Observations support spherically closed dynamic space without dark energy

Tuomo Suntola

Suntola Consulting Ltd., Tampere University of Technology, Finland

When interpreted with the standard theory of cosmology, recent observations of the apparent magnitude vs. redshift of Type Ia supernovae suggest an accelerating expansion of space. The acceleration is justified by assuming the presence of an unknown dark energy working against gravitation at cosmological distances. The assumption of dark energy is equivalent to Einstein's cosmological constant, which he originally proposed to prevent a collapse of spherically closed space which he assumed to be static. If Einstein's spherically closed space, the surface of a 4-sphere, is allowed to expand in a zero energy balance between the energies of motion and gravitation, no cosmological constant or dark energy is needed. In a thorough analysis of such expansion, the apparent magnitude, m, versus redshift, z, obtains the form $m = M_0 + 5 \log z + 2.5 \log (z+1)$, which completely agrees with the Type Ia supernovae observations [1,2]. Due to the assumed spherical geometry and the zero energy balance, the obtained magnitude prediction is absolute in its nature; it has no free parameters like Ω_m, Ω_λ, or the Hubble constant H_0 that are needed in the corresponding equation derived from the standard cosmology model. In space, described as a dynamic 4-sphere, the fourth dimension is geometrical in its nature, allowing a universal time coordinate. The velocity of light becomes directly linked to the velocity of space in the direction of the 4-radius and the rest energy of mass gets the meaning of the energy of motion mass possesses mass due to the expansion of space. As further consequences of the zero-energy balance, buildup of mass centers in space result in local bending of space allowing solutions of the perihelion advance of planetary orbits, the bending of light and the Shapiro delay in closed mathematical form. The characteristic absorption and emission frequencies of atomic objects become linked to local motion and gravitation, which means that the concept of proper time is replaced by a direct effect of motion and gravitation on the frequencies of atomic oscillators. In dynamic spherical space the well known equality between the total gravitational energy and the rest energy of mass in space reflects the zero energy balance driving the expansion of spherically closed space.

Keywords: Dark energy, expansion of space large-scale structure of universe, cosmological parameters, distances and redshifts, observations

1. INTRODUCTION

In the early 1900's when the theory of relativity was formulated the view of the structure of space was quite limited. The expansion of space had not been detected and the galactic structures were unknown. It was natural to think space as static entity without a specific center or a universal reference at rest. When Einstein in 1917 published his view of the cosmological structure of space as the "surface" of a 4-sphere, he needed the famous cosmological constant to prevent a collapse of space into singularity [3].

In static space the interpretation of the observed constancy of the velocity of light led to a spacetime concept with a time-like fourth dimension and variable distance and time coordinates characterized as proper time and proper distance. Dilated time was explained as a consequence of the velocity the object relative to the observer, and through a curved spacetime, a property of the spacetime geometry.

If spherically closed space is allowed to contract and expand in a zero-energy balance of motion and gravitation, the Einsteinian time-like fourth dimension becomes replaced by a purely metric dimension in the direction of the motion of space along the 4-radius of the structure. The center of symmetry and the reference at rest for the expansion and contraction of spherically closed space is in the center of the 4-sphere. Expansion of spherically closed space does not create motion within space; the momentum of the expansion appears only in the direction of the 4-radius perpendicular to all space directions. The related energy of motion appears as the rest energy of matter in space. In a kinematic sense,

The Nature of Light: What is a Photon?, edited by Chandrasekhar Roychoudhuri, Catherine Creath, Al F. Kracklauer, Proceedings of SPIE Vol. 5866 (SPIE, Bellingham, WA, 2005) · 0277-786X/05/$15
doi: 10.1117/12.621065

homogeneous expansion of the 4-sphere is observed as recession of objects in space at a velocity proportional to their distance from the observer.

Closed spherical space gives an essentially more ordered picture of our universe and the prevailing laws of nature than does the standard cosmology model and the relativity theory behind it. Instead of a sudden appearance in a big bang, the buildup and release of the energy of matter in space can be described as a continuous process from infinity in the past through singularity to infinity in the future. Following the zero energy principle, any expression of energy in space becomes related to the energetic state of whole space through a chain of cascaded systems.

2. ZERO-ENERGY BALANCE IN A 4-SPHERE

In spherically closed space a natural solution is not static space but space subject to contraction and expansion. Dynamics based on a zero-energy principle shows the rest energy of matter as the energy of motion mass has due to the contraction or expansion of space in the fourth dimension, in the direction of the 4-radius. As a consequence of the conservation of the primary energy created in the contraction-expansion process, the velocity of space in the fourth dimension sets the upper limit to velocities obtainable in space. The "great mystery" of the equality of the rest energy and the gravitational energy of all mass in space is a direct indication of the zero-energy balance of motion and gravitation in space [4].

In contraction, started from the state of rest at infinity in the past, motion is gained against release of gravitational energy. In expansion, motion works against gravitation resulting in gradual deceleration of expansion until rest at infinity (see Figure 1).

