots \text{the virial theorem} \dots \quad (3.1)$$

We have mass in orbit, in the Cosmos, with a tangent velocity,  $v_t$ , and in an expanding Cosmos moving with a radial velocity,  $v_r$ . There are no velocity changes, which would be accelerations, to produce forces. We have tangent and radial velocity and kinetic energy. Kinetic energy uses,  $v_t^2$  or  $v_r^2$ . Multiply by  $2/r$ :

$$\frac{m \cdot v_t^2}{r} = \frac{G \cdot m \cdot M}{r^2} \text{ centrifugal force} = \text{gravitational force} \quad (3.2)$$

In orbiting systems, centrifugal force equals gravitational force. Center fleeing centrifugal force equals center seeking centripetal force. If the centrifugal force is stronger the bodies drift apart. If the gravitational force is stronger the bodies drift together. The average forces must be equal for the orbits to endure.

This is just another way of writing Kepler’s third law.  $v_t$  is the tangent orbital velocity. M and m are masses, in orbit with each other, with the radius r between them. G is the gravitational constant. Multiply by  $\frac{r}{m}$ , yielding the virial theorem:

$$v_t^2 \cdot r = G \cdot M \text{ or } v_r^2 \cdot r = G \cdot M \dots \text{the virial theorem} \dots \quad (3.3)$$

It works just as well with electric forces.

### 4 Kepler’s third law

The period of a circular orbit is p.

$$p = \frac{2\pi r}{v_t} \dots \text{therefore} \dots v_t^2 = \frac{4\pi^2 r^2}{p^2}$$

Substitute for  $v_t^2$  in equation (3.3)

$$\frac{4\pi^2 r^2}{p^2} = \frac{GM}{r} \quad (4.1)$$

and collect terms.

$$4\pi^2 r^3 = p^2 GM \quad (4.2)$$

The cube of the radius is proportional to the square of the period. This is Kepler's third law but we will usually use it in the centrifugal force equals the gravitational force form. This equation and the idea of conservation of energy are both indubitably correct and are central to our arguments.

## 5 Light in orbit

$$\frac{m \cdot v_t^2}{r} = \frac{G \cdot m \cdot M}{r^2} \quad \text{centrifugal force} = \text{gravitational force} \quad (3.2)$$

Starting again from, the centrifugal force equals the gravitational force equation (3.2):

Substitute for the tangent velocity  $v_t = c$ .

Now the orbital velocity is  $c$  and light can orbit at the radius of the Cosmos at  $r = c \cdot \text{age}$  where the Cosmos is expanding at the radial velocity,  $v_r = c$ :

$$\frac{m \cdot c^2}{r} = \frac{G \cdot m \cdot M}{r^2} \quad (5.1)$$

We know that gravity deflects light from numerous cases of gravitational lensing. It is almost trivial to postulate that a deflection of light with one mass could become an orbit of light with a much greater mass. This shows Newtonian gravity, not warped space time, keeping light in orbit and causing gravitational lensing. Multiply by  $r$ :

The orbiting rest energy now equals the gravitational energy:

$$m \cdot c^2 = \frac{G \cdot m \cdot M}{r} \quad \text{rest energy} = \text{gravitational energy} \quad (5.2)$$

The orbital velocity is  $c$  where light and energy orbit at the specific radius,  $r = c \cdot \text{age}$ .

Light might follow a circular orbital path, a bent path as in gravitational lensing or a spiral path with a decreasing gravitational force where everything spirals out as the gravitational force decreases with age. How can the gravitational force decrease with age if  $G = gk \cdot \text{age}$  increases with age?

## Gravitational force

decreases with age as follows:

$$force = \frac{G \cdot m \cdot M}{r^2} = \frac{gk \cdot age \cdot m \cdot M}{v_r^2 \cdot age^2} = \frac{gk \cdot m \cdot M}{v_r^2 \cdot age} \quad (5.3)$$

The gravitational force decreases because the *age* in the numerator is canceled by the  $age^2$  in the denominator.

## Gravitational energy

remains the same with age as the Cosmos expands:

$$m \cdot c^2 = \frac{G \cdot m \cdot M}{r} = \frac{gk \cdot age \cdot m \cdot M}{v_r \cdot age} = \frac{gk \cdot m \cdot M}{v_r} \quad (5.4)$$

The gravitational energy stays the same because the age cancels.

Light could form a spherical region or shell where light orbits. Any mass or energy inside the shell would contribute to the total mass increasing the radius of the shell. Light could form an empty shell with energy confined to the shell since light has energy and consequently mass. An empty shell of a black hole with only orbiting light or energy does requires some thought. See the section (10) on Geons .

Multiply by  $r/m$ . These three equations (6.1) to (6.3) are our definitions of a black hole.

## 6 Orbiting light black holes

$$c^2 \cdot r = G \cdot M \dots \dots \dots \text{black hole definition} \dots \dots \dots \quad (6.1)$$

Compare this with:

$$v^2 \cdot r = G \cdot M \dots \dots \dots \text{from the virial theorem} \dots \dots \dots \quad (3.3)$$

$$\frac{c^2 \cdot r}{G \cdot M} = 1 \dots \dots \dots \text{black hole definition} \dots \dots \dots \quad (6.2)$$

And our final black hole definition:

$$\frac{M}{r} = \frac{c^2}{G} = 1.35E27 \frac{kg}{m} = \frac{mass}{radius} \cdot ratio \dots \dots \dots \quad (6.3)$$

The current value of the mass per radius ratio. The ratio decreases with time. The mass stays the same but the radius;  $r = v_r \cdot age$

increases with age.  $G = gk \cdot \text{age}$ ; the gravitational constant also increases with age. We might call these Newtonian black holes.

Black hole mass is  $1.35E27 \frac{kg}{meter}$  currently. This is a solar mass every 1476 meters. A ten solar mass black hole would have a radius of 14760 meters. This is mass = r time a ratio because  $M/r = kg/m$ , a ratio. One might, in error here, expect mass proportional to  $r^3$  as in volume.

## 7 Variable G

$$c^2 \cdot r = G \cdot M \dots \text{Our black hole definition from } \dots \quad (6.1)$$

Here we take c and M to be constants. If r is a variable and increases with age, as it must as it expands, since  $r = v_r \cdot \text{age}$  or  $r = c \cdot \text{age}$ , then G is a variable and must increase with age. This can be written  $G = gk \cdot \text{age}$ . gk is the increase in the gravitational constant per second as seen below.

$$\frac{c^2 \cdot r}{M} = G \text{ or } \frac{c^2 \cdot v_r \cdot \text{age}}{M} = G \text{ or } \frac{c^2 \cdot c \cdot \text{age}}{M} = gk \cdot \text{age or } \frac{c^3}{M} = gk$$

If G and r are both proportional to age then the orbiting and gravitational energy are constant with expansion including cosmic expansion. Energy is conserved.

$$gk = \frac{gk \cdot \text{age}}{\text{age}} = \frac{G}{\text{age}} = G \cdot H_0 = 1.41E-28 \frac{m^3}{kg \cdot s^3} \quad (7.1)$$

gk appears to vary with mass, and is constant only while the mass of the Cosmos stays constant, in contrast to  $H_o$  which is Hubble's variable constant and G which is the variable gravitational constant.

You may have noticed that G has a value of about 1/15 billion.

$$G = 6.673E-11 \frac{m^3}{kg \cdot s^2} \approx \frac{1}{15 \cdot \text{billion}} \frac{m^3}{kg \cdot s^2} \quad (7.2)$$

$G = gk \cdot \text{age}$ , increases by a small amount every year.

$$\frac{\Delta G}{\text{year}} \approx \frac{1}{15 \cdot \text{billion}} - \frac{1}{15 \cdot \text{billion} + 1} = 4.5E-21 \frac{m^3}{kg \cdot s^3} \quad (7.3)$$

Per second:

$$\frac{\Delta G}{\text{second}} = gk = \frac{c^3 \cdot s}{M_c \cdot s} = 1.41E-28 \frac{m^3}{kg \cdot s^3} \quad (7.4)$$

Per year:

$$\frac{\Delta G}{\text{year}} = \frac{c^3 \cdot 31.5E6 \cdot s}{M_c \cdot \text{year}} = 4.44E-21 \frac{m^3}{kg \cdot s^3} \quad (7.5)$$

In age:

$$G = gk \cdot \text{age} = \frac{c^3 \cdot 4.73E17 \cdot s}{M_c} = 6.673E-11 \frac{m^3}{kg \cdot s^2} \quad (7.6)$$

How do we detect such a small ongoing increase in the gravitational constant? Do the ancient stars, galaxies and supernova look different?

$$M_c \cdot gk = c^3 \quad \text{or} \quad gk = \frac{c^3}{M_c} \quad \text{or} \quad G = \frac{c^3}{M_c} \cdot \text{age} \quad (7.7)$$

As the  $M_c = \text{the mass of the Cosmos}$  goes up the  $gk$  goes down when  $c$  is a constant.  $G = gk \cdot \text{age}$  so as the mass goes up  $G$  and gravitational forces go down. If the mass of the Cosmos ' $M_c$ ' has increased over time, through merging with other masses, then the gravitational 'constant'  $G$  would have decreased with every increase in mass while also increasing with age.

## 8 Mass of the Cosmos

$$c^2 \cdot r = G \cdot M \dots \text{Our black hole definition from} \dots \quad (6.1)$$

Expand with  $r = v_r \cdot \text{age}$  and  $G = gk \cdot \text{age}$ :

$$c^2 \cdot v_r \cdot \text{age} = gk \cdot \text{age} \cdot M \quad (8.1)$$

Multiply by  $1/\text{age}$ .

$$c^2 \cdot v_r = gk \cdot M \quad \text{so} :$$

$$v_r = M \frac{gk}{c^2} \quad \text{or} \quad M = v_r \frac{c^2}{gk}. \quad \text{When } v_r = c \text{ then} : \quad (8.2)$$

$$M_c = \frac{c^3}{gk} = 1.91E53 \cdot kg, \text{ the mass of the Cosmos [11]} \quad (8.3)$$

6E56 g or 6E53 kg according to Ciufolini and Wheeler [12]. If mass is due to gravity rather than gravity due to mass, would it explain rest energy equals gravitational energy in equation (5.4)? Gravity is likely due to the dynamic charge of electrons and protons on their elliptical orbits in atoms. Therefore, mass is also likely due to charge. See Electric Gravity [17]

## 9 Expanding black holes

$$r = v_r \cdot age = c \cdot age = \frac{M \cdot G}{c^2} \text{ so} \quad (9.1)$$

$$G = \frac{c^3 \cdot age}{M_c} \text{ or } M_c = \frac{c^3 \cdot age}{G} \text{ or } M_c \cdot G = c^3 \cdot age \quad (9.2)$$

If  $r = v_r \cdot age$  increases with age, as it must in an expanding Cosmos, then  $G = \frac{c^3 \cdot age}{M_c}$  must also increase with age.  $M$  is the mass of any black hole.  $M_c$  is the mass of the Cosmos. Mass and  $c$  are constants.  $v_r$  is the constant radial velocity of expansion at its perimeter.

$$v_r \cdot age = \frac{M \cdot c^3 \cdot age}{M_c \cdot c^2} \quad (9.3)$$

Substitute for  $r = v_r \cdot age$  and  $G = \frac{c^3 \cdot age}{M_c}$ . The age cancels.

$$v_r = \frac{M \cdot c}{M_c} = M \cdot c \frac{G}{c^3 \cdot age} = M \frac{gk \cdot age}{c^2 \cdot age} = M \frac{gk}{c^2} \quad (9.4)$$

As the mass,  $M$ , goes up the radial velocity,  $v_r$ , goes up.

$$\frac{v_r}{c} = \frac{M}{M_c} \quad (9.5)$$

The radial velocities and masses are ratios. The radial velocity of expansion is constant and proportional to mass.

### Black hole mass and radial velocity

$$v_r = M \frac{gk}{c^2} = M \cdot 1.568E^{-45} \frac{m}{s \cdot kg} \quad (9.6)$$

$$Ten \cdot solar \ masses = 1.99E31 \cdot kg \text{ so } v_r = 3.12E^{-14} \frac{m}{s} \quad (9.7)$$

$$A \ billion \cdot solar \ masses = 1.99E39 \cdot kg \text{ so } v_r = 3.12E^{-6} \frac{m}{s}$$

$$\text{and expands at } 98 \frac{m}{year}. \quad (9.8)$$

$$9.61E22 \cdot solar \ masses = \text{the mass of the Cosmos} = M_c$$

$$\text{and } 1.91E53 \cdot \text{kg so } v_r = 299792458 \frac{m}{s} = c \quad (9.9)$$

Black holes expand in proportion to their mass. The radius of the Cosmos expands at the speed of light,  $c$ , or 1 light year per year, because it has enough mass for it to expand at  $c$ . This proportionally small expansion is one year in the age of the Cosmos or one part in 15 billion per year.

## Dark energy

If our Cosmos reached its current mass by merging with other masses, as I suspect, then at earlier times it would have had a radial velocity ‘ $v_r$ ’ less than  $c$ . Each merging would have increased its mass and radial velocity.

One might say that its radial velocity of expansion ‘ $v_r$ ’ is accelerating, with each increment in mass, in keeping with the theory of ‘dark energy’.

## 10 Geons

In 1955, John Archibald Wheeler found an interesting way to treat the concept of body in general relativity which he called Geons [9].

“An object can, in principle, be constructed out of gravitational radiation or electromagnetic radiation, or a mixture of the two, and may hold itself together by its own gravitational attraction. The gravitational acceleration needed to hold the radiation in a circular orbit of radius  $r$  is of the order of  $\frac{c^2}{r}$ . The acceleration available from the gravitational pull of a concentration of radiant energy of mass  $M$  is of the order  $\frac{GM}{r^2}$ . The two accelerations agree in order of magnitude when ...”

$$\frac{c^2}{r} = \frac{G \cdot M}{r^2} \text{ or } c^2 \cdot r = G \cdot M \dots \text{from equation} \dots (6.1)$$

“... A collection of radiation held together in this way is called a geon (gravitational electromagnetic entity) and is a purely a classical object. ... Studied from a distance, such an object presents the same kind of gravitational attraction as any other mass... A geon made of pure gravitational radiation a ... gravitational geon ... owes its existence to a localized – but everywhere regular – curvature of spacetime, and to nothing

more. In brief, a geon is a collection of electromagnetic or gravitational wave energy, or a mixture of the two, held together by its own gravitational attraction, that describes mass without mass. [10]”

Wheeler gave the name to the “black hole” in 1967. Curious that he did not use the formula he gave to geons in 1955 and apply it to black holes.

## 11 Orbital forces decrease with time

The orbital centrifugal and gravitational forces are:

$$\frac{m \cdot v_t^2}{r} = \frac{G \cdot m \cdot M}{r^2} \dots \dots \dots \text{from equation} \dots \dots \dots (3.2)$$

Substitute for  $v_t = c$ ,  $r = c \cdot \text{age}$ ,  $G = gk \cdot \text{age}$  and  $M = M_c = c^3 / gk$ .

$$\frac{m \cdot c^2}{c \cdot \text{age}} = \frac{gk \cdot \text{age} \cdot m \cdot c^3}{(c \cdot \text{age})^2 \cdot gk} \tag{11.1}$$

Collect terms.

$$\frac{m \cdot c}{\text{age}} = \frac{m \cdot c}{\text{age}} \tag{11.2}$$

The centrifugal and gravitational forces are equal and decrease with age. The forces were much stronger in the past. The stars burned brighter. The hotter star in a binary pair shows more redshift [7]. Light from a distant earlier time has a greater redshift.

How does this affect Hubble’s constant and distance calculations?

Star formation, accretion and fusion rates would have been much faster with the stronger forces in the past. The standard candle, Type 1A supernovas, would have been affected.

What does this do to the accelerating universe dark energy theory?

## 12 Orbiting Light Black holes

$$\text{mass of a black hole} = \frac{c^2 \cdot r}{G} = \frac{c^2 \cdot v_r \cdot \text{age}}{gk \cdot \text{age}} = \frac{c^2 \cdot v_r}{gk} \tag{12.1}$$

$$\text{mass of the Cosmos} = \frac{c^2 \cdot r}{G} = \frac{c^2 \cdot c \cdot \text{age}}{gk \cdot \text{age}} = \frac{c^3}{gk} \tag{12.2}$$



$$\text{radius of a black hole} = \frac{\text{mass} \cdot G}{c^2} = v_r \cdot \text{age} \quad (12.3)$$

$$\text{radius of the Cosmos} = \frac{c^3}{gk} \frac{gk \cdot \text{age}}{c^2} = c \cdot \text{age} \quad (12.4)$$

$$\text{surface area} = \frac{4\pi \cdot \text{mass}^2 \cdot G^2}{c^4} = 4\pi \cdot c^2 \cdot \text{age}^2 \quad (12.5)$$

$$\text{density} = \frac{\text{mass}}{\text{volume}} = \frac{3 \cdot \text{mass}}{4\pi \cdot r^3} = \frac{3 \cdot c^2}{4\pi \cdot r^2 \cdot G} = \frac{3 \cdot c^6}{4\pi \cdot \text{mass}^2 \cdot G^3}$$

Substituted for  $r = \frac{\text{mass} \cdot G}{c^2}$  or  $\text{mass} = \frac{c^2 r}{G}$ .

$$\frac{3}{4\pi \cdot gk \cdot \text{age}^3} = 1.6E-26 \frac{kg}{m^3} = 1.6E-29 \frac{g}{cm^3} \quad (12.6)$$

The lowest density black hole is our Cosmos. The mass of a proton or hydrogen atom is 1.67E-27 kg so the average density of the Cosmos [19] is about ten protons per cubic meter and is decreasing with the cube of the age of the Cosmos.

### 13 Black hole density and radius

$$\text{density} = \frac{\text{mass}}{\text{volume}} = \frac{3 \cdot c^2}{4\pi \cdot r^2 \cdot G} = \frac{3 \cdot c^6}{4\pi \cdot \text{mass}^2 \cdot G^3} \quad (13.1)$$

Notice the  $\text{mass}^2$  and  $r^2$  in the denominator. Ten times mass or r equals density divided by 100.

$$\text{radius of a black hole} = \frac{\text{mass} \cdot G}{c^2} = v_r \cdot \text{age} \quad (13.2)$$

Density goes up as mass goes down.

$$20 \text{ solar mass black hole} = 3.68E17 \frac{kg}{m^3} \text{ and } r = 29531 \cdot m \quad (13.3)$$

Half the mass equals four times the density

$$10 \text{ solar mass black hole} = 1.47E18 \frac{kg}{m^3} \text{ and } r = 14765 \cdot m \quad (13.4)$$

Half the mass equals four times the density

$$5 \text{ solar mass black hole} = 5.9E18 \frac{kg}{m^3} \text{ and } r = 7383 \cdot m \quad (13.5)$$

Nuclear density =  $1 \cdot 10E21 = 1E21 \frac{kg}{m^3}$ :

$$0.222 \text{ solar mass black hole} = 1E21 \frac{kg}{m^3} \text{ and } r = 472 \cdot m \quad (13.6)$$

Below this, with decreasing radius or mass, the black hole exceeds nuclear density, an unlikely event. The, calculated not actual, density approaches infinity as the radius or mass approaches zero.

## 14 Black holes without infinities

x-ray bursters cluster around 1.4 solar masses =  $2.8E30 \cdot kg$  [22], and radius [23] of  $9600 - 11000 \cdot m$  which yields,

$$x\text{-ray burster density} \approx 5.0E17 \frac{kg}{m^3} \text{ to } 7.6E17 \frac{kg}{m^3} \quad (14.1)$$

As mass accretes in a binary star system, from a companion star, onto the x-ray burster star, it reaches a point, where the added mass explodes in a fusion explosion called a type 1A super nova. This limits the mass of the star which is then ready for more accretion. Apparently, they do not become black holes by this route of accretion and fusion explosions. The collapse or merger of large stars does provide a route for black hole creation.

It would not be surprising if black holes start their life above nuclear density. Black hole density decreases with mass and radius *not* increases. As black holes get bigger their density decreases. The lowest density black hole is our Cosmos.