A detailed analysis of the intrinsic forms of the energies of motion and gravitation in a homogeneous 4-shere allows the expression of the zero energy condition as

$$M_{\Sigma}c_4^2 - \frac{GM_{\Sigma}M''}{R_4} = 0 \qquad (1)$$

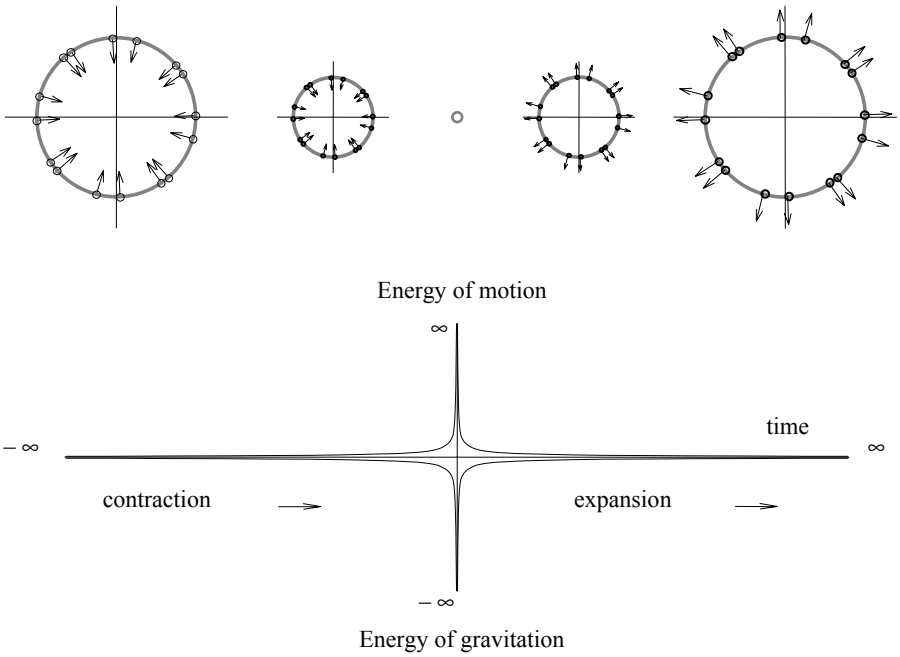

Figure 1. Energy buildup and release in spherical space. In the contraction phase, the velocity of space in the direction of the 4-radius increases due to the energy gained from loss of gravitation. In the expansion phase, the velocity gradually decreases, while the energy of motion gained in contraction is returned to gravity.

where G is the gravitational constant, c_0 is the velocity in the direction of the radius R_4 of the 4-sphere, and $M'' = I_g \cdot M_\Sigma$ is the mass equivalence of the total mass M_Σ in space. The factor $I_g = 0.776$ comes from the integration of the gravitational energy of a 4-sphere. Equation (1) links the velocity of the contraction or expansion along the 4-radius R_4, to the gravitational constant, the total mass in space, and the 4-radius as

$$c_4 = \pm\sqrt{\frac{GM''}{R_4}} = \pm\sqrt{\frac{GI_g M_\Sigma}{R_4}} \tag{2}$$

Applying a mass density $\rho \approx 0.55 \cdot \rho_c$, where ρ_c is the Friedmann critical mass density, 4-radius $R_4 = 14 \cdot 10^9$ light years (present estimate of the Hubble radius), and the gravitational constant $G = 6.7 \cdot 10^{-11}$ [Nm^2/kg^2] equation (2) gives $c_0 = 300\,000$ km/s which is equal to the present velocity of light. Conservation of energy in interactions in space requires that the maximum velocity obtainable in space is equal to the expansion velocity c_4, which confirms the interpretation of $c_0 = c_4$ as the velocity of light in hypothetical homogeneous space. It also confirms the interpretation of the rest energy as the energy of motion mass has due to the motion of space in the direction of the 4-radius.

When solved for time t since singularity, the expansion velocity, and the velocity of light in space obtains the form

$$c_0 = \frac{dR_4}{dt} = \left(\frac{2}{3}GM''\right)^{1/3} t^{-1/3} \tag{3}$$

Time t from singularity can be expressed as

$$t = \frac{2}{3}\frac{R_4}{c_0} \tag{4}$$

which means that for a Hubble radius of 14 billion light years [corresponding to Hubble constant $H_0 = 70$ [(km/s)/Mpc], the age of the expanding universe since singularity is 9.3 billion years.

3. UNIFIED EXPRESSIONS OF ENERGY

Following the zero-energy principle in the buildup of mass centers in space, the velocity of free fall of mass becomes related to the velocity of space in the fourth dimension. In order to conserve the total energy of motion, local space becomes tilted resulting in a reduction in the momentum in the local fourth dimension and the locally available rest energy of matter. Accordingly, the velocity of free fall in space is obtained against a reduction of the velocity of space in the local fourth dimension, which also means that the velocity of light is a function of the tilting angle and, accordingly, the gravitational potential and the distance from a local mass center (see Figure 2).

Due to the nature of the rest energy of matter as the energy of motion due to the motion in space, mass should not be considered as a form of energy but, instead, the substance for the expression of energy. Such an approach leads to unified expressions of energy and relates all forms of the energy of matter to the energy matter has at rest in hypothetical homogeneous space expanding at velocity c_0.