## 15 Merging black holes

*A short fable about eggland:*

*In eggland, two eggs touch. Their shells merge much like soap bubbles merge to make a larger soap bubble. Their contents merge. Where there was two eggs, there is now one larger egg with two yokes.*

*Over time, there is a very big egg with many crowded yokes.*

*The yokels being unaware of the mechanics of merging make up odd stories about their creation and their importance to the creator.*

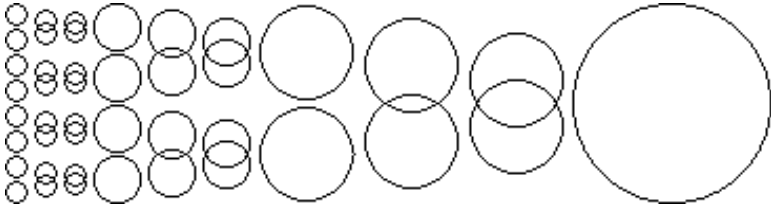


Figure 3: Merging black holes

Looking at figure (3). Visualize two soap bubbles or black holes that overlap, their contents merge, thereafter being enclosed by a single larger sphere, of their combined diameters.

Little ones merge to make big ones.

The light and energy that previously orbited around each black hole will, after their travel through space, eventually orbit at this new larger radius.

All these photons orbiting at the same radius have many photon-photon impacts which eventually tends to make the very thin layer of photons uniform.

Not all of these photon-photon [24] or gamma-gamma scatterings are elastic. Many of these impacts emit radiation (thermal or Hawking) which reaches us as the cosmic microwave background the CMB.

## 16 Spherical caps of merging spheres

See figure (3) above. A spherical cap is a part cut off a sphere. When two spheres merge they create a lens shaped merged region. The volume of the lens shaped merged region includes four time the volume of the spherical cap. The volume of a spherical cap is:

$$\text{volume of a spherical cap} = \frac{1}{3}\pi r^3(3 - fr)fr^2 \quad (16.1)$$

with  $fr$  being the fraction of  $r$ , that is the height of the cap. The volume of a sphere equal to four spherical caps would be

$$\text{volume of four spherical caps} = \frac{4}{3}\pi r^3(3 - fr)fr^2 \quad (16.2)$$

equals the volume of a sphere when

$$1 = (3 - fr)fr^2 \text{ when } fr = .6527036 \quad (16.3)$$

The volume of four spherical caps equals the volume of a sphere of radius  $r$  when  $fr = .6527036$ .

When the spherical caps of merging black holes of the same size reach  $.6527036$  of their radius, the volume and the mass of the merged portions satisfies the mass/radius formula for a black hole.

$$\text{volume of the sphere} = \frac{4}{3}\pi r^3 \text{ when } (3 - fr)fr^2 = 1 \quad (16.4)$$

The new velocity distribution in the merged black hole will cause all the orbits to relocate over time but these are small acceleration forces in a low density Cosmos like our own.

Light and energy will eventually occupy an orbit at the new now larger radius of the black hole. The masses within will seek their own new orbits.

The acceleration at the edge of the Cosmos is:

$$\frac{c}{age} = 6.33E-10 \frac{m}{s^2} \quad (16.5)$$

and is fractionally smaller within the Cosmos. This is billions of times smaller than the acceleration of gravity at the Earths surface of  $9.8 \frac{m}{s^2}$ .

Far from being a dramatic event, the merging of low density black holes would be hardly detectable from an acceleration stand-point. A black hole approaching ours would be invisible until the merging. Its contents would then become visible in our Cosmos.

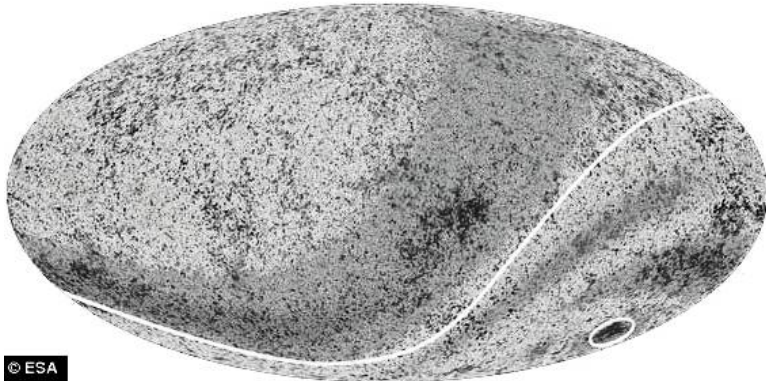


Figure 4: CMB, Cosmic Microwave Background, asymmetry per ESA

# 17 Rotation of the Cosmos

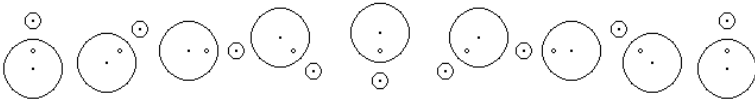


Figure 5: Binary rotations

As the light and energy orbit the expanding Cosmos, it takes longer to reach a reference point against the background universe. Newton would call this reference point absolute space. Mach would call it the fixed stars. The Cosmos, galaxy and solar system all rotate, with respect to that which is outside our cosmic dynamic unit. Looking at figure (5). If the background universe has features which are close enough, and these features are not black holes, then they may be visible through the intense orbiting energy and light around the Cosmos. Seeing through this orbital energy seems possible since stars are visible near the sun during an eclipse as starlight perpendicular to the huge energy flow from the sun. We might be seeing such features in the Hubble telescope deep field photographs. It would not be remarkable if the background universe looks the same as it does within our dynamic unit Cosmos.

## Angular Velocity

$$\begin{aligned}
 \text{angular velocity} &= \frac{d}{dt} \text{angle of rotation} = \\
 \frac{\text{tangent velocity}}{\text{radius}} &= \frac{v_t}{r} = \frac{c}{c \cdot \text{age}} = \frac{1}{\text{age}}
 \end{aligned}
 \tag{17.1}$$

is equal to this second equation

$$\frac{d}{dt} \ln(\text{age}) = \frac{1}{\text{age}}
 \tag{17.2}$$

so that

$$\int \frac{d}{dt} \text{angle of rotation} = \int \frac{d}{dt} \ln(\text{age})
 \tag{17.3}$$

Integrating on both sides, per Sylvanus P. Thompson [16], the sum of the little bits of the angle of rotation equals the sum of the little bits of the natural logarithm of the age of the Cosmos.

$$\text{angle of rotation} = \ln(\text{age})
 \tag{17.4}$$

The rate of change of the angle of rotation is the angular velocity.

$$\begin{aligned}\frac{d}{dt} \text{angle of rotation} &= \frac{d}{dt} \ln(\text{age}) \\ \text{angular velocity} &= \frac{d}{dt} \ln(\text{age}) = \frac{1}{\text{age}}\end{aligned}\quad (17.5)$$

The rate of change of the angular velocity is, the angular deceleration, the rate of the slowing of the rotation of the Cosmos.

$$\begin{aligned}\frac{d}{dt} \text{angular velocity} &= \frac{d}{dt} \frac{1}{\text{age}} \\ \text{angular acceleration} &= \frac{d}{dt} \frac{1}{\text{age}} = \frac{-1}{\text{age}^2}\end{aligned}\quad (17.6)$$

$$\begin{aligned}\text{angle of rotation} &= \ln(\text{age}) \\ 40.7 \cdot \text{radians} &= \ln(4.73E17)\end{aligned}\quad (17.7)$$

The base of the natural logarithms is,  $\epsilon$ , epsilon.

$$\epsilon^{\text{angle of rotation}} = \epsilon^{40.7} = 4.73E17 \cdot \text{seconds} = \text{age} \quad (17.8)$$

$$\ln(\text{age} \cdot 2) = \ln(\text{age}) + \ln(2) \quad (17.9)$$

Each time the Cosmos doubles in age or size the angle of rotation of the Cosmos increases by the natural logarithm of 2.

$$\ln(2) = .693 \cdot \text{radians} = 39.7 \cdot \text{degrees} \quad (17.10)$$

We are currently at 40.7 radians so

$$\frac{40.7}{2\pi} = 6.5 \cdot \text{revolution} \quad (17.11)$$

might have been made by the orbiting light and energy in the age of the Cosmos. This revolution started when the Cosmos was only

$$\epsilon^{40.7-6.28} = 8.88E14 \cdot s = 28.1 \cdot \text{million} \cdot \text{years old} \quad (17.12)$$

We are currently at

$$\epsilon^{40.7} = 4.73E17 \cdot s = \text{age} = 15 \cdot \text{billion} \cdot \text{years old} \quad (17.13)$$

The next revolution, of the Cosmos, will last until the age is

$$\epsilon^{40.7+6.28} = 2.53E20 \cdot s = 8017 \cdot \text{billion} \cdot \text{years old} \quad (17.14)$$

The slowly stirring Cosmos is slowing down.

$$\text{angular acceleration} = \frac{d}{dt} \frac{1}{\text{age}} = \frac{-1}{\text{age}^2} = -4.46E-36 \frac{1}{s^2} \quad (17.15)$$

This is the second derivative of the angle of rotation. This very small rate that the Cosmos is decelerating in its rotation is necessary for the equilibrium between rotation and expansion of the Cosmos. It satisfies the rules of dynamics.

The Cosmos rotated faster when it was smaller and younger. This difference in rotation might be detected but the angular acceleration is profoundly slow at  $\frac{-1}{\text{age}^2} = -4.46E-36 \frac{1}{s^2}$ .

We are rotating with the Cosmos. Everything has the same slowing universal angular velocity,  $\frac{1}{\text{age}} = 2.11E-18 \frac{1}{s}$ , as a component of their local angular velocity.

## 18 Inertial accelerations

To calculate the path of expansion of a particle we need the vector sum of three accelerations; the centrifugal, tangent and Coriolis. These are components of the so called fictitious forces which are more properly called forces due to inertia. They are certainly not fictitious if you take the Machian view [30] that inertia is the acceleration dependent gravitational force exerted by the rest of the Cosmos.

### Centrifugal acceleration

A tangent velocity causes a radial force.

The centrifugal and gravitational forces are equal.

$\frac{m \cdot v_t^2}{r}$  is the radial centrifugal force.

$\frac{v_t^2}{r}$  is the tiny acceleration felt by light or energy in orbit at the perimeter of the Cosmos.

$$\frac{v_t^2}{r} = \frac{v_t^2}{v_r \cdot \text{age}} = \frac{c^2}{c \cdot \text{age}} = \frac{c}{\text{age}} = 6.33-10 \frac{m}{s^2} \quad (18.1)$$

### Tangent Deceleration

A radial velocity causes a tangent force.

We can calculate the tangent deceleration using the torque formula.

$$\text{torque} = \text{force} \cdot \text{radius} = m \cdot a \cdot r$$

*torque = moment of inertia · angular acceleration*

*torque =  $m \cdot r^2 \cdot \text{angular acceleration} = m \cdot a \cdot r$*

*$a = r \cdot \text{angular acceleration} = \text{tangent deceleration} =$*

$$a = v_r \cdot \text{age} \cdot \frac{-1}{\text{age}^2} = \frac{-v_r}{\text{age}} = \frac{-c}{\text{age}} \quad (18.2)$$

The direction of deceleration is opposite of rotation. This is the tangent negative of the centrifugal force.

## **A note on the unknown moment of inertia of the Cosmos**

$$\text{moment of inertia of a ring} = \text{mass} \cdot r^2 \quad (18.3)$$

$$\text{moment of inertia of a spherical shell} = \frac{2}{3} \text{mass} \cdot r^2 \quad (18.4)$$

$$\text{moment of inertia of a solid sphere} = \frac{2}{5} \text{mass} \cdot r^2 \quad (18.5)$$

We are not too far off when we call the Cosmic

$$\text{moment of inertia} = \text{mass} \cdot r^2 = \text{mass} \cdot c^2 \cdot \text{age}^2 \quad (18.6)$$

The moment of inertia increases with the square of the age.

## **Forces perpendicular to the velocity**

Centrifugal force =  $\frac{m \cdot v_r^2}{r}$  is a radial force produced by a tangent velocity. The force is perpendicular to the velocity.

Deceleration force =  $\frac{m \cdot v_r^2}{r}$  is a tangent force produced by a radial velocity. The force is perpendicular to the velocity.

## **Coriolis acceleration**

A radial velocity causes a tangent force.

Inertia will cause a radial outward directed mass, on a rotating platform, to lag behind in a direction opposite to the rotation. This is a deceleration force. This is the reaction. The action which is the Coriolis acceleration is in the direction of the rotation. A person in an accelerating car is pushed back against the seat. This



is a reaction to the acceleration. The acceleration is in the direction of the velocity. The reaction is in the direction opposite the velocity.

$$\begin{aligned} \text{Coriolis acceleration} &= 2 \cdot \text{angular velocity} \cdot v_r = \\ 2 \cdot \frac{v_t}{r} \cdot v_r &= 2 \cdot \frac{v_t}{v_r \cdot \text{age}} \cdot v_r = 2 \cdot \frac{v_t}{\text{age}} = 2 \cdot \frac{c}{\text{age}} \end{aligned} \quad (18.7)$$

$v_t$ , the tangent velocity at the perimeter of the Cosmos, is  $c$ .

## 19 Cosmic Expansion

Now that we have calculated the inertial accelerations, we can look at the way the Cosmos expands. We have the

$$\text{centrifugal acceleration} = \frac{c}{\text{age}} \quad (19.1)$$

directed radially out. We have the

$$\text{Coriolis acceleration} = 2 \cdot \frac{c}{\text{age}} \quad (19.2)$$

in the direction of rotation, and the

$$\text{rotational deceleration} = \frac{-c}{\text{age}} \quad (19.3)$$

in the direction opposite of rotation. The resultant of these accelerations, is 45 degrees between the direction of rotation and the outward directed radius. It has a value of,

$$\sqrt{2} \cdot \frac{c}{\text{age}} = 8.96E-10 \frac{m}{s^2} \quad (19.4)$$

A particle moving in this way traces out a logarithmic spiral.

We have seen that the

$$\text{angle of rotation} = \ln(\text{age}) \quad (19.5)$$

This can be written as

$$\text{age} = e^{\text{angle of rotation}} \quad (19.6)$$

Now

$$r = c \cdot \text{age} \quad (19.7)$$

can be written as

$$r = c \cdot \epsilon^{\text{angle of rotation}} \quad (19.8)$$

This is the equation of a logarithmic spiral. It is no coincidence that many galaxies have a spiral shape. Their spiral is expected in an expanding rotating Cosmos.

## Logarithmic Spiral

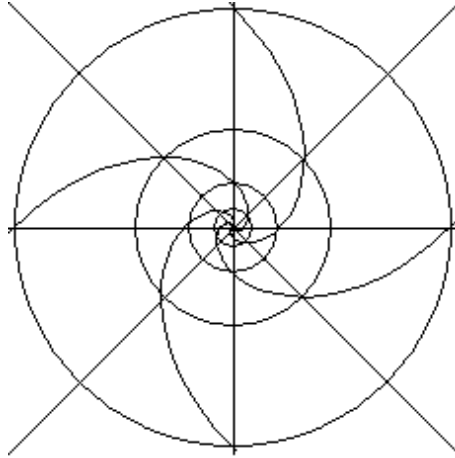


Figure 6: Logarithmic spirals

This one has  $r = 4^{\frac{\theta}{\pi}}$ . The Cosmos requires the similar  $r = c \cdot \epsilon^{\theta}$ .  
 $r$  = radius. The angle of rotation =  $\ln(r)$

Indeed, it is not that space expands but that the distance between orbiting masses increases as they spiral out and apart from each other in figure (6) as the Cosmos expands and slows in its rotation.

The tangent velocity of the stars orbiting in galaxies, stays the same as the galaxies expand and the orbital periods increase conserving energy per the flat rotation curves of galaxies [36]. Any velocity change would require force and energy which are absent.

## Torque

$$\text{torque} = \text{moment of inertia} \cdot \text{angular acceleration}$$

$$\text{torque} = M \cdot r^2 \cdot \text{angular acceleration}$$

$$torque = M \cdot v_r^2 \cdot age^2 \cdot angular\ acceleration$$

The moment of inertia increase with the square of r or age. But:

$$\frac{v_r}{c} = \frac{M}{M_c} \quad and \quad v_r^2 = \frac{c^2 \cdot M^2}{M_c^2}$$

therefore:

$$torque = M \cdot \frac{c^2 \cdot M^2}{M_c^2} \cdot age^2 \cdot angular\ acceleration$$

$$torque = \frac{c^2 \cdot M^3}{M_c^2} \cdot age^2 \cdot angular\ acceleration$$

If the mass of the black hole is,  $M = M_c$ , the mass of the Cosmos then

$$torque = M_c \cdot c^2 \cdot age^2 \cdot \frac{-1}{age^2} = M_c \cdot c^2 \tag{19.9}$$

We see that the  $age^2$ , in the square of the radius, in the moment of inertia, increases at the same rate the angular acceleration,  $1/age^2$ , decreases so that the  $age^2$  in each cancels and the energy stays constant. We will see the same thing in the torque of a spinning galaxy.

The radius of the Cosmos increases while the rotation of the Cosmos slows down, and with it all the black holes and galaxies, without a change in energy or use of power, always in dynamic equilibrium. Orbits spiral out as the gravitational force decreases with the age of the Cosmos.

## 20 Galactic Matters

Dark matter can be explained by matter present farther out from the galaxy than is seen in the optical or radio spectrum. There are orbiting atomic hydrogen clouds in this dark region. Each meter of radius adds a fixed amount of mass to a bigger volume so the density decrease with radius. The galaxy extends to the radius at which the galaxy is the same density as the Cosmos. We have a tangent velocity,  $v_t$ , of 210,000 m/s [33] at a radius within the galaxy of 30 kpc = 98,000 light years =  $9.26E20$  m or [34] or [35]. The mass contained within this orbit using the virial theorem is the visible matter:

$$visible\ matter = \frac{v_t^2 \cdot radius}{G} = \frac{(210000 \frac{m}{s})^2 \cdot 9.26E20 \cdot m}{G} =$$

$$6.12E41 \cdot kg \text{ or } 308 \cdot \text{billion solar masses} \quad (20.1)$$

The mass/radius ratio:

$$\frac{\text{mass}}{\text{radius}} \text{ ratio} = \frac{m}{r} = \frac{v_t^2}{G} = \frac{6.12E41 \cdot kg}{9.26E20 \cdot m} = 6.61E20 \frac{kg}{m} \quad (20.2)$$

The tangent velocity:

$$v_t = \sqrt{\frac{m}{r} \cdot G} = \sqrt{\frac{m}{v_r \cdot age} \cdot gk \cdot age} = \sqrt{\frac{m}{v_r} \cdot gk} = 210014 \frac{m}{s} \quad (20.3)$$

The mass added by the next meter of radius, 6.61E20 kg, when divided by the volume added by the next meter of radius, is the density at this radius. The mass/radius ratio, divided by the area of a sphere, at this radius, is the density at this radius:

$$\frac{6.61E20 \frac{kg}{m}}{4\pi(9.26E20 \cdot m)^2} = 6.13E-23 \frac{kg}{m^3} \quad (20.4)$$

I suspect that this very low density of matter or dark matter, would usually be hard to detect, for example with 21 cm radiation [31], but it is obviously still probably matter not some mysterious stuff. Radio telescopes can detect the atomic hydrogen at 21 cm, if it is dense enough along their line of sight. Cold molecular hydrogen [32] which is more stable and probably much more common is unfortunately invisible at radio wavelengths. It may be detected in the future as the unseen dark matter.

## Flat rotation curves of galaxies

$$\frac{m \cdot v_t^2}{r} = \frac{G \cdot m \cdot M}{r^2} \dots \dots \dots \text{from equation } \dots \dots \dots (3.2)$$

Using (3.2) in reference to galaxies. Multiply by  $r/m$  yielding the virial theorem again.

$$v_t^2 \cdot r = G \cdot M \dots \dots \dots \text{from the virial theorem } \dots \dots \dots (3.3)$$

As  $r$  the radius within a galaxy increases,  $v_t^2$  the tangent velocity of stars, at that radius within the galaxy should decrease with  $G \cdot M$  taken as a constant, in keeping with Kepler.