In a detailed analysis of free fall, it can be shown that in space expanding at velocity c_0 in the direction of the 4-radius the kinetic energy obtained in free fall by conserving the total energy of motion is

$$E_{kin(esc)} = c_0 m\left(c_{0\delta} - c_\delta\right) = c_0 m\Delta c \tag{5}$$

where $c_\delta = c$ is the velocity of light = the velocity of space in the local fourth dimension in tilted space and c_0 is the velocity of space along the 4-radius in non-tilted space (see Figure 2). Local rest energy in tilted space obtains the form

$$E = c_0 m c_\delta = c_0 m c \tag{6}$$

Buildup of kinetic energy by conserving the zero energy balance at a constant gravitational potential, where the velocity of light c is unchanged obtains the form

$$E_k = c_0\left(m_{eff} - m\right)c = c_0 \Delta m \cdot c \tag{7}$$

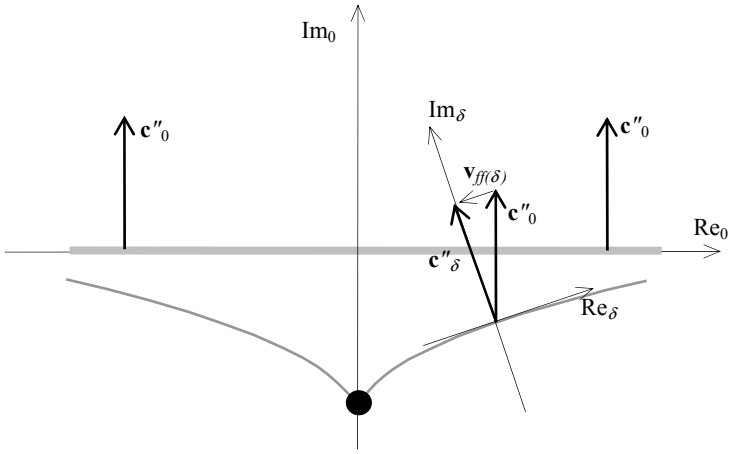

Figure 2. As a consequence of the conservation of the primary energies of motion and gravitation, the buildup of a mass center in space bends spherical space locally causing a tilting of space near a mass center. The local imaginary axis is always perpendicular to local space. As a consequence, the local imaginary velocity of space, and accordingly the local velocity of light, is reduced in tilted space.

which is equal to the expression of the kinetic energy in the theory of special relativity, but for a completely different reason than that taught by relativity theory.

The source for the increased mass (the buildup of effective mass) in equation (7) may be Coulomb energy which, by applying the vacuum permeability μ_0 rather than the vacuum permittivity ε_0, obtains the form

$$E_{\mathrm{EM}} = -\frac{q_1 q_2 \mu_0}{4\pi r} c_0 c = -c_0 m_{\mathrm{EM}} c \tag{8}$$

where the m_{EM} is denoted as the mass equivalence of electromagnetic energy with the dimensions of kilogram [kg]. Comparison of equation (8) with equations (5 – 7) shows the unified expression of the kinetic energy in space the rest energy and the Coulomb energy.

"Free fall" of a charged particle from distance r_1 to r_2 in Coulomb field releases the energy

$$\Delta E_{\mathrm{EM}} = -\frac{q_1 q_2 \mu_0}{4\pi}\left(\frac{1}{r_1} - \frac{1}{r_2}\right) c_0 c = -c_0 \Delta m_{EM} c \tag{9}$$

which now obtains the form of mass release from the Coulomb field to the kinetic energy of the object accelerated (see equation (7).

We can extend the unified expression of energy to the energy of electromagnetic radiation by first solving for the minimum dose of electromagnetic radiation as the energy of radiation emitted by a single oscillation cycle of a unit charge in a dipole of length z_0. Following the standard procedure of solving Maxwell's equations, and again [, by X] applying the vacuum permeability μ_0 rather than the vacuum permittivity ε_0, we obtain

$$E_\lambda = \frac{P}{f} = \frac{e^2 z_0^2 \chi \mu_0 16\pi^4 f^4}{12\pi c f} = \left(\frac{z_0}{\lambda}\right)^2 \frac{2}{3}\left(2\pi^3 e^2 \mu_0 c_0\right) f \tag{10}$$

which essentially has the form of Planck's equation $E = hf$.

In dynamic space moving at velocity c in the fourth dimension, a point source like an emitting atom can be considered as a dipole in the fourth dimension. In one cycle, a point source at rest in space moves the distance of one wavelength the fourth dimension perpendicularly to all space directions. For a point source all space directions are in the "normal

plane" of the dipole, which eliminates the power density factor 2/3 in equation (10). The energy emitted by a single transition of a unit charge in a point source can thus be solved as emission from one wavelength dipole ($z_0 = \lambda$) as

$$E_\lambda = \chi_\lambda \cdot 2\pi^3 e^2 \mu_0 c_0 \cdot f = hf = h_0 fc = \frac{h_0}{\lambda} c_0 c = m_\lambda c_0 c \tag{11}$$

where χ_λ is a dimensionless factor that includes a possible geometrical factor due to the fourth dimension and the ratio of the velocity of light in hypothetical homogeneous space c_0 to the local velocity of light c on the Earth, where the value of the Planck constant h has been defined. Factor χ_λ can be solved in the form

$$\chi_\lambda = \frac{h}{2\pi^3 e^2 \mu_0 c} \frac{c}{c_0} = \frac{6.626068765 \cdot 10^{-34}}{5.99695618 \cdot 10^{-34}} \frac{c}{c_0} \approx 1.1049 \tag{12}$$

In equation (11), $m_\lambda = h_0/\lambda$, is the mass equivalence of electromagnetic radiation with dimensions of kilogram [kg], and $h_0 = h/c$ is the intrinsic Planck constant independent of the velocity of light. Application of the intrinsic Planck constant h_0 allows a unified format for the energy of a quantum (the energy of one cycle of radiation emitted by a single electron transition in a point source)

$$E_\lambda = hf = h_0 f c_0 = \frac{h_0}{\lambda} c c_0 = m_\lambda c c_0 \tag{13}$$

By applying equations (10) and (11), the fine structure constant obtains the form

$$\alpha \equiv \frac{e^2 \mu_0 c}{2h} = \frac{e^2 \mu_0 c}{2 \cdot 1.1049 \cdot 2\pi^3 e^2 \mu_0 c} \approx \frac{1}{1.1049 \cdot 4\pi^3} \approx 7.2973 \cdot 10^{-3} \approx \frac{1}{137} \tag{14}$$

which show the fine structure constant as a purely mathematical, dimensionless constant without connections to any physical constants. Applying the fine structure constant to the Coulomb energy for unit charges $q_1 = q_2 = e$ in equation (8), the Coulomb energy obtains the form

$$E_{\mathrm{EM}(0)} = -\frac{e^2 \mu_0}{4\pi r} c_0 c = -\alpha \frac{h_0}{2\pi r} c_0 c = -c_0 m_{\mathrm{EM}(0)} c \tag{15}$$

which demonstrates the close connection between the Coulomb energy and the energy of electromagnetic radiation.

As a consequence of the conservation of energy in free fall in the buildup of mass centers in space, the local velocity of light is found to be a function of the local gravitational potential. In a detailed analysis taking into account the chain of inbuilt cascaded gravitational systems (mass centers) in space, the local velocity of light in the n:th gravitational frame can be expressed as

$$c = c_0 \prod_{i=1}^{n} (1 - \delta_i) \tag{16}$$

where the gravitational factors δ_i can be expressed as

$$\delta_i = \frac{M_i}{M''} \frac{R''}{r_i} = \frac{GM_i}{c_0 c\, r_i} \approx \frac{GM_i}{r_i c^2} \tag{17}$$

where M_i is the central mass of the local system i, and r_i is the distance to the barycenter of the system.

Conservation of energy in the buildup of kinetic energy in local energy systems in a constant gravitational potential is expressed via the transfer of mass from the potential energy of the system to the object accelerated. Such an energy transfer occurs through the buildup of momentum in a space direction. As a part of the conservation of the zero energy balance in space, the buildup of momentum in space reduces the momentum of the object in the fourth dimension. This is described as a reduction of the internal mass of the moving object. An implication of the energy conservation is that the product of the effective mass and the internal mass is conserved. Internal mass reduces the momentum balancing the gravitational force by all mass in space on the moving mass object. In other words, the overall conservation of energy

means that "expression of energy through motion in space reduces the energy the object expresses in the fourth dimension", which also means a quantitative expression of the Mach's principle.

As a demand of the energy balance of an object moving in a local energy system n, the internal mass of the object obtains the form

$$m_I = m\sqrt{1-\beta_n^2} \quad m_{I(n)} = m\sqrt{1-\beta_n^2} \tag{18}$$

where m is the rest mass and β_n the velocity of the object in the local system. The rest mass is subject to a similar reduction due to the motion of the local system in its parent system and, further, due the motions of the parent systems in their parent systems as