However, what is seen is that the tangent velocity  $v_t$  is largely flat, that is, the velocity stays the same with increasing radius once outside the galactic core. This is called a rotation curve [35] or a

flat rotation curve [36] as illuminated by Seth Shostak with radio telescopes in the sixties [37] and later by Vera Rubin [38].

These flat rotation curves have been used as evidence that there is a 'halo' of dark matter in galaxies. A halo where a fixed mass is added for each meter increase in the radius of the galaxy. The above equation can be written as:

$$\frac{M}{r} = \frac{v_t^2}{G} = \frac{mass}{radius} \cdot ratio \quad (20.5)$$

The  $v_t$  will stay flat or constant with increasing radius if the mass/radius ratio is maintained within the galaxy. Both r and G vary with age.

This is similar to the mass/radius ratio seen as a defining condition for a black hole and the Cosmos:

$$\frac{M}{r} = \frac{c^2}{G} = 1.35E27 \frac{kg}{m} = \frac{mass}{radius} \text{ ratio from equation (6.3)}$$

## Galactic Density

The galaxy has a constant m/r ratio where R is the galactic radius.

$$\frac{m}{r} R = mass \text{ and } \frac{3}{4\pi R^3} = volume \quad (20.6)$$

$$\frac{mass}{volume} = \frac{m}{r} \frac{3 \cdot R}{4\pi R^3} = \frac{m}{r} \frac{3}{4\pi R^2} = galactic density \quad (20.7)$$

The galactic density decreases as  $1/R^2$ . I postulate that the upper limit for the radius of the galaxy would be the radius at which the galactic density at that radius, R, equals the average density of the Cosmos

$$Galactic density = Cosmic density \quad (20.8)$$

$$\frac{m}{r} \frac{3}{4\pi \cdot R^2} = \frac{3 \cdot M_c}{4\pi \cdot c^3 \cdot age^3}$$

but  $m/r = v_t^2/G$  from equation (20.5) so

$$\frac{v_t^2}{G} \frac{1}{R^2} = \frac{M_c}{c^3 \cdot age^3}$$

$$\frac{v_t^2}{R^2} = \frac{M_c \cdot G}{c^3 \cdot age^3}$$

$$\frac{v_t^2}{R^2} = \frac{c^3 \cdot gk \cdot age}{gk \cdot c^3 \cdot age^3}$$

$$v_t^2 \cdot age^2 = R^2$$

$$v_t \cdot age = R \quad (20.9)$$

## Galactic rotational period

$$\text{Rotational period} = \frac{2\pi \cdot R}{v_t} = \frac{2\pi \cdot v_t \cdot \text{age}}{v_t} = 2\pi \cdot \text{age} \quad (20.10)$$

The radius and the rotational period of the galaxies are proportional to the age of the Cosmos, as is the Cosmos. Rotational energy is conserved. At earlier times the rotational periods were less and the rotation faster. Distant galaxies are viewed at earlier times so they appear to be smaller and rotating faster.

## Hubble expansion in the galaxy



Figure 7: Galaxy expansion

Galactic expansion is seen in figure (7). The tangent velocity  $v_t$ , which is seen in the flat rotation curves of galaxies, times the age of the Cosmos equals the radius,  $R$ , of the galaxy. This suggests that there is a Hubble expansion occurring within the galaxy.

$$R = v_t \cdot \text{age} = 210,000 \frac{m}{s} \cdot 4.73E17 \cdot s = 9.94E22 \cdot m = 3.22 \cdot \text{Mpc}$$

$$R = 10.5 \cdot \text{million} \cdot \text{light years} = \text{galactic radius} \quad (20.11)$$

Only the inner 98,000 light years is visible being dense enough for star formation. The galaxy is as low in density as the Cosmos at the perimeter of the galaxy.

$$\text{Hubble's constant} = \frac{1}{\text{age}} = H_0 \approx 65 \text{ km/s} \cdot \text{Mpc}$$

$$v_r = \frac{R}{\text{age}} = R \cdot H_0 = 3.22 \cdot \text{Mpc} \cdot 65 \frac{\text{km}}{\text{s} \cdot \text{Mpc}} = 209,000 \frac{m}{s} = v_r \approx v_t \quad (20.12)$$

The radial velocity equals the tangent velocity at the perimeter of the galaxy.

When the tangent velocity of something equals its radial velocity. It spirals out at a constant angle of 45 degrees. This is the same spiral for the galaxy and for the Cosmos.

## Dark matter halo

$$M_g = \text{galactic mass} = \frac{m}{r} \cdot R$$

$$M_g = 6.61E20 \frac{kg}{m} \cdot 9.94E22 \cdot m = 6.57E43 \cdot kg \quad (20.13)$$

Dark matter = total matter - visible matter:

$$\text{Dark matter} = 6.57E43 \cdot kg - 6.12E41 \cdot kg = 6.51E43 \cdot kg \quad (20.14)$$

$$\frac{6.51E43 \cdot kg}{6.12E41 \cdot kg} = \frac{\text{dark matter}}{\text{visible matter}} \text{ratio} = \frac{106}{1} \quad (20.15)$$

The 106/1 ratio of dark matter/visible matter.

$$\frac{v_t^2}{G} = \frac{M_g}{r} \quad (20.16)$$

The mass to radius ratio. For  $v_t^2$  and  $M/r$  to remain constant,

$$\frac{v_t^2}{c^3} \frac{M_c}{age} = \frac{M_g}{v_t \cdot age} \quad (20.17)$$

substituted  $G = \frac{c^3 \cdot age}{M_c}$  and  $r = v_t \cdot age$ .

$$\frac{v_t^3}{c^3} = \frac{M_g}{M_c} \quad \text{or} \quad \frac{v_t^3}{c^3} = \frac{M_g \cdot gk}{c^3} \quad (20.18)$$

The ratio of velocities and masses of the galaxy and the Cosmos.

$$M_g = \text{mass of galaxy} = \frac{M_c \cdot v_t^3}{c^3} = \frac{c^3}{gk} \frac{v_t^3}{c^3} = \frac{v_t^3}{gk} \quad (20.19)$$

Compare equation (8.3) where the mass of the Cosmos,  $M_c = \frac{c^3}{gk}$ .

## Torque of the spinning galaxy

Here mass is the mass of the galaxy.  $r$  is the radius of the galaxy.  $v_r$  is the radial velocity of expansion at the perimeter of the galaxy or  $v_r = v_t$  the characteristic tangent velocity of the flat rotation curve of the galaxy.

$$\text{torque} = \text{moment of inertia} \cdot \text{angular acceleration}$$

$$\text{torque} = \text{mass} \cdot r^2 \cdot \text{angular acceleration}$$

$$torque = mass \cdot v_r^2 \cdot age^2 \cdot \frac{1}{age^2} = mass \cdot v_r^2 \quad (20.20)$$

We see that the square of the radius in the moment of inertia for the galaxy,  $v_r^2 \cdot age^2$ , increases at the same rate the angular acceleration of the galaxy,  $1/age^2$ , decreases so that the  $age^2$  in each cancels and the energy stays constant. The radius of the galaxy increases while the rotation of the galaxy slows down without a change in energy or use of power. Orbits spiral out as the gravitational force decreases with the age of the Cosmos.

## 21 Hubble expansion in the Solar System

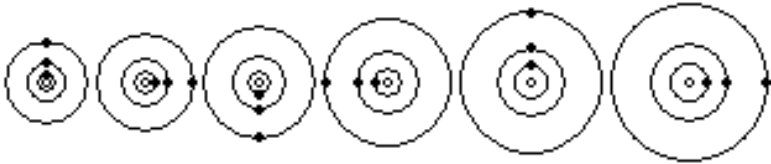


Figure 8: Solar system expansion

If the Hubble expansion extends to the solar system as shown in figure (8), then all the planets share the same very small precession rate [43], of their major axis within the planet's elliptic plane.

An expanding ring slows in its rotation. We calculate a change in angular velocity which is due to a radial Hubble velocity. This effect may be detected by atomic clocks or by large ring laser gyroscopes [45] which detect absolute rotations.

The length of the orbit, when divided by  $2\pi$  radians per revolution equals the meters per radian or

$$meters \text{ per radian} = \frac{2\pi r}{2\pi \cdot radians} = \frac{r}{radians} \quad (21.1)$$

$r$  is the distance from the sun to any planet.  $v_r = r/age$ , the radial velocity, the Hubble expansion velocity in meters per second.

$$\frac{v_r}{meters \text{ per radian}} = \frac{\frac{r}{age}}{\frac{r}{radians}} = \frac{radians}{age} \quad (21.2)$$

We see that the  $r$ 's cancel so that this rate of precession is universally true for the entire solar system and is not tied to any radius.



This is Hubble as a rotation rate.

$$\frac{\text{radians}}{15 \cdot \text{billion years}} = 6.66E-11 \frac{\text{radians}}{\text{year}} =$$

$$1.375E-5 \frac{\text{arcs}}{\text{year}} = \text{precession} \quad (21.3)$$

This is a very small angle to measure.

The gravity probe B satellite was seeking to measure a Lense-Thirring frame dragging of  $4,200E-5$  arcs/year.

$$\frac{31,556,926 \frac{\text{seconds}}{\text{year}}}{1,296,000 \frac{\text{arcs}}{\text{year}}} = 24.35 \frac{\text{seconds}}{\text{arcs}} \quad (21.4)$$

For the Earth to cover one arc second of circumference in its orbit.

$$24.35 \frac{\text{seconds}}{\text{arcs}} \cdot 1.375E-5 \frac{\text{arcs}}{\text{year}} = 3.35E-5 \frac{\text{seconds}}{\text{year}} \quad (21.5)$$

which is the amount added yearly to the orbital period by the Hubble expansion. This is one leap second being added to our orbit in the solar system every 2,986.8 years.