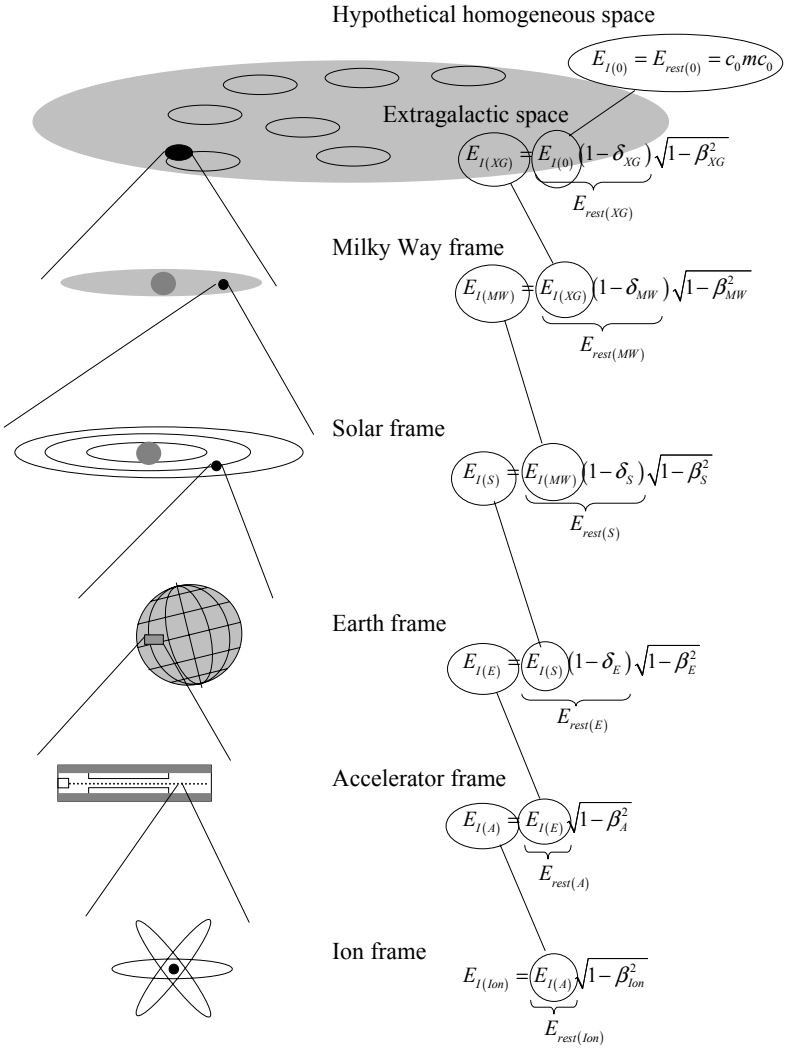

Figure 3. The rest energy of an object in a local frame is determined by the internal energy of the local frame in its parent frame. The internal energy is the imaginary component of the rest energy. The system of cascaded energy frames relates the internal energy of an object in a local frame to the rest energy of the object in hypothetical homogeneous space.

$$m = m_0 \prod_{i=1}^{n-1} \sqrt{1-\beta_i^2} \tag{19}$$

where m_0 is the rest mass of the object at rest in hypothetical homogeneous space.

By applying equations (16) and (19) the rest energy of mass m in a local energy frame can be expressed as

$$E = c_0 mc = mc_0^2 \left(1-\delta_n\right) \prod_{i=1}^{n-1} \left(1-\delta_i\right) \sqrt{1-\beta_i^2} \tag{20}$$

As a consequence of the conservation of the total energy in closed dynamic space, the rest energy of mass objects appears as a function of the gravitational state and motion of the object. Motion *of* a local energy system reduces the rest energy available for mass *in* the local system (see Figure 3).

4. THE EFFECT OF MOTION AND GRAVITATION ON CHARACTERISTIC FREQUENCIES

By applying the intrinsic Planck constant defined in equation (13), the standard non-relativistic expression of the energy states of electrons in a hydrogen-like atom solved from Schrödinger's equation can be expressed in form

$$E_{Z,n} = \frac{e^4 \mu_0^2}{8h_0^2} \left(\frac{Z}{n}\right)^2 c_0 m_e c = \frac{\alpha^2}{2} \left(\frac{Z}{n}\right)^2 E_e \tag{21}$$

where E_e is the rest energy of an electron in the nucleus energy frame. With reference to equation (20), the energy states of hydrogen-like atoms are functions of the gravitational state and motion of the atom. By applying equations (20) and (21), Balmer's formula for the characteristic frequencies of hydrogen-like atoms obtains the form

$$f_{(n1,n2)} = \frac{\Delta E_{(n1,n2)}}{h_0 c_0} = Z^2 \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] \frac{\alpha^2}{2h_0} m_e c = f_{0(n1,n2)} \prod_{i=1}^{n} \left(1-\delta_i\right) \sqrt{1-\beta_i^2} \tag{22}$$

where factors δ_i and β_i define the state of gravitation and motion of the atom

$$f_{0(n1,n2)} = Z^2 \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] \frac{\alpha^2}{2h_0} m_{e(0)} c_0 \tag{23}$$

where c_0 is the expansion velocity of hypothetical homogeneous space, and $m_{e(0)}$ is the mass of an electron at rest in hypothetical homogeneous space. As shown by equations (22) and (23), the characteristic frequency of a specific transition in an atom is a function of both the state of motion and gravitation of the atom.

Equation (22) combines the coordinate time scales in different frames like the Earth Centered Inertial Frame applied in satellite systems and the Solar Barycenter Frame applied in observations in the solar system and extends the coordinate time structure from hypothetical homogeneous space to local laboratory frames on the rotating Earth and anywhere in space.

Because the expansion velocity of space is subject to a gradual decrease with the expansion of space, the reference frequency $f_{0(n1,n2)}$ in equation (23) declines with time as

$$f_{n1,n2} = \frac{\alpha^2 m_{e(0)}}{2h_0} \left(\frac{2GM''}{3}\right)^{1/3} Z^2 \left[\frac{1}{n_1} - \frac{1}{n_2}\right] \cdot t^{-1/3} \tag{24}$$

where G is the gravitational constant and M_Σ is the total mass in space. As shown by equation (22), the characteristic frequency is directly proportional to the local velocity of light, c, which means that in local measurements based on atomic clocks, the velocity of light is observed as constant.

When solved for characteristic wavelength, Balmer's formula obtains the form

$$\lambda_{(n1,n2)} = \frac{c}{f_{(n1,n2)}} = \frac{\lambda_{0(n1,n2)}}{\prod_{i=1}^{n}\sqrt{1-\beta_i^2}} \tag{25}$$

where

$$\lambda_{0(n1,n2)} = \frac{c_0}{f_{0(n1,n2)}} \tag{26}$$

Accordingly, the characteristic wavelength is subject to an increase due to the motion of the emitting atom, but it is not affected by the gravitational state (or the velocity of light).