The perihelion shift of Earth's orbit due to general relativity is of 3.84 arcs/century, or  $3.84E-2$  arcs/year or .935 (seconds of time)/year. Relativity subtracts nearly a leap second every year [39]. Hubble precession is 3194 times smaller.

The entire solar system is slowing in its rotation while it expands, like a dynamic unit, like the galaxy and like the Cosmos. It is a consequence of the slowing rotation of the Cosmos and is tied by dynamics to the expansion of the Cosmos.

The precession is proportional to  $1/\text{age}$ .

$$v_r = \text{radial velocity} = \frac{r_{\text{earth}}}{\text{age}} \quad (21.6)$$

The Earth orbits the sun at  $r_{\text{earth}} = 149E9$  m so

$$v_r = \frac{r_{\text{earth}}}{\text{age}} = \frac{149E9 \cdot \text{m}}{4.73E17 \cdot \text{s}} = 3.16E-7 \frac{\text{m}}{\text{s}} = 9.97 \frac{\text{m}}{\text{year}} \quad (21.7)$$

$v_r$  is too small to measure for the Earth.

## Radial velocity is not tangential velocity

$$v_t^2 \cdot r_{earth} = G \cdot M_{sun} \dots \dots \text{from the virial theorem} \dots \dots (3.3)$$

The earths orbital velocity is:

$$v_t = \sqrt{\frac{G \cdot M_{sun}}{r_{earth}}} = 29,785 \frac{m}{s} \quad (21.8)$$

## The Moon

The moon orbits the Earth much closer at  $r_{moon} = 380E6$  m but the Apollo missions to the moon left behind corner reflectors so that the round trip of laser pulses could be timed and the receding velocity of the moon measured.

$$v_r = \frac{r_{moon}}{age} = \frac{380E6 \cdot m}{4.73E17 \cdot s} = 8.02E-10 \frac{m}{s} = 25.3 \frac{mm}{year} \quad (21.9)$$

The moons measured radial velocity is 38 mm/year and is usually attributed to tidal drag and not the expansion of the universe. I postulate, 25 mm is due to a Hubble expansion and 13 mm is due to tidal drag.

## Planetary Spirals

To calculate the path of expansion of a planet we need the vector sum of three accelerations.

We have the

$$\text{tangent rotational deceleration} = \frac{-v_r}{age} \quad (21.10)$$

in the direction opposite of rotation.

We have the radial centrifugal acceleration, equals the negative of the rotational deceleration, directed radially out.

$$\text{centrifugal acceleration} = v_r \cdot \text{angular velocity} = \frac{v_r}{age} \quad (21.11)$$

Finally, we have the

$$\text{coriolis acceleration} = 2 \cdot \frac{v_r}{age} \quad (21.12)$$

in the direction of rotation.

The resultant of these accelerations, is 45 degrees between the direction of rotation and the outward directed radius. It has a value of,

$$\sqrt{2} \cdot \frac{v_r}{age} \quad (21.13)$$

A particle moving in this way traces out a logarithmic spiral.

$$\text{torque} = \text{moment of inertia} \cdot \text{angular acceleration}$$

$$\text{torque} = m \cdot r^2 \cdot \text{angular acceleration}$$

$$\text{torque} = m \cdot v_r^2 \cdot \text{age}^2 \cdot \text{angular acceleration}$$

$$\text{torque} = m \cdot v_r^2 \cdot \text{age}^2 \cdot \frac{-1}{\text{age}^2} = \text{mass} \cdot v_r^2 \quad (21.14)$$

Here mass is the mass of a planet.  $r$  is the distance from the sun.  $v_r = r/\text{age}$  is the radial velocity. We see that the square of the radius in the moment of inertia for the planet,  $v_r^2 \cdot \text{age}^2$ , increases at the same rate the angular acceleration of the planet,  $1/\text{age}^2$ , decreases so that the  $\text{age}^2$  in each cancels and the energy stays constant.

Expansion and rotation rates are linked. The distance from the sun to the planets increases and the orbital periods of the planets lengthen without a change in velocity, energy or the use of power.

Orbits spiral out as the gravitational force decreases with the age of the Cosmos. Spiral galaxies are the evidence.

Orbits are seen to spiral in with General Relativity like the precession of Mercury [39], precession of quasars by gravitational waves [40] and [41] and like the rosettes of Arnold Sommerfeld [42].

## 22 Ellipses

The ellipse is the path of point that moves, so that the sum of its distance from the two foci is constant.

A whisper at one focus of an elliptical room, is heard at the other focus in the room, because the distance and travel time from focus to focus, is the same for any path of sound reflecting off the walls.

Light acts the same, with the same geometry, with ellipsoidal mirrors. The two foci can be called the origin and the destination.

Light leaves the origin as an expanding sphere and reflects at the ellipsoidal surface as a ring. It is a ring because it is the intersection of a sphere and ellipsoid. This reflection focuses the light onto the destination.

The overall travel time from the origin to reflection, to destination, is always the same for all angles of light departing from the origin.

If we retain the origin and destination and change to a luminous expanding sphere we can eliminate the mirror and reflection while

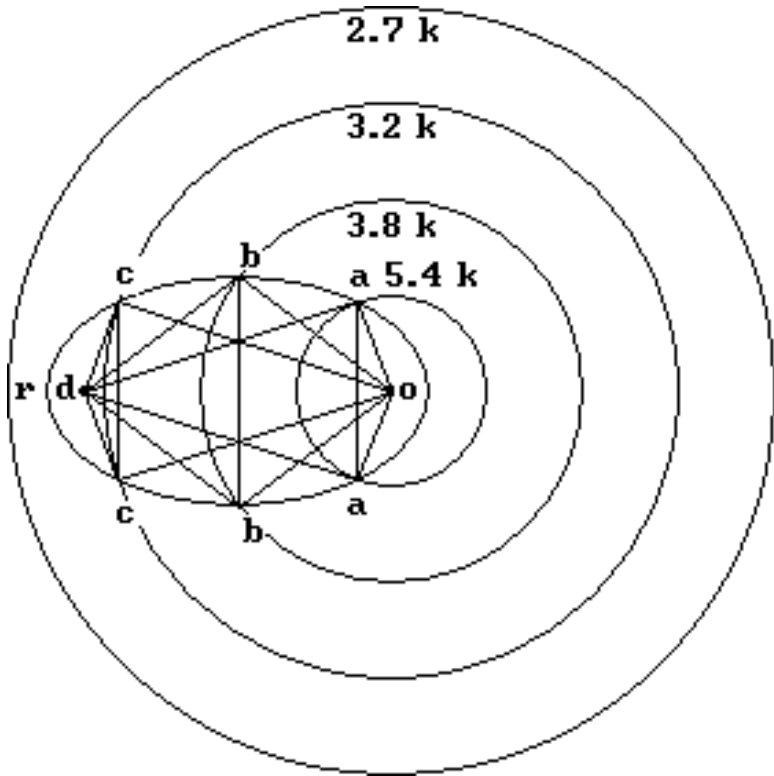


Figure 9: Cosmic cross section

The CMB temperature,  $k$ , is going down because of the inverse square law of radiation as the Cosmos expands. Compare this with figures 1 and 11.

keeping the geometry of the intersection of an expanding sphere and ellipsoid.

The luminous sphere is the shell of Cosmos which emits the CMB, Cosmic Microwave Background. Now the ellipsoid is an abstraction that exists in concept but not in reality. The ellipsoid defines the path of things that are perceptible at our location at a certain time.

## 23 Cosmic Cross Section

A cosmic cross section is seen in figure (9).

We are located at someplace like  $d$  which moves out as the

Cosmos expands.  $d$  is at an unknown fraction of the radius of the Cosmos,  $fr$ . The eccentricity of the ellipse is  $fr$ .  $d$  is on a concentric radius =  $fr \cdot c \cdot age$  and is moving radially and tangentially with a velocity =  $fr \cdot c$ . See figure (2). See the animation at [14].

$$r(\text{angle}) = \frac{c \cdot age}{2} \cdot \frac{1 - fr^2}{1 \pm (\cos(\text{angle}) \cdot fr)} \quad (23.1)$$

This is the polar form of the ellipse drawn from the center focus [44], which is the origin,  $o$ , on figure (9). The radius of the expanding sphere, which intersects the ellipse is,  $r$ , in the equation.

As the angle is varied, the points form an ellipse stretched in the radial direction with,  $fr \cdot c \cdot age$ , as the distance between the foci,  $od$ , on figure (9). The sum of the distances from the two foci, to a point, is always equal to  $c \cdot age$ .

The angle and radius when rotated around the center line of the ellipse trace a ring that is the intersection of the sphere and the ellipsoid,  $aa$ ,  $or$ ,  $bb$ ,  $or$ ,  $cc$ , on figure (9).

This nested series of rings may partially polarize the CMB, Cosmic Microwave Background, along the axis of the origin see figure (10). Other polarizations seem likely. There is evidence that light traveling through space is polarized in a non-random direction [46].

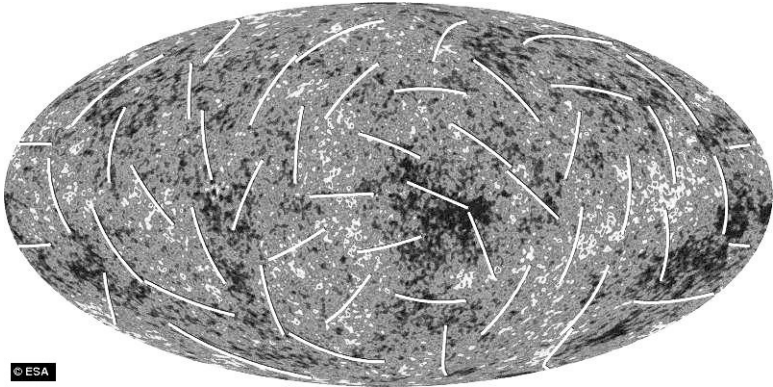


Figure 10: CMB, Cosmic Microwave Background, polarization per ESA

There is also evidence from the Planck satellite [47] that space could be rotating from the asymmetry in the average temperatures of the CMB on opposite hemispheres of the sky as if we are offset from the center and seeing differences in velocity as differences in temperature.