The reduction of the frequencies of atomic clocks in motion is a consequence of the energetic state, the state of gravitation and motion (velocity) of the clock. The frequency is neither a function of the velocity of the clock relative to an observer nor a function of the acceleration the clock. There is no place for the Lorentz transformation or the equivalence principle in the Dynamic Universe.

All energetic states in space are related to the reference at rest in hypothetical homogeneous space. The unified expressions of energy apply in all local frames in space and manifest the zero energy principle as a universal law of nature. There is no place for the principle of relativity in the Dynamic Universe.

5. COSMOLOGICAL APPEARANCE OF SPHERICALLY CLOSED SPACE

As a consequence of the identical velocities of space along the 4-radius and electromagnetic radiation in space, the optical distance D, which is the distance traveled by light from object A_1 to object B in space (the tangential component of the path), is equal to the corresponding change of the radius (see Figure 4). The wavelength of electromagnetic radiation propagating in expanding space is subject to an increase in direct proportion to the expansion of space. In spherically closed space the Hubble law obtains the form

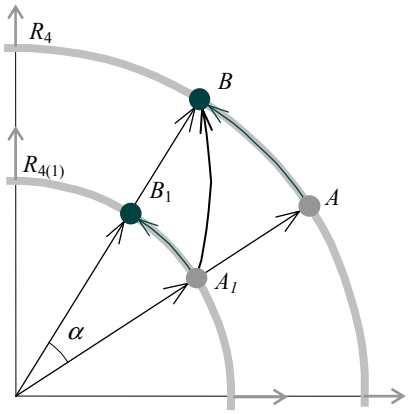

Figure 4. Propagation of electromagnetic radiation from object A_1 in Universe state $R_{4(1)}$ to object B in Universe state R_4.

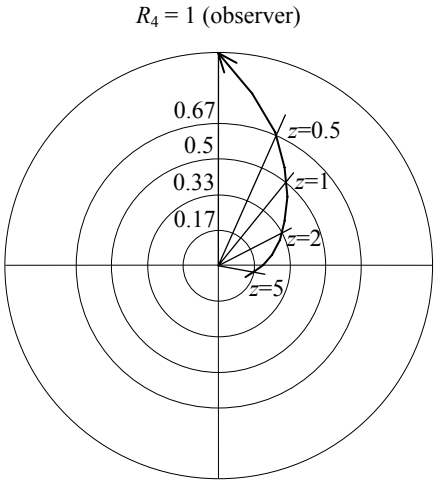

Figure 5. The length of the R_4 radius and the location of objects for redshifts $z = 0$ to 5. Location $R_4 = 1$ is the observer's location. The optical distance to the object is the tangential length of the path, which is equal to the difference between the present R_4 radius and the R_4 radius as it was when the light was emitted. For example, the light emitted at $R_4 = 0.17$ in the drawing is redshifted by $z = 5$ after traveling the distance $D = (1–0.17)R_4 = 0.83 \cdot R_4$ in expanding space.

$$z = e^{\alpha} - 1 = \frac{D}{R_4} e^{\alpha} = \frac{D/R_4}{1 - D/R_4} \tag{27}$$

where α is the distance angle of the object relative to the 4-center of space (see Figure 4). The maximum optical distance of an object in space is $D = R_4$. Figure 5 illustrates the development of the optical path and the redshift from objects at different R_4 radii of space.

The optical angle θ subtended by an object can be expressed as the ratio of a standard rod r_s and the optical distance. When normalized to (r_s/R_4), we get

$$\frac{\theta_{\mathrm{DU(rod)}}}{r_s/R_4} = \frac{z+1}{z} \tag{28}$$

(see Figure 6). The observation angle of expanding objects obtains the Euclidean form

$$\frac{\theta_{\mathrm{DU(exp.obj.)}}}{r_s/R_4} = \frac{1}{z} \tag{29}$$

The prediction of equation (29) is strongly supported by observations of angular sizes of radio sources (see Figure 7).

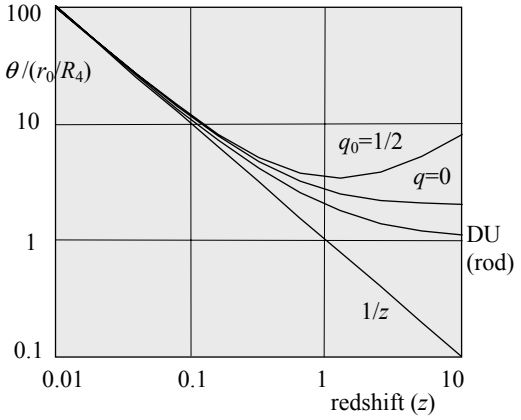

Figure 6. Normalized observation angle of a standard rod as a function of redshift in the DU model and in the standard model with expansion parameter q_0 as $q_0 = ½$ and $q_0 = 0$. The reference line $1/z$ shows the observation angle of the standard rod in Euclidean space. For objects expanding in space, the prediction for the observation angle obtains the Euclidean $1/z$ form.