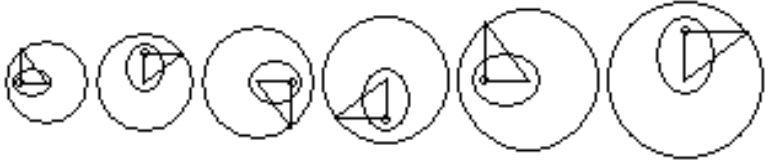


Figure 11: Expanding ellipses

## 24 Blackbody watts from temperature

A flux of radiation has a Kelvin temperature. We see the temperature of the sun as 5778 Kelvin. We can convert this to  $\frac{\text{watts}}{\text{meter}^2}$  for black body radiation with the Stephan and Boltzmann law.

$$K^4 \cdot 5.5698E-8 \frac{W}{m^2} = \frac{W}{m^2} \quad (24.1)$$

$$\text{The suns temperature} = 5778 \text{ Kelvin} = 62E6 \frac{W}{m^2} \quad (24.2)$$

The sun has a wattage of  $62E6 \frac{\text{watts}}{\text{meter}^2}$  over the surface area of the sun of  $4\pi(695E6 \cdot m)^2$  or a total of 3.77E26 watts. At the distance of the Earth, 149E9 m, this is

$$\frac{3.77E26 \cdot \text{watts}}{4\pi(149E9 \cdot m)^2} = 1341.8 \frac{\text{watts}}{m^2} = 394 \cdot K = 249.5 \cdot F \quad (24.3)$$

We can work the CMB in just this way.

Space is quite hot in the sun at 249.5-F. Only the Earth's atmosphere protects us. Treat the atmosphere with respect. Look at what happened to Venus with its runaway greenhouse effect.

## 25 Uniformity of the CMB

The question of the uniformity of the CMB, Cosmic Microwave Background, is usually answered; that we appear to be at the center of the Big Bang, because the Big Bang explosion happened everywhere. A more quantitative, and less miraculous solution, looks again at figure (9).

A ray of CMB reaches us after two distinct intervals.

The first interval starts at the center focus, at the origin, at point, o, on figure (9).

It is with the expanding and cooling spherical shell, before the ray of CMB, which we will be observing, is emitted. Examples on figure (9) are the lines, oa, ob, and, oc.

The temperature and  $watts/meter^2$ , of the expanding sphere, is proportional to the inverse square of the radius.

The second interval, is the travel of the ray of CMB through space, after it leaves the expanding spherical shell. Examples on figure (9) are the lines, ad, bd, and, cd. It ends with the reception of the CMB, at the observer at point, d.

The temperature and  $watts/meters^2$ , of the CMB during the second interval, is also proportional to the inverse square of the radius.

The two intervals always add up to c-age meters in age seconds in any direction the observer looks.

For CMB emitted early in the Cosmos, there is a shorter interval with the expanding sphere, and a much longer path through space interval to reach the observer.

For CMB emitted later, there is a longer spherical expansion interval, before the CMB is emitted, but a shorter path through space interval to the observer.

The expanding spherical shell, the CMB which it emits, and the CMB during its travel through space, all have a temperature proportional to the inverse square of the distance traveled from the origin, o.

When the radius of the Cosmos was, oa, it emitted CMB from the entire spherical surface. Only that from the ring, on the sphere at, aa, will reach, d, at the same time as the other rings on the same ellipsoid.

A similar argument can be seen in the rings, bb, and, cc. All the CMB from the various rings which intersect the ellipse arrive at point, d, at the same time and temperature.

$$oa + ad = ob + bd = oc + cd = or = c \cdot age \quad (25.1)$$

The formulas in the next section, show the relationship between radius and temperature.

The CMB had a temperature at point, a, of 5.4 K when the Cosmos was one fourth its age and size. It arrived at point, d, at 2.7 K after expanding for three fourths the age of the Cosmos.

The temperature at point, b, was 3.8 K when the Cosmos was one half its age and size. It arrived at point, d, at 2.7 K after expanding for half the age of the Cosmos.

The temperature at point, c, was 3.2 K when the Cosmos was three fourths its age and size. It arrived at point, d, at 2.7 K after

expanding for one forth the age of the Cosmos.

The temperature is going down because of the inverse square law of radiation not because of the expansion of the vacuum of space.

## 26 Black body watts from the CMB

A flux of radiation has a Kelvin temperature. We see the temperature of the CMB, Cosmic Microwave Background, as 2.725 Kelvin. We can convert this to *watts/meter<sup>2</sup>* for black body radiation with the Stephan and Boltzmann law.

$$K^4 \cdot 5.5698E-8 \frac{W}{m^2} = \frac{W}{m^2} \quad (26.1)$$

Reorder

$$CMB \cdot temperature \cdot = 2.725 \cdot Kelvin = 3.07E-6 \frac{W}{m^2} \quad (26.2)$$

When one sees something, it is in terms of  $W/m^2$  and the inverse square law. The  $W/m^2$  times the area of the Cosmos = wattage of the CMB, because as we saw in figure (9), the temperature at point, d, where the observer is located, is the same as at point, r, the radius of the Cosmos.

$$4\pi \cdot r_{Cosmos}^2 \cdot 3.07E-6 \frac{W}{m^2} = 7.77E47 \cdot W = power = \frac{energy}{second} \quad (26.3)$$

The CMB has the luminosity of a 7.77E47 watt light bulb seen from a distance of 15 billion light years. This much power output requires 2E21 suns.

This is the same as 7.77E47 watts stretched over the interior surface area of a sphere with a radius of 15 billion light years.

The CMB is emitted from the interior of the expanding radiant spherical region herein for simplicity called the shell which is where light orbits at the perimeter of the Cosmos.

The non-elastic impact of some of the photons within this thin spherical shell is the source of the CMB. One might view this as being inside a huge hot spherical shell, watching it emitting heat as it expands and cools with the inverse square of its radius.

The light was accumulated in this shell as the Cosmos gained mass and orbiting light through the merging of masses or black holes.

The energy emitted in 15 billion years by the CMB, if the energy output is constant, is

$$7.77E47 \cdot watts \cdot age = 3.68E65 \cdot Joules \quad (26.4)$$



For comparison, the energy of the Cosmos,

$$M_c \cdot c^2 = 1.7E70 \cdot \text{Joules} \quad (26.5)$$

$$\frac{M_c \cdot c^2}{4\pi c^2 a g e^2 \cdot 3.07E-6 \frac{W}{m^2}} = \frac{1.72E70 \cdot J}{3.68E65 \cdot J} = 46,739 \quad (26.6)$$

If the CMB is the remnant energy from the Big Bang then why is it so feeble?

However, if the CMB is emitted instead through the non-elastic impact of photons at the perimeter of the Cosmos then this small value of energy makes some sense.

The gravitational and centrifugal accelerations on the photon in orbit are  $c/age$ . As the Cosmos expands the photons orbit at a larger radius and the orbital accelerations decrease.

The rate of change of the acceleration is  $1/age^2$ .  $1/r_{Cosmos}^2 = 1/c^2 age^2$ . The  $W/m^2$  of the CMB is:

$$CMB = \frac{7.77E47 \cdot W}{4\pi r_{Cosmos}^2} = \frac{7.77E47 \cdot W}{4\pi c^2 age^2} = 3.07E-6 \frac{W}{m^2} \quad (26.7)$$

$$\frac{7.77E47 \cdot W}{3.07E-6 \frac{W}{m^2}} = 4\pi r_{Cosmos}^2$$

$$\frac{7.77E47 \cdot W}{4\pi \cdot 3.07E-6 \frac{W}{m^2}} = r_{Cosmos}^2$$

$$\sqrt{\frac{7.77E47 \cdot W}{4\pi \cdot 3.07E-6 \frac{W}{m^2}}} = r_{Cosmos} = 1.42E26 \cdot m \quad (26.8)$$

The rate of change of the orbital acceleration is proportional to the  $W/m^2$  of the CMB.

## 27 Shrinking shells of CMB

We can map the power of the CMB onto the smaller spheres and higher temperature when the Cosmos was younger, as long as we keep well clear of infinities.

$$\sqrt{\frac{3.07E-6 \frac{W}{m^2}}{5.5698E-8 \frac{W}{m^2}}} = (2.725 \cdot K)^2$$

$$\frac{\sqrt{\frac{7.77E47 \cdot W}{4\pi \cdot 5.569E-8 \frac{W}{m^2}}}}{(temperature \cdot K)^2} = radius \cdot m$$

Collect terms.

$$\frac{1.0537E27 \cdot m}{(temperature \cdot K)^2} = radius \cdot m \quad (27.1)$$

The radius, of the expanding spherical shell of CMB, is proportional to the inverse square of the temperature. The following examples map temperature and radius.

The radius of the Cosmos currently at 2.725 K =

$$\frac{1.0537E27 \cdot m}{(2.725 \cdot K)^2} = 1.42E26 \cdot m =$$

$$1.42E26 \cdot m = c \cdot age = r_{Cosmos} = 15 \cdot billion \cdot light \cdot years \quad (27.2)$$

$$At \ the \ radius \ of \ the \ Cosmos \ \sqrt{\frac{1.0537E27 \cdot m}{1.42E26 \cdot m}} = 2.725 \cdot K$$

$$At \ \frac{3}{4} \ the \ radius \ of \ the \ Cosmos \ \sqrt{\frac{4}{3}} \cdot 2.725 \cdot K = 3.15 \cdot K$$

$$At \ \frac{1}{2} \ the \ radius \ of \ the \ Cosmos \ \sqrt{\frac{2}{1}} \cdot 2.725 \cdot K = 3.85 \cdot K$$

$$At \ \frac{1}{4} \ the \ radius \ of \ the \ Cosmos \ \sqrt{\frac{4}{1}} \cdot 2.725 \cdot K = 5.45 \cdot K$$

At an age of 1.5 million years, at the freezing point of water of 273 K.

$$\frac{1.0537E27 \cdot m}{(273 \cdot K)^2} = 1.42E22 \cdot m =$$

$$1.42E22 \cdot m = \frac{r_{Cosmos}}{10000} = 1.5 \ million \ light \ years \quad (27.3)$$

## 28 Planck Satellite Asymmetry

The CMB is presumed uniform in the current cosmological standard model. Figure (4) shows the temperature asymmetry in the spherical shell of the CMB. Moving toward the shell produces a blue shift and moving away from the shell produces a red shift. This figure shows the observer is moving with a complex motion. Figure (2) shows both tangent and radial velocity.