DU: $\dfrac{\theta_{\mathrm{DU(rod)}}}{r_s/R_4} = \dfrac{z+1}{z}$; $\dfrac{\theta_{\mathrm{DU(exp.obj.)}}}{r_s/R_4} = \dfrac{1}{z}$

Standard cosmology:

$$\frac{\theta_{\mathrm{F}}}{(r_s/R_H)} = \frac{q_0^2 (z+1)^2}{q_0 z + (q_0 - 1)\left(-1 + \sqrt{1 + 2q_0 z}\right)}$$

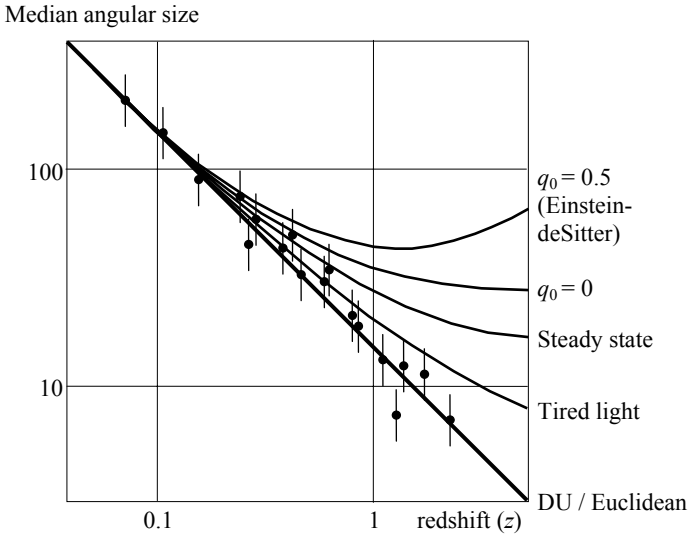

Figure 7. Comparison of equation (29) with the predictions of the standard cosmology model for various q_0 values (without evolution) and the tired light model [A. Sandage: The Deep Universe, original data for the median angular sizes (arcsec) and redshifts for radio-sources by Kapahi's (1987)]. The prediction given by equation (29) is the straight line with Euclidean appearance showing a considerable match with observations.

As a major difference from the standard cosmology model, in the Dynamic Universe the orbital radii of local gravitational systems are subject to the expansion of space. The radii of planetary systems as well as the radii of galaxies expand in direct proportion to the expansion of the 4-radius R_4. Accordingly, out of the 3.8 cm annual increase of the Earth to Moon distance 2.8 cm comes from the expansion of space and only 1 cm comes from tidal effects.

Dilution of the rest energy of matter with the decreasing velocity of light in expanding space means that the rate of all internal atomic processes slows down with the expansion. Also, the rate of radioactive decay decreases with the expansion, which means that the results of radioactive dating shall be corrected for higher decay rate in the past. As demonstrated in Figure 8, the 14 billion year result produced by dating assuming a constant decay rate is reduced to about 9 billion years when taking into account the decreasing decay rate. The reduction solves the currently recognized problem of the age of the oldest stars apparently exceeding the age of expanding space.

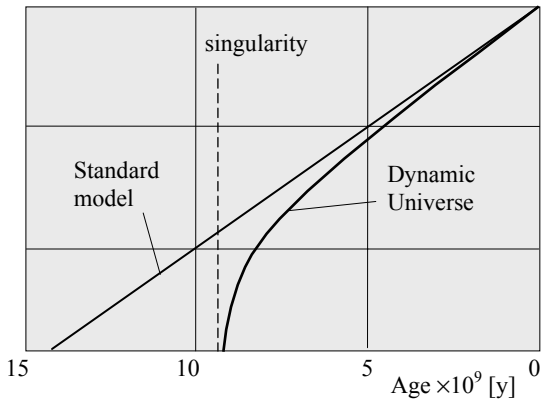

Figure 8. Accumulation of decay products according to the standard model with a constant decay rate and the DU model with a decreasing decay rate.

Perhaps the most striking recent cosmology observation is the magnitude versus redshift of supernova explosions [5,6,7]. When interpreted with the standard cosmology model, the observations mean that the expansion of space is accelerating instead of decelerating as could be expected due the work done against gravitation. To motivate the acceleration, dark energy in the form of Ω_λ has been added to the expression of the apparent magnitude in the standard model

$$m = M + 5\log\left[\frac{c(1+z)}{H_0}\int_0^z \frac{1}{\sqrt{(1+z)^2(1+\Omega_m z) - z(1+z)\Omega_\lambda}}\,dz\right] + 25 \tag{30}$$

In the Dynamic Universe, the expression of the apparent magnitude obtains the form

$$m = M_0 + 5\log z + 2.5\log(z+1) \tag{31}$$

which, agrees with observations at least as well as the standard model with optimized Ω_m, Ω_λ, and H_0. The excellent fit of equation (31) lends strong support to the zero energy balance of closed spherical space (see Figure 9) [8]. In equation (31) the only parameter is the reference magnitude M_0, whereas in the standard cosmology prediction (30) there are, additionally, two density parameters and the Hubble constant as parameters to be optimized.

In spherically closed space, the background radiation appears as radiation propagated trough a full 360° path around the expanding sphere. With reference to equation (27), the redshift of background radiation is

$$z = e^{2\pi} - 1 = 534.5 \tag{32}$$

The 4-radius of space at the time of the emission of the background radiation was $R_{4(0)} = R_4/535.5 \approx 26$ million light years, which occurred about 750 000 years after the singularity.

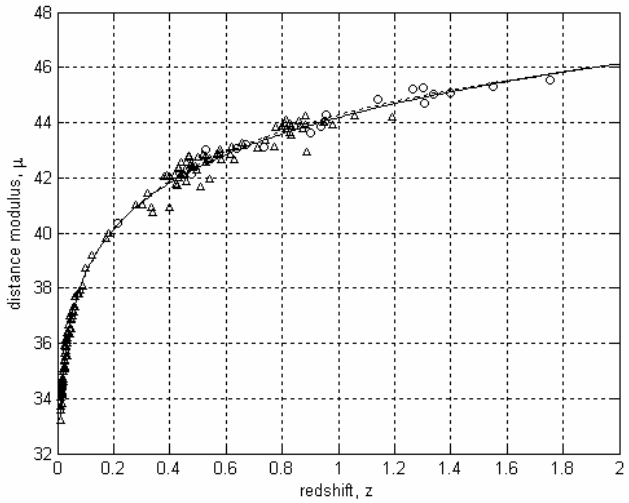

Figure 9. Distance modulus $\mu = m - M$, vs. redshift for Riess et al's gold dataset and the data from the Hubble Space Telescope (HST). The triangles represent data obtained via ground-based observations, and the circles represent data obtained by the HST. The optimum fit for the standard cosmology equations is shown by the dashed line, and the fit for the equation (31)

$m = M_0 + 5 \log z + 2.5 \log (z + 1)$

is shown, slightly below, by the solid line [8].

6. SUMMARY

Some important physical and cosmological consequences of the zero energy balance in spherically closed space can be summarized as follows:

- Universal, absolute time applies to all phenomena in space.
- A local state of rest is a property of a local energy system instead of a property of an inertial observer.
- The rest energy of matter is the energy of motion mass possesses due to the motion of space in the fourth dimension; conservation of the total rest energy in interactions in space relates any state of motion in space to the state of rest in hypothetical homogeneous space.
- The buildup and release of the rest energy of matter can be described as a zero energy process from infinity in the past through singularity to infinity in the future.
- The characteristic emission and absorption frequency due to an electron transition in atomic objects is a function of the velocity and gravitational potential of the atom in the local energy system and the parent systems; as a consequence, coordinate time scales in cascaded gravitational frames and proper times in systems of motion can all be linked to universal absolute time.
- Electromagnetic resonators can be studied as closed energy systems; as an implication, Michelson–Morley type experiments in moving frames show a zero result.
- Precise predictions for Shapiro-delay, perihelion advance of planetary orbits and the bending of light path near mass centers can be expressed in closed mathematical form
- The annual Doppler shift of pulsars, the Roemer–effect, and the aberration of starlight get their natural solutions.
- The radii of local gravitational systems expand in direct proportion to the expansion of the 4-radius of space.
- Distant space is observed in Euclidean geometry (e.g. the angular sizes of radio sources).
- The prediction derived for the magnitude versus redshift of a standard emission source gives a perfect fit to recent supernova observations without an assumption of dark energy [8].
- The age of expanding space obtains the form $t = 2/3\ R_4/c$.
- Age estimates obtained by radioactive dating are reduced due to the higher decay rate in the young universe (the decay rate is inversely proportional to $t^{1/3}$).

– The expansion of space continues to infinity; the energy of matter, material, and radiation diminishes in the course of the expansion until it becomes zero at infinity, thus completing the cycle of observable physical existence.

ACKOWLEDGEMENTS

The presentation of this paper in the symposium "The Nature of Light: What is a Photon?" in SPIE conference in San Diego 2005 has been supported by the Foundation of the Finnish Society of Electronics Engineers. The author expresses his gratefulness to the Foundation and the Society. Acknowledgement is also due to Bob Day for his outstanding analysis of the magnitude versus redshift data of supernova observations.

REFERENCES

1. Tuomo Suntola, *Theoretical Basis of the Dynamic Universe*, ISBN 952-5502-1-04, 290 pages, Suntola Consulting Ltd., Helsinki, 2004
2. Tuomo Suntola, "*Dynamic space converts relativity into absolute time and distance*", Physical Interpretations of Relativity Theory IX (PIRT-IX), London, 3-9 September 2004
3. Einstein, A., *Kosmologische Betrachtungen zur allgemeinen Relativitätstheorie*, Sitzungsberichte der Preussischen Akad. d. Wissenschaften (1917)
4. Feynman, R., Morinigo,W., Wagner,W., Feynman Lectures on Gravitation (during the academic year 1962-63) , Addison-Wesley Publishing Company (1995), p. 10]
5. Perlmutter et al., "Measurements of Omega and Lambda from 42 High-Redshift Supernovae", 1999, Astrophys.J., 517, 565 (astro-ph/9812133)
6 Knop et al., "New Constraints on Omega_M, Omega_Lambda, and w from an Independent Set of Eleven High-Redshift Supernovae Observed with HST", 2003, Astrophys.J., 598, 102 (astro-ph/0309368)
7. Riess et al., "Type Ia Supernova Discoveries at z > 1 From the Hubble Space Telescope: Evidence for Past Deceleration and Constraints on Dark Energy Evolution", Astrophys.J., 2004, 607, 665-687 (astro-ph/0402512)
8. Tuomo Suntola and Robert Day, "Supernova observations fit Einstein-deSitter expansion in 4-sphere", arXiv / astro-ph/0412701 (2004)