## 29 Large Scale Structure

There are groupings of mass in space so great that gravity, in the age of the Cosmos, would be inadequate for their formation from hydrogen gas. These are called large-scale structure [25]. An example is the Sloan great Wall [26]. Their great mass would have been reflected in the observed inhomogeneities in the CMB were the standard theory right.

The merging of black holes, does however, explain these structures and the Planck satellite anomaly [47]. The smaller black hole in a merging black hole pair has a much higher density. The merged contents are enclosed in a much larger volume. The merged photons are bunched together. From within, one sees only the merged contents. The smaller black hole leaves behind a higher residual mass density, in the stretched out, merged contents, which is the artifact or footprint of their merging. See figure (12).

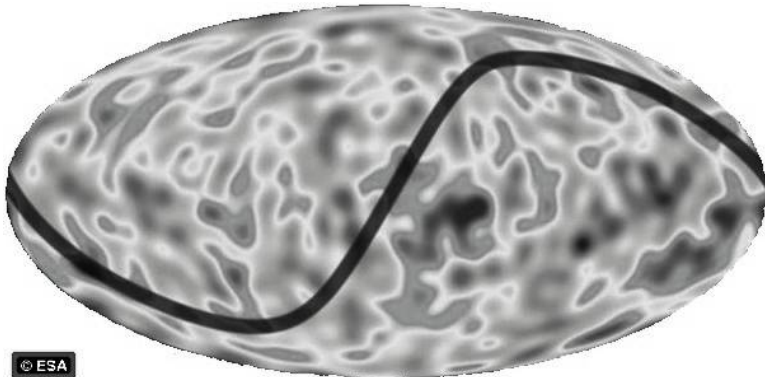


Figure 12: CMB, Cosmic Microwave Background, anomaly per ESA

## 30 Comparing Black Holes

First, in the orbiting light black holes we have rest energy equals gravitational energy and centrifugal force equals gravitational force.

Second, in the Schwarzschild black holes we have kinetic energy equals gravitational energy.

The original black hole definition goes back centuries and is based on escape velocity from a star exceeding the speed of light.

If the escape velocity only equals the speed of light then light will escape. This is the case with the Schwarzschild black hole. The idea with escape velocity is that the escaping object is slowing continuously and reaches infinity with zero velocity and zero kinetic and gravitational energy.

$$.5 \cdot m \cdot v_r^2 = \frac{G \cdot m \cdot M}{r} \quad (30.1)$$

The kinetic energy equals the gravitational energy. Here,  $v_r$ , is the radial velocity, the escape velocity. Substitute  $v_r = c$ .

$$m \cdot c^2 = \frac{2 \cdot G \cdot m \cdot M}{r} \quad (30.2)$$

The rest energy equals twice the gravitational energy. The energy of the escaping light is twice the gravitational energy.

$$\frac{m \cdot c^2}{r} = \frac{2 \cdot G \cdot m \cdot M}{r^2} \quad (30.3)$$

Multiplied by  $1/r$ . The centrifugal force now equals twice the gravitational force when  $v_t = c$ . Light can not be restrained to an orbit in the Schwarzschild black hole.

$$r = \frac{2 \cdot G \cdot M}{v_r^2} \quad (30.4)$$

Isolated r. If r = infinity in this escape velocity equation then:

$$infinity = \frac{2 \cdot G \cdot M}{v_r^2} \quad (30.5)$$

which is OK.  $v_r$  is the radial velocity which can approach zero at infinity. But  $v_r$  can't be c unless c approaches zero.

$$r = \frac{2 \cdot G \cdot M}{c^2} = \textit{Schwarzschild \cdot radius} \quad (30.6)$$

When,  $v_r = c$ , this is the Schwarzschild radius where it is frequently seen in General Relativity as,  $r=2M$ , by using 'geometric units' such that c and G are one [27].

Obviously, this odd shorthand obscures the possible and necessary variability of G in an expanding and dynamic Cosmos.

What happens when you put a variable G in GR?

'Atomic units' where the mass, radius, charge, energy and Planck's constant within atoms are all one, also obscure variability.

If  $r = \text{infinity}$  and  $v_r = c$  in equations (30.5) and (30.6) then

$$\text{infinity} = \frac{2 \cdot G \cdot M}{c^2} \quad (30.7)$$

which is false in the traditional black hole,  $c$  can not go to zero at infinity.

$$.5 \cdot m \cdot c^2 = \frac{G \cdot m \cdot M}{r} \quad (30.8)$$

This is kinetic energy equals gravitational energy or the rest energy equals twice the gravitational energy.  $c$  is the escape velocity. Collect terms. Equations (31.2) to (31.8) are the Schwarzschild black hole equations.

## 31 Schwarzschild black holes

We have four numbers,  $G$ ,  $c$ ,  $r$ , and  $M$ . We will use:

$r = c \cdot \text{age} = 15 \cdot \text{billion} \cdot \text{light years}$  and

$G = gk \cdot \text{age}$ , canceling the age in  $r$ , making mass a constant.

$$M_u = \frac{c^2 \cdot r}{2 \cdot G} = \frac{c^3}{2 \cdot gk} = 9.56E52 \cdot kg = \text{mass of the Universe} \quad (31.1)$$

This Schwarzschild mass is half the value of orbiting light black holes, with  $M_c = \frac{c^2 \cdot r}{G} = 1.91E53 \cdot kg$  from equation (8.3).

The 2 is a characteristic of Schwarzschild black holes.

$$c^2 \cdot r = 2 \cdot G \cdot M \quad \text{Schwarzschild black hole} \quad (31.2)$$

$$\frac{c^2 \cdot r}{G \cdot M} = 2 \quad \text{Schwarzschild black hole} \quad (31.3)$$

$$r = \frac{2 \cdot G \cdot M}{c^2} = \text{Schwarzschild} \cdot \text{radius} \quad (31.4)$$

This Schwarzschild radius of the universe = the orbiting light black hole radius. Both expand at  $c$  for the age of the universe.

$$r_{\text{universe}} = r_u = \frac{2 \cdot G \cdot M_u}{c^2} = c \cdot \text{age} = 15E9 \cdot \text{light} \cdot \text{years} \quad (31.5)$$

$$\frac{M}{r} = \frac{c^2}{2 \cdot G} = 6.73E26 \frac{kg}{m} = \frac{\text{mass}}{\text{radius}} \text{ratio} \quad (31.6)$$

This Schwarzschild ratio is half the value of the orbiting light black hole. The Schwarzschild density:

$$\frac{mass}{volume} = \frac{3 \cdot mass}{4\pi r^3} = \frac{3 \cdot c^2}{8\pi \cdot G \cdot r^2} = \frac{3 \cdot c^6}{32\pi \cdot mass^2 \cdot G^3} \quad (31.7)$$

$$mass = \frac{c^2 \cdot r}{2 \cdot G} \text{ or } r = \frac{2 \cdot G \cdot mass}{c^2}.$$

The density decreases with the square of the radius or mass.

The Schwarzschild density of the Cosmos:

$$\frac{3 \cdot c^2}{8\pi \cdot G \cdot c^2 \cdot age^2} = \frac{3}{8\pi \cdot G \cdot age^2} = \frac{3}{8\pi \cdot gk \cdot age^3} = \quad (31.8)$$

$$7.97E-27 \frac{kg}{m^3}.$$

Density is about 5 protons per meter cubed. This is half the density of the Cosmos we calculated for orbiting light black holes. Schwarzschild black holes are twice as big and half as massive and dense as orbiting light black holes. The factor of 2, seen above, is missing from orbiting light black holes. This difference may be testable.

## 32 Tests for Orbiting Light Black Holes

Energy in orbit black holes are not the photon-sphere, outside the event horizon of Schwarzschild black holes [28], where light might orbit at  $r = \frac{3 \cdot G \cdot M}{c^2}$  [29] and the velocity  $c$ .

In orbiting light black holes the velocity of the gas clouds at  $r = \frac{3 \cdot G \cdot M}{c^2}$  is less than  $c$  and possibly detectable.

This difference may be detectable with the measurement of orbital periods of x-ray emitting clouds that orbit some black holes in binary systems of a black hole and star. A radiating mass of gas orbiting a black hole is like a lighthouse beacon sweeping past Earth hundreds of times per second.

## 33 What is reasonable?

At a temperature below 3000 K plasma becomes transparent to light. The radius from section [27] becomes:

$$\frac{1.0537E27 \cdot m}{(3000 \cdot K)^2} = 1.18E20 \cdot m = 12,466 \text{ light years?} \quad (33.1)$$

At an age of 12,466 years? It would fit in the core of a galaxy. This is only the CMB, but this much power would require an absurdly

large star. An inside out or hollow star since its radiation comes to us from every direction. We have allowed the ease of doing calculations to project something absurd.

At its present mass, our Cosmos could never have been that small or young.

We can see that these formulas, and others like them, might be used to trace back to a creation event at a point of infinite temperature and density.

This has become dogma, trussed up with patches, which helps obscure the absurdity of physical infinities.

Since smaller black holes merge to make bigger black holes, consider that the Cosmos came about by the merging of black holes, in a multi-verse of black hole universes. Multi-verses separated by space *not* multiple dimensions.

Low density black holes are big, old and expanding fast so they incorporate a lot of space over time.

Big ones present a bigger target for merging. Old ones present a target for merging that has been around for a long time. Space seems well populated with black holes.

It is a small step, for our dynamic unit, our Cosmos, to be just another ordinary low density black hole in a universe full of the same.

A ledger might have beliefs on the left side, and evidence for those beliefs on right side. The dynamics described here are mathematically consistent beliefs, which don't require physical infinities.

The evidence is the values presented by the mass, radius and density of the Cosmos, source and uniformity of the CMB, the spiral shape and the flat rotation curves of galaxies and the prevalence of dark matter.

All the parts slip together seamlessly. The dynamics locks all the parts together. There are no free parameters which might be adjusted to reflect a point of view.

